2023 International Conference on the Cooperation and Integration of Industry, Education, Research, and Application(Shenyang)

Subject Forum “Low-Carbon Green Development and Engineering Thermochemistry”

Sponsors: Ministry of Education of the People's Republic of China
The People's Government of Liaoning Province

Organizers: Educational Department of Liaoning Province
Shenyang University of Chemical Technology

Shenyang • China

September 14-15, 2023

2023 International Conference on the Cooperation and Integration of Industry, Education, Research and Application

Subject Forum "Low-Carbon Green Development and Engineering Thermochemistry"

September 14-15, 2023; Shenyang, China

With the guidance of the Ministry of Education of China and the local governments involved, the International Conference on the Cooperation and Integration of Industry, Education, Research, and Application has been successfully held for four years since 2018 and attracted high attention from the attendees worldwide. In order to further meet the cooperation needs of all parties, and enlarge the benefits of the conference, the National Center for Schooling Development Program (CSDP) will promote the 2023 International Conference on the Cooperation and Integration of Industry, Education, Research and Application from September 14th to 15th, via a hybrid mode combining the in-person and online meetings. Representatives from Chinese and international universities and colleges, enterprises, and research institutes are invited to join the in-depth exchanges and discussions about cooperation.

Shenyang University of Chemical Technology is responsible for hosting the subject forum No. 4 on "**Low-carbon green development and engineering thermochemistry**". Because of the highly honored achievement and reputation of your institution in the related fields, we sincerely invite you and also the experts of your institution to attend the subject forum No. 4 of the Conference.

Forum Chair:

Guangwen Xu President, Professor, FREng

Shenyang University of Chemical Technology

Attachment 1: Conference Arrangement
Attachment 2: Introduction of Lecturers
Attachment 3: Abstracts of Lectures

Attachment 1:

Subject Forum "Low-Carbon Green Development and Engineering Thermochemistry" Arrangement

1. Sponsorship and Organization

Sponsors: Ministry of Education of China

People's Government of Liaoning Province

Coordinator: National Center for Schooling Development Programme

Organizers: Educational Department of Liaoning Province

Shenyang University of Chemical Technology

2. Participants

Experts, scholars, research teams, and young scholars from universities and research institutes in all countries, such as Russia, Ukraine, Belarus, the United States, Britain, etc.; Experts and scholars from related universities and research institutes in China, and representatives from relevant companies and enterprises. Participants can attend the Conference via either in-person or online mode. No registration fee is required.

3. Date, Location and Zoom Information

Date: September 14-15, 2023

Location: Opening ceremony of the Conference (Morning of Sep. 14): Banquet Hall on the Second Floor of NEU International Hotel (No.80, Wenti West Road, Heping Distract, Shenyang);

14 日上午 大会开幕式在东北大学国际学术交流中心二层宴会厅

Subject forum No. 4 (Sep. 14 afternoon-15): Shenyang University of Chemical Technology Academic Lecture Hall (11th Street, Economic and Technological Development Zone, Shenyang)

14 日下午-15 日 分论坛 4 在沈阳化工大学校部学术报告厅

Zoom: Meeting ID: 810 5418 8125　　Passcode: 888

4. Accommodation

Voda Garden Hotel （沃达花园酒店）

Address: 126 Shenliao West Road, Economic and Technological Development Zone, Shenyang

5. Live broadcast

You are also welcome to scan the QR code below to join our conference via Tiktok or WeChat.

Tiktok

WeChat

6. Forum Agenda

September 14, 2023 Lecture time includes 5 min for questions				
Time	**Lecturer**	**Institution**	**Lecture**	**Chair**
09:30-11:30	Opening Ceremony of 2023 International Conference on the Cooperation and Integration of Industry, Education, Research and Application			
11:30-14:00	Launch and rest			
Subject Forum "Low-Carbon Green Development and Engineering Thermochemistry"				
14:00-14:10	Director	Educational Department of Liaoning Province	Welcome speech	Guangwen Xu
14:10-14:50	Huiming Cheng	Shenzhen Advanced Technology Research Institute, Chinese Academy of Sciences Professor, CAS member	Repairing and upcycling of electrode materials from spent lithium ion batteries	
14:50-15:30	Xiaonian Li	Zhejiang University of Technology (ZUT) Professor, FCAE, Former President of ZUT	Industrial Catalyst Technology for Chemical Manufacturing	
15:30-16:10 (08:30-09:10 UK)	Yulong Ding	The University of Birmingham, UK Professor, FREng	Thermochemcial-based in-process CO_2 splitting for steelmaking decarbonisation	
16:10-16:30	Coffee break & Photographing			
16:30-17:10 (09:30-10:10 UK)	Raffaella Ocone	Heriot-Watt University, UK Professor, FREng	Technologies Making Hydrogen Happen	Xiaonian Li

17:10-17:40 (10:10-10:40 UK)	Ondřej Mašek	University of Edinburgh, UK Professor, Editor of RCM	Integration of biochar production with other biomass applications	
17:40-18:10 (10:40-11:10 UK)	Hyungwoong Ahn	University of Edinburgh, UK Senior lecture	PSA-SPUR: An Advanced Adsorption Process for Heavy Component Recovery and Its Application for On-board Carbon Capture	
Dinner and rest				
September 15, 2023 Lecture time includes 5 min for questions				
08:30-09:00 (08:30-09:00pm,Sep 14,CA)	Xiaotao Bi	The University of British Columbia, Canada Professor, FCAE	Thermo-catalytic conversion of biomass residues to biofuels under microwave irradiation	Dingrong Bai
09:00-09:30 (10:00-10:30 JP)	Koyo Norinaga	Nagoya University, Japan Professor, director	Challenges and perspectives in a new direct air capture (DAC) process	
09:30-10:00	Qinhui Wang	Zhejiang University Professor, director	Development on Biomass combustion and gasification technologies based on fluidized bed process	
10:00-10:20	Coffee break & Photographing			
10:20-10:50	Yizhuo Han	Institute of Coal Chemistry, Chinese Academy of Sciences Professor, director	Influence of regulation of the surface oxygen species on Ni-based catalyst on reaction behavior of CH_4-CO_2 reforming and carbon deposition	Shicheng Zhang

10:50-11:20 (10:50-11:20 AUS)	Hongwei Wu	Curtin University, Australia Professor, Editor-in-Chief of Energy & Fuels	Ternary Phase Diagram of Pyrolytic Lignin, Mixed Solvent and Water as a Tool for Phase Stability Predication and Control of Bio－oil from Biomass Fast Pyrolysis	
11:20-12:00	Guangwen Xu	Shenyang University of Chemical Technology President, FREng	Engineering thermochemistry to cope with challenges in carbon neutrality	
12:00-13:30	Launch and rest			
13:30-14:00	Xiaogang Hao	Taiyuan university of technology Professor, director	PVFC coupling system for recovering high-boiling point organics with high-purity from aqueous solutions	Hui Li
14:00-14:30 (08:00-08:30 FR)	Anthony Dufour	University of Lorraine, France Professor, director	An overview on engineering thermochemistry in CNRS. Nancy, France	
14:30-15:00	Huiyan Zhang Rui Xiao	Southeast University Professor, director	Production of high-quality liquid fuels, carbon materials and syngas via biomass directional conversion	
15:00-15:30 (08:00-08:30 UK)	Zhibing Zhang	The University of Birmingham, UK Professor, FREng	Chemical Product Engineering for Sustainable Development	
15:30-15:50	Coffee break			
15:50-16:20	Qiang Lu	North China Electric Power University Professor, director	R&D and Application of Multi-source Organic Solid Wastes Pyrolysis	Hao Luo
16:20-16:45	Qingang Xiong	South China University of Technology Professor, director	Particle- to Reactor-scale CFD Simulation of Biomass Pyrolysis and ML-based Development of Reduced-order Models	

16:45-17:10	**Baigang An**	**University of Science and Technology Liaoning Professor, director**	**Cathode design matching catalytic kinetics of oxygen reactions for zinc-air battery**	
17:10-17:35 (10:10-10:35 UK)	**Ewa Marek**	**University of Cambridge, UK Associate Professor**	**Chemical looping for sustainable production of chemicals**	
17:35-18:00	**Jenny Rizkiana**	**Bandung Institute of Technology, Indonesia Assistant Professor**	**Towards circular economy of Indonesian biodiesel industry**	

7. Contact

Ping An

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Shenyang University of Chemical Technology

Attachment 2:

Introduction of Lecturers

Hui-Ming Cheng

Shenzhen Advanced Technology Research Institute, Professor, CAS member

Prof. Hui-Ming Cheng graduated from Hunan University, China in 1984 and received his Ph. D in 1992 from Institute of Metal Research, CAS (IMR CAS). He is the director of both the Advanced Carbon Research Division of Shenyang National Laboratory for Materials Science, IMR CAS since 2001, and the Institute of Technology for Carbon Neutrality, Shenzhen Institute of Advanced Technology, CAS since 2021. He is a member of Chinese Academy of Sciences and a member of TWAS. He used to work at Kyushu Research Center of AIST and Nagasaki University, Japan from 1990 to 1993, and MIT, USA from 1997 to 1998. His research activities mainly focus on low-dimensional materials, energy materials and devices. He has published over 850 papers with an h-index of 155, and is a Highly Cited Researcher in three fields of materials science, chemistry, and environment and ecology. He has given over 230 plenary/keynote/invited lectures at various conferences, and won three 2nd class State Natural Science Award of China (2006, 2017, 2020), Charles E. Pettinos Award from American Carbon Society, Felcht Award from Germany, and ACS Nano Lecture Award. He has also spun off several high-tech companies, and is the founding Editor-in-Chief of Energy Storage Materials.

Xiaonian Li

Zhejiang University of Technology, Professor, FCAE

Dr. Xiaonian Li is a professor and Ph.D. supervisor at the Zhejiang University of Technology. He has been appointed by the Ministry of Education as the Changjiang Distinguished Professor, and elected as a fellow of the Canadian Academy of Engineering. Dr. Li also serves as a member of the 8th State Council Discipline Appraisal Group for Chemical Engineering and Technology, an executive council member of the Chemical Industry and Engineering Society of China, an executive council member of the Chinese Society for Dialectics of Nature/Philosophy of Nature, Science and Technology, the secretary-general of the Chinese think tank on green catalysis, etc.

Dr. Li has long been dedicated to industrial catalyst development, green process innovation, and industrial applications for chemical manufacturing processes relevant to ammonia-amine and chlorine industries. He has won the second prize of the State Technological Invention Award in 2018, the first prize of the Technological Invention Award of the Ministry of Education in 2013, the first prize in the Technology Progress Award of the Ministry of Chemical Industry, the second prize in the State Technological Invention Award, the first prize in the Technology Progress Award of Zhejiang Province, the China Youth Science and Technology Award, etc. Dr. Li has been granted over one hundred invention patents (including the United States, Europe, and Japan), and developed products with a dominant position in the global market, accumulating significant social and billion-dollar economic benefits. He has undertaken projects supported by the National Key Research and Development Program, developed mercury-free catalysts for vinyl chloride synthesis and copper-based catalysts for Cl_2 production by HCl oxidation, as well as their relevant process technologies, and thus contributed to the sustainable development of vinyl chloride and chlor-alkali industry with a production capacity of tens of millions of tons.

Yulong Ding

The University of Birmingham, Professor, FREng

Professor Yulong Ding is founding Chamberlain Chair of Chemical Engineering and founding Director of University of Birmingham Centre for Energy Storage. His research has been on energy materials and processes. He has published some 450 technical papers with 350+ in peer-reviewed journals (GS H-Index ~80) and filed 100+ patents. He currently serves on Molten Salts Advisory Group of UK Department for Business, Energy and Industrial Strategy, Royal Society Net Zero Panel and IChemE Publication Medal Assessment Panel, and recently led a Royal Society briefing note in Climate Change: Science and Solutions. He has been recognised by the election to Royal Academy of Engineering (2020); IChemE Clean Energy Medal (2021); IChemE Global Awards in three categories of Energy, Research Project and Outstanding Achievement (2019).

Raffaella Ocone

Heriot Watt University, Professor, FREng

Raffaella Ocone obtained her first degree in Chemical Engineering from the Università di Napoli, Italy and her MA and PhD in Chemical Engineering from Princeton University, USA. She holds the Chair of Chemical Engineering in the School of Engineering and Physical Sciences at Heriot-Watt University (HWU) since 1999. She is a Fellow of the Royal Academy of Engineering (FREng), the Royal Society of Edinburgh (RSE), the Institution of Chemical Engineers (IChemE), and the Royal Society of Chemistry. In 2007 she was appointed Cavaliere of the Order of the Star of Italian Solidarity by the President of the Italian Republic. In The Queen's 2019 New Year Honours she was appointed Officer of the British Empire (OBE) for services to engineering. Raffaella was named as one of the top 100 Most Influential Women in the Engineering Sector in 2019 in the list produced by board appointments firm Inclusive Boards in partnership with the Financial Times. At HWU, Raffaella is the Head of the Multiphase Multiscale Engineering Modelling (MMEM) research group. She has worked in a number of international Institutions such as the Università di Napoli (Italy); Claude Bérnard Université, Lyon (France); Louisiana State University (USA); Princeton University (USA). She was the first "Caroline Herschel Visiting Professor" in Engineering at RUHR Universität, Bochum, Germany (July-November 2017) and the recipient of a Visiting Research Fellowship from the Institute for Advanced Studies, Università di Bologna, Italy (March-April 2018). Raffaella's main area of research is in the field of modelling complex (multi-phase) reactive systems with emphasis to the development of responsible technologies in the energy arena. Currently she is the EPSRC Established Career Fellow in Particle Technology.

Ondřej Mašek

University of Edinburgh, Professor, Editor of RCM

Prof. Ondřej Mašek is a full professor and Personal Chair of Net Zero Emission Technologies at the University of Edinburgh and Lead of Biochar Production and Development at the UK Biochar Research Centre (UKBRC). For the past eighteen years, Prof. Mašek's research has been dedicated to various aspects of thermo-chemical conversion of biomass and fossil resources to added-value products, e.g., materials, electricity, heat, chemicals or fuels, and associated issues related to efficiency, sustainability and GHG emissions. Prof. Mašek joined the University of Edinburgh in 2009 and, together with colleagues, co-founded the UK Biochar Research Centre at the School of Geosciences, the first such centre in the World. His research has since been focused on converting biomass to biochar and co-products for atmospheric carbon sequestration and adaptation to climate change (tackling environmental issues and making agricultural production more efficient and resilient). His main focus is on targeted biochar products (engineered biochar) and informed selection, i.e., a more sophisticated method for biochar production and application, allowing higher desired impacts with lower inputs. Prof. Mašek has led and participated in a number of UK, EU and international projects, with a total budget of over £20m, and has a large number of active collaborations with industry, ranging from start-ups to multinationals. Since 2007 he has published over 150 peer-reviewed papers with over 8400 citations and an h-index of 45 (Google Scholar). Prof. Mašek's research group consists of post-doctoral researchers, PhD and MSc students, visiting academics and visiting research students working on a range of challenges related to biochar production and applications, such as atmospheric carbon removal and storage, use of biochar in environmental remediation, biochar in construction applications, biochar computational modelling, use of biochar in AD and dark fermentation, biochar use in polymers, etc.

Hyungwoong Ahn

University of Edinburgh, Senior lecture

Dr. Hyungwoong Ahn is a senior lecturer at the University of Edinburgh. His research mainly focuses on separation processes (adsorption, circulating fluidized bed, etc.), process simulation, carbon capture processes. He has published over 50 papers and holds over ten patents. Dr. Hyungwoong Ahn conducted postdoctoral research at University College London (2003-2005) and worked as a senior research engineer at SK Energy (2005-2009) before joining in the University of Edinburgh. Dr. Hyungwoong Ahn was selected as a finalist in the Energy Award of the IChemE Global Award 2016, and was awarded the KOFST Brain Pool Fellowship . He is the Managing Editor of Adsorption Journal and Editorial board member of Resources Chemicals and Materials.

Xiaotao Bi

University of British Columbia, Professor, FCAE

Dr. Xiaotao Bi is the Methanex professor in clean energy systems in the Department of Chemical and Biological Engineering at the University of British Columbia. He is a Fellow of Canadian Academy of Engineering and Engineering Canada. He is the Director of UBC Clean Energy Research Centre (www.cerc.ubc.ca), and the co-director of China-Canada Bioenergy Network (www.c-cbc.ubc.ca).

His current research has been focused on development of fluidized bed reactors for biomass gasification, torrefaction and catalytic pyrolysis, and integrated assessments of bioenergy systems. He has published 400+ peer-reviewed papers with a Google H-Index of 77. He was the recipient of a UBC Killam Senior Research Fellowship (2011), AIChE Particle Technology Forum Lectureship Award (2012), Teaching Excellence Award of UBC Chemical and Biological Engineering Department (2014), CSChE Design and Industrial Practice Award (2020) and BC Bioenergy Sector Award (2022).

Koyo Norinaga

Nagoya University, Professor, director

Koyo Norinaga is a Professor and a director at Research Center for Net Zero Carbon Society at Nagoya University Japan. He received his BE, ME, and PhD in Chemical Engineering from Hokkaido University, Japan. After working as an Assistant professor at Tohoku University during 1999-2002, he moved to Germany and worked as an Alexander von Humboldt research fellow and a senior scientist at Karlsruhe Institute of Technology (KIT) for four years. He came back to Japan and had made his carriers at Hokkaido and Kyushu University as an Associate Professor from 2006 to 2017. In the NEDO moonshot project, he is keen to develop an energy saving direct air capture technology that utilizes liquefied natural gas coldness.

He got the Progress Award of the Japan Institute of Energy on his achievements in the "Chemistry and kinetics of hydrocarbon pyrolysis" in 2012, and also received the Distinguished Paper Awards in 2015 and 2016, both from the Japan Institute of Energy. Prof. Norinaga has 150+ publications and 100+ invited talks. His research interests include CO_2 separation by chemical absorption, CO_2 utilization process, thermochemical conversion of biomass, and modeling & simulation for the chemically reacting flows. He is now conducting government and private sector funded research projects with more than 15 companies to develop chemical processes for closing the carbon cycle.

Qinhui Wang

Zhejiang University, Professor, director

Wang Qinhui, Professor of State Key Laboratory of Clean Energy Utilization (CEU), Zhejiang University in China. Vice Director of National Energy Technology R&D (experimental) Center on Clean Coal Conversion. Vice Director of Collaborative Innovation Center of Clean Coal Power Plant with Poly-generation. Executive Council Member of Chinese Society of Particulogy； Vice director of Fluidization Study Committees, Chinese Society of Particulogy； Vice Director, Division of Engineering Thermalchemical, The Chemical Industry and Engineering Soicety of China; Commissioner, Thermal Power chapter, Chinese Society for Electrical Engineering (CSEE). The main research fields are coal (biomass) combustion and gasification, circulating fluidized bed combustion and gasification, Coal poly-generation technology, pollutants removal, CO_2 capture technology and measurement on gas solid multiphase flow.

Yizhuo Han

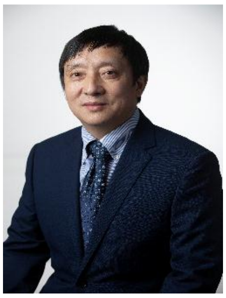
Institute of Coal Chemistry, CAS, Professor, director

Dr. HAN Yizhuo, professor of the Institute of Coal Chemistry, Chinese Academy of Sciences, Taiyuan, Shanxi, China. Dr. Han graduated from East China University of Science and Technology (ECUST), Shanghai in 1983. He got his doctoral degree in The University of Tokyo in 1996, and had worked in the National Institute of Materials and Chemical Research in Tsukuba, Japan, as a STA Fellow (Science and Technology Agency, Japan) from 1999 to 2001. He has been engaging in research and development of new catalytic conversion process of syngas, methanol, dimethyl ether and CO_2 , such as, one step dimethyl ether synthesis from syngas in slurry phase, slurry phase methanation of syngas, low temperature oxidation of dimethyl ether or methanol to DMM(dimethoxymethane)/MF(methyl formate), vapor phase carbonylation of methanol to acetic acid/methyle acetate over Ni/AC catalyst, methane reforming with CO_2 and tri-reforming of methane with CO_2, water and oxygen using Ni based catalysts.

Hongwei Wu

Curtin University, Australia, Professor

Prof. Hongwei Wu received his Bachelor and Master of Engineering in Thermal Power Engineering from Huazhong University of Science and Technology, China. He then pursued his PhD in Chemical Engineering at the University of Newcastle, Australia, and received his PhD degree in August 2000. After a two-year postdoctoral fellowship at Monash University, Australia, Prof Wu was appointed as a junior lecturer in the Department of Chemical Engineering at Curtin University, Australia, in August 2002. He was then promoted to Senior Lecturer in 2006, Associate Professor in 2008 and full Profession of Chemical Engineering in 2010. He has won the 2010 Curtin Commercial Innovation Award and 2011 Western Australia Innovator of the Year Woodside Encouragement Award. He was also the recipient of the inaugural 2018 Curtin Awards for Excellence in Higher Degree by Research Supervision. He is a fellow of the Combustion Institute (2019). After served as Associate Editor (2008-2019), Prof Wu has then been appointed as the new Editor-in-Chief of Energy & Fuels (http://pubs.acs.org/ef) by the American Chemical Society since Jan 2020.



Guangwen Xu

Shenyang University of Chemical Technology,

President, Professor, FREng

Prof. Guangwen Xu, President/Chair professor of Shenyang University of Chemical Technology (SYUCT), Director of Key Laboratory of Resources Chemicals and Material of Ministry of Education. He has been recognized by the election to Royal Academy of Engineering (2022). He has dedicated himself to thermochemical sciences and technologies for more than 30 years. As the chair scientist or project leader, he has undertaken tens of national, international and industrial grant projects for scientific researches and technical developments. By far, he has published more than 500 journal articles and two monographs about fuel deco decoupling thermochemical conversion and micro fluidization, respectively. He has granted more than 130 intellectual patents including 50 international patents authorized by oversea countries. His papers published have received totally more than 12000 citations , leading to a personal h-index of 57 (Scopus).

He inaugurated the new interdiscipline of Engineering Thermochemistry, and well led his team for successful developments and commercialization of several thermochemical fuel conversion and environment protection technologies. Innovative technologies developed in his team have widely deployed in more than 15 provincial regions of China and some in Korea, Canada and France for more than 300 industrial installations and research instruments and/or facilities. Up to now, the total economic revenue generated from the technology applications has reached 7 billion RMB, while the technology applications significantly contributed to high-efficiency and clean production of a totally annual economic value above 700 billion RMB. He has founded international journals Carbon Resources Conversion (CRC, IF:6.0) and Resources Chemicals and Materials (RCM). He has awarded 10 first-class provincial / miniterial awards by CAS, Liaoning Province, Sichuan Province, China Petroleum and Chemical Industries Federation (CPCIF), and a few other national Societies of China.

Xiaogang Hao

Taiyuan University of Technology,
Professor, director

Dr. Xiaogang Hao is a full professor of Taiyuan University of Technology, China from 2004. He received his Ph.D degree from Sichuan University, China in 1997. He worked as an associate professor at Department of Chemical Engineering, Taiyuan University of Technology, China (07/1999-12/2004), a visiting scholar at University of Washington (Seattle), USA (09/2002-10/2003), a Senior Visiting scholar at University of Waterloo, Canada (8/2007-2/2008), a Senior Visiting scholar at University of Western Ontario, Canada (3/2013-9/2013). Now he served as the President of the Society of Chemical Engineering of Shanxi Province; Director of the Chemical Industry and Engineering Society of China, and Director of the Chinese Society of Particuology; Member of Electric Drive Membrane Special Committee, Membrane Industry Association of China; Member of Engineering Thermochemistry Special Committee, the Chemical Industry and Engineering Society of China. His research interests include clean conversion of carbon resources, electroactive materials, membrane separation and computational chemical engineering. In recent years, he has undertaken 10 million yuan of scientific research projects supported by the National Natural Science Foundation of China and the Ministry of Science and Technology. He has published more than 400 research papers and more than 50 patents, he is also a reviewer of more than 100 academic journals.

Anthony Dufour

University of Lorraine, Professor, director

Prof. Anthony Dufour is a research scientist at CNRS (The National Center for Scientific Research, France) working on the thermochemical conversion of biomass and wastes. He did his PhD on hydrogen production by biomass gasification for the National Gas Company (now ENGIE) in collaboration with several French research centres. Then he joined CNRS Nancy (the Chemical Engineering Lab.) in 2008.

His main research interests are: fundamentals of biomass pyrolysis (by mass spectrometry, in-situ analysis, etc.), reactivity of carbons, catalysis for tar reforming or bio-oil hydrodeoxygenation, development of pyrolysis, liquefaction and gasification reactors, interdisciplinary assessment of bioenergy routes. He was instrumental in organising the international symposium PYRO2016 (www.pyro2016.com) and PyroLiq2019 and 2023 (with F. Berruti, M. Garcia-Perez and W. Prins). He have collaborated with 100+ researchers from academia and industry. He served as an editor of Journal of Analytical & Applied Pyrolysis (Elsevier) from 2017 to 2020. He is currently the executive editor of Energy & Fuels (ACS).

Huiyan Zhang

Southeast University, Professor, director

Huiyan Zhang received his PhD in Thermal Engineering from Southeast University in 2012. He is now a professor of the School of Energy and Environment of Southeast University. He is the winner of the National Science Fund for Excellent Young Scholars and the Jiangsu Province Distinguished Young Scholars. He is the leader of a National Key Research and Development Program project. His research expertise is in the high value-added utilization of biomass and organic wastes. For biomass feedstocks, a novel approach of selective deconstruction for thermal utilization has been developed. Oxygen-rich cellulose is transformed through directed oxygen transfer to produce clean oxygenated fuels like alcohols and ethers. Carbon-rich lignin materials are subjected to targeted oxygen removal to produce high-quality hydrocarbon liquid fuels. For plastic waste, a technology for catalytic pyrolysis co-production of high-value carbon nanomaterials and hydrogen gas is designed and developed. For mixture organic wastes, a new gasification concept to obtain high quality syngas and achieve comprehensive pollutant removal. He obtained 5 prizes as the first contributor including the first prize of Technological Invention of Ministry of Education, special gold medal of Geneva International Inventions Exhibition. He has published more than 200 peer-reviewed papers (more than 7000 citations with h-index 45), including Science, Nature Commun., Energ. Environ. Sci., PNAS, Combust. Flame. He has been selected as a Highly Cited Researcher in China by Elsevier for four consecutive years. He is an associate editor of Energy Research & Utilization. He serves as Editorial Board or Guest Editor of 8 Journals, such as Fuel processing Technology, Science of The Total Environment, and so on.

Rui Xiao

Southeast University, Professor, director

Rui Xiao received his PhD in Thermal Engineering from Southeast University in 2005. He worked at University of Kentucky and University of Cambridge as visiting scholars in 2007 and 2014 respectively. He is now a professor and the dean of the School of Energy and Environment of Southeast University, and the director of Key Laboratory of Energy Thermal Conversion and Control of Ministry of Education. He is the winner of the National Science Fund for Distinguished Young Scholars and is currently employed by the Ministry of Education of China as a Chang Jiang Scholars Distinguished Professor.

His research expertise is in the high value-added utilization of biomass, chemical looping gasification for hydrogen-rich syngas preparation and efficient pyrolysis of waste tire. Biomass is directly converted to non-oxygen-containing fuels by catalytic pyrolysis, or transformed to oxygen-containing fuels by pyrolysis and following hydrogenation in mild conditions. The oxygen-containing products can also be used as fuel additives. For hydrogen-rich syngas preparation, the sintering mechanisms and design of oxygen carriers, the effects of the self-moisture in the biomass gasification are investigated. He was honored with Second Award of Science and Technology Progress of China and 10 Awards including First Award of Natural Science of the Ministry of Education, First Award of Science and Technology Progress of Jiangsu Province, etc. He has published more than 380 peer-reviewed papers (more than 12000 citations with h-index 60), including Science, Energy Environ. Sci., Combust. Flame. He is an associate editor of Fuel Processing Technology, and editorial board members of International Journal of Greenhouse Gas Control.

Zhibing Zhang

The University of Birmingham, Professor, FREng

Professor Zhibing Zhang (BEng MSc PhD DSc CEng FIChemE FREng) is Leader of Micromanipulation and Microencapsulation Research Group, and Co-Director of the China Institute at the University of Birmingham, UK. Moreover, he is Director of Microforce Measurement Ltd UK, Vice President of World Bioprotection Forum, Member of International Partnership Programmes Steering Group of the Royal Academy of Engineering, Member of Sino-British Engineering Technology Cooperation Steering Committee, Assessor of the Chinese Academy of Sciences, Member of the Editorial/Advisory Boards of 3 international journals, and Member of EPSRC Peer Review College & Engineering Panel.

Qiang Lu

North China Electric Power University,

Professor, director

Qiang Lu, full professor and Ph.D. advisor in North China Electric Power University, director of the National Engineering Research Center of New Energy Power Generation. He was honored as the Chang Jiang Scholar of Ministry of Education, the "Ten Thousand Plan" Young Talent, and obtained the Excellent Young Scientists Fund of NSFC. He has published more than 200 SCI papers with more than 7000 citations as the first/corresponding author, has granted more than 60 invention patents as the first inventor, 7 of which have been licensed for implementation or transferred. He was awarded the Second Prize of National Science and Technology Progress (2nd), the First Prize of Hebei Provincial Technology Invention (1st), the First Prize of Science and Technology Progress of the Ministry of Education (twice, 2nd and 3rd) and the China Patent Excellence Award (twice, both 1st), as well as other scientific and technological awards. He has independently developed a series of key technologies and equipment for the efficient pyrolysis and resource utilization of biomass/organic solid waste, clean and efficient combustion and safe operation, and selective catalytic reduction removal of flue gas nitrogen oxides, etc., which have achieved large-scale applications.

Qingang Xiong

South China University of Technology, Professor

Prof. Qingang Xiong is a tenured Full Professor at the State Key Laboratory of Pulp and Paper Engineering/School of Light Industry and Engineering, South China University of Technology. He is awardee of the National "Overseas High-level Talent Recruit Program" Youth Project in 2020 and "Future Chemical Scholars" of the Global Association of Chinese Chemical Engineers in 2021. He also won First Prize of the National Award for Progress in Business Science and Technology of China in 2022 (ranking 3/15) and Best Application Award for the First (2013) Supercomputing Application Award of the Chinese Academy of Sciences (ranking 5/14). Prof. Xiong's research area are mainly simulation and experiment on multiphase flow and fluidization, thermochemical conversion of particles, flow and heat transfer of porous media, energy utilization and heat transfer enhancement. So far, Prof. Xiong has published more than 50 papers in authoritative journals as first/corresponding author, which has received more than 2500 independent citations from SCI journals; has led and completed one Frontier Project of the US Department of Defense (with funding of 500,000 US dollars). Currently, Prof. Xiong is in charge of a National "Overseas High-level Talent Recruit Program" Youth Project, a general project of the National Natural Science Foundation of China, two international (regional) cooperation and exchange projects of the National Natural Science Foundation of China, and a general project of the Guangdong Provincial Natural Science Foundation of China. Prof. Xiong has served as panelist and reviewer of programs and awards for the United States National Science Foundation, the United States Department of Energy, the American Chemical Society, the China Society of Particuology, etc. At present, Prof. Xiong is youth board member of the China Society of Particuology, head of CFD youth group of the professional committee "Process Modeling and Simulation" of the China Society of Chemical Engineering, and youth editorial board member of the SCI journal Biochar.

Baigang An

University of Science and Technology Liaoning, Professor, director

Baigang An is the Liaoning provincial specially recruited professor and he is the person in charge of Liaoning Innovative Research Team in Univ. Prof. An is the one of BaiRen level in the Liaoning BaiQianWan Talents Program, and he is the Director of the Liaoning key laboratory of materials for energy application and electrochemistry. Currently, Prof. An is the Dean of School of Chem Eng in the Univ. of Sci and Techn of Liaoning, served as the review expert of Talents Award Program of China Association for Science and Technology, the editorial board member of Chinese Chemical Letters, the council member of Chemical Industry and Engineering Education Society of China, the council member of New Material Branch of Chemical Industry and Engineering Society of China, the standing member of Liaoning Chemical Industry and Engineering Society, the standing member of Technological Innovation Alliance in the New Energy Vehicles Industry of Liaoning province. He is also the letter-reviewed expert of National Natural Science Foundation of China and the peer-reviewed expert of Natural Science Foundation of Zhejiang Province. He was awarded the Doctor of Engineering in applied chemistry major of Tianjin University in 2003. He was awarded the Post-Doctor of Institute of Multidisciplinary Research for Advanced Materials of Tohoku Univ. (Japan) from December, 2007 to April, 2009. Materials for energy application and electrochemistry storing technology, metal electrochemistry corrosion and protection research, etc. are his main research orientation. In the past 5 years, he undertook 3 programs of National Natural Science Foundation of China, 15 programs authorized by the province, the ministry and the enterprise. He won one first prize in the scientific and technological progress award of Metallurgical Mines' Association of China, one second prize in the scientific and technological progress award of Liaoning province, and one second prize in the teaching achievement award of China Petroleum & Chem Eng Education Association. He published above 100 SCI papers in the journal such as Science, Chem Soc Rev , Nature Commun. , Angewandte Chemie-International Edition, Appl Catal B, Nano Energy, Small, etc. In addition, 12 invention patents were approved.

Ewa Marek

University of Cambridge, Associate Professor

Dr Ewa Marek is an associate professor at the Department of Chemical Engineering and Biotechnology, University of Cambridge and a fellow of Jesus College. Before that, for five years, she was a post-doctoral associate in the Engineering Department, also in Cambridge. She worked for six years on industrial R&D and advanced measurement methods in Nottingham (UK), Petten (Netherlands) and Warsaw (Poland). She studied energy and chemical processing (BEng, MSc) in Cracow and carbon capture processes (PhD) in Katowice (both in Poland).

Jenny Rizkiana

Bandung Institute of Technology

Jenny Rizkiana received his bachelor's degree in Chemical Engineering from Institut Teknologi Bandung, Indonesia, in 2009 and Doctoral degree from Graduate School of Science and Technology, Hirosaki University, Japan, in 2016. In 2016 he joined the Department of Chemical Engineering, ITB and now he is an Assistant Professor at Department of Bioenergy Engineering and Chemurgy, Institut Teknologi Bandung, Indonesia. His research areas are focused on Biobased energy and materials, including Thermocatalytic conversion, biomass processing and biorefinery, and zeolite catalysis for biomass conversion. His professional activities include certified professional engineer, certified assessor of Renewable Energy Engineering, and member of Technical Committee of Indonesia National Standard Board for Solid and Gas Bioenergy. He is also a member of the Institute of Engineer Indonesia and Indonesian Bioenergy Expert Association.

Attachment 3:

Abstracts of Lectures

Repairing and upcycling of electrode materials from spent lithium ion batteries

Hui-Ming Cheng (hm.cheng@siat.ac.cn)

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2 Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences, Shenyang 110016, China

Electrical energy storage is becoming more and more important due to the widespread use of electrical vehicles and large-scale storage of electricity from wind farms and solar power plants for grid. Lithium ion batteries are taking a dominant role in these fields, and their consumption is exponentially increasing in recent years. However, the major elements of lithium, cobalt, nickel, etc used in lithium ion batteries are either rare or geographically unbalanced, mostly relying on import. Therefore, it is essential to find some alternative ways to replace lithium ion batteries or to recycle these substances greenly and efficiently. We have attempted in both ways in recent years. In particular, we have making great efforts to directly recycle and then reuse the electrode materials from spent lithium batteries in a green, cost-effective, and short-processing ways. For example, we have obtained high-voltage cathode materials, regenerated graphite anode materials, and multi-functional high-performance electrocatalysts from spent lithium ion batteries with good feasibility based on technical economic analysis.

Keywords: energy storage, lithium ion battery, resource, recycling

Industrial Catalyst Technology for Chemical Manufacturing

Xiaonian Li

Zhejiang University of Technology, China

Wherever the hand touches, there are chemical products; wherever the gaze falls, there are chemical changes. Chemical manufacturing is one of the milestones in human civilization, as it contributes to creating a better life.

Industrial catalyst technology is fundamental for achieving low-carbon green growth for chemical manufacturing processes. This report takes typical and important chemical manufacturing processes as examples to introduce the progress and development in thermal catalysis industrial technology, including the synthesis of inorganic ammonia, which is 50% of the nitrogen source in the human body and the second-largest chemical product also used as a hydrogen carrier, with an annual production of nearly 60 million tons in China and 180 million tons worldwide. This report also covers the synthesis of organic amines, the essential components for thousands of pharmaceutical (agricultural) chemicals and materials in modern life. Furthermore, it highlights the advancements in vinyl chloride production using mercury-free catalysts, and chlorine recycling in the chlor-alkali industry, with a production capacity of tens of millions of tons per year.

Thermochemcial-based in-process CO_2 splitting for steelmaking decarbonisation

Yulong Ding

The University of Birmingham, UK

This talk presents a novel thermochemcial-based solution to steelmaking decarbonisation. Such a process uses a perovskite materials for in-process carbon dioxide splitting at a moderate temperature range of 700-800 °C powered by renewable energy.

Integration of biochar production with other biomass applications

Ondřej Mašek (ondrej.masek@ed.ac.uk)

UK Biochar Research Centre, School of GeoSciences, University of Edinburgh, UK

Key Words: biochar, bioenergy, biorefineries, BECCS, hydrogen

The use of pyrolysis as a technology has been in development for several decades, with a focus on bio-oil production and waste management. More recently, its potential integration with other bioenergy and biorefinery concepts has been proposed to take advantage of potential synergies. In this presentation, we will explore different options for integrating pyrolysis with other thermochemical or biological systems to create a zero-waste biorefinery. We will provide specific examples of the benefits of this integration, including:

1) The beneficial use of mineral-rich residues from biomass processing, which can release nutrients like K and P into soil or growing media. Our research shows that minerals are readily available and can be controlled by adjusting pyrolysis conditions.

2) Increased yield of methane and improved stability of AD reactors. Our research demonstrates that certain types of biochar can be used to control ammonia inhibition in AD reactors and increase methane yield.

3) The co-production of biochar and other products using waste lignin.

The biochar produced from these applications has numerous potential uses in environmental management, agriculture, horticulture, forestry, engineering applications, and construction. This can contribute to efforts to mitigate and adapt to climate change.

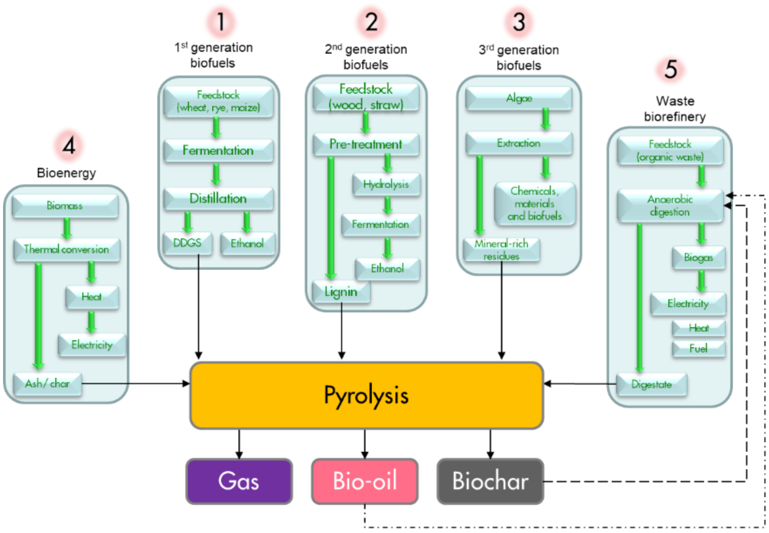

Figure 1: Five examples of potential integration of pyrolysis and biochar production with bioenergy and biorefinery technologies.

PSA-SPUR: An Advanced Adsorption Process for Heavy Component Recovery and Its Application for On-board Carbon Capture

Hyungwoong Ahn (H.Ahn@ed.ac.uk)

Institute for Materials and Processes, School of Engineering, The University of Edinburgh, Robert Stevenson Road, EH9 3FB, UK

Up to now, carbon capture researches and commercialisation projects have been focused mostly on fossil fuel power stations and industrial plants that feature single CO_2 emission sources of very large scales. To achieve the net zero emission target, however, it is essential to curtail substantially the CO_2 emission from all the CO_2 emission sources regardless of their scales including maritime shipping sector[1]. The amine capture units that have been often chosen as a capture option for decarbonising power plants may not be best suited for capturing CO_2 from ships, the CO_2 emission scales of which are much smaller than those of power plants. Meanwhile, it is well known that adsorption processes are competitive over other separation processes for industrial gas separation applications of small to medium scales[2].

A PSA-SPUR system is an advanced adsorption process designed for recovering the heavy component from a gas mixture, not necessitating unrealistically low pressures for desorption. The novel adsorption process is capable of achieving the high CO_2 purity and recovery targets at the same time, without having to operate the process within a very narrow window of operating conditions for good performance. In this study, the PSA-SPUR system was designed for its application for ship-based carbon capture and optimised for the best performance using the unique Equilibrium Theory model[3,4]. The theoretical results were validated by experimental campaign using the lab-scale six-column Pressure Swing Adsorption rig.

Keywords: CO_2 capture, pressure swing adsorption (PSA), ship, equilibrium theory model

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Thermo-catalytic conversion of biomass residues to biofuels under microwave irradiation

Xiaotao Bi

Clean Energy Research Centre

The University of British Columbia

This presentation will provide an overview of our recent work on the effect of microwave irradiation on pyrolysis of biomass particles using several low-cost catalysts for the improvement of bio-oil and biochar qualities. The experiments were performed in a custom-built 1 kw microwave reactor using potassium phosphate, natural zeolite, bentolinte and red mud as catalysts. The results showed that the microwave irradiation created more micropores of biochar resulting in higher specific surface area and the presence of catalyst promoted cracking of heavy molecules in the vapour phase, leading to lowered acidity and viscosity of bio-oil.

Challenges and Perspectives in a New Direct Air Capture (DAC) Process

Koyo Norinaga (norinaag@nagoya-u.jp)

Research Center for Net Zero Carbon Society, Institute of Innovation for Future Society, Nagoya University, Nagoya, Japan

According to the report by "IEA Net Zero by 2050", the amount of carbon dioxide to be captured to achieve carbon neutrality in 2050 is 7.6 Gt worldwide. Direct Air Capture (DAC) that removes carbon dioxide from the atmosphere is said to account for 980 million tons of that. It is difficult to separate and recover the extremely diluted 400 ppm of carbon dioxide in the atmosphere. There are several separation techniques such as chemical absorption, physical adsorption and membrane separation, among which the chemical absorption method has been used for the longest time as a carbon dioxide separation and recovery technique. The chemical absorption method requires a lot of energy when desorbing carbon dioxide from the absorbent liquid, but from the viewpoint of capturing ultra-low concentrations of carbon dioxide in the atmosphere more reliably, the method using chemical reaction is considered still to have some advantages. In this presentation, I will talk about trends in the development of technologies for atmospheric carbon dioxide that are progressing in various places, and the development status and prospects of DAC technology by the chemical absorption method using cold energy, which is being developed by Nagoya University.

Development on Biomass Combustion and Gasification Technologies Based on Fluidized Bed Process

Wang Qinhui

State Key Laboratory of Clean Energy Utilization (CEU), Zhejiang University

Biomass is one of main renewable energy resource, meanwhile, the environment pollution due to burning or piling up the agriculture waste in land is serious. To using the agriculture/forest waste in clean and high efficiency, several biomass combustion and gasification technologies have been developed based on fluidized bed process in Zhejiang University. Based on the research on the mechanism of biomass combustion, the transform process of alkali/chlorine (KCl) and high temperature corrosion due to alkali and chlorine, the circulating fluidized bed combustion technology for agriculture/forest waste with high alkali content is developed. The first circulating fluidized bed boiler (75t/h steam capacity) fired with typical agriculture waste (rice/wheat straw) in the world is operated successfully and more than 150 boilers for agriculture/forest waste have been operated.

Meanwhile, biomass circulating fluidized bed gasification technology is developed for agriculture waste. The first circulating fluidized bed gasifier (8t/h) fired with rice husk/corn stalk (50%:50%) coupled with large scale coal pulverized coal plant in China is operated successfully in July, 2018. To increasing the unitization benefit of the biomass, a new biomass fluidized bed gasification technology cogenerated char and steam is developed and operated successfully.

Influence of Regulation of The Surface Oxygen Species on Ni-based Catalyst on Reaction Behavior of CH_4-CO_2 Reforming and Carbon Deposition

Chao Li[1,2], Meng Zhang[3], Zeling Zhou[4], Junfeng Zhang[1], Faen Song[1]
Qingde Zhang[1], **Yizhuo Han**[1]

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2 University of Chinese Academy of Sciences, Beijing, China
3 School of Chemistry, Zhengzhou University, Zhengzhou, China
4 Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian, China

Dry reforming of methane with CO_2 (DRM) is able to transform two greenhouse gases, CH_4 and CO_2, into high value-added syngas. Efficient and cheap Ni catalysts have been widely studied in the DRM reaction. However, the Ni based catalysts suffer from rapid deactivation caused by the sintering of active metal and/or carbon deposition, which limits their industrial application. The inherent reason of carbon deposition is that the rate of CH_4 dissociation is relatively fast than that of CO_2 activation at severely high reaction temperature, 700-850 ℃. This study focuses on the problem of carbon deposition faced by Ni-based catalysts including Ni/ZrO_2, hydroxyapatite (CaHAP) supported Ni catalysts, and metal or F-modified Ni catalysts. The regulation of CO_2 activation process was achieved by adjusting the oxygen species over the catalyst surface. Furthermore, the mechanism of the reaction molecule activation and carbon removal affected by the surface oxygen species was studied in depth. Besides, the bifunctional effects of active metal and support properties were discussed as well. This study might provide some meaningful references for the design and development of the efficient and stable catalyst for the DRM reaction.

Ternary Phase Diagram of Pyrolytic Lignin, Mixed Solvent and Water as a Tool for Phase Stability Predication and Control of Bio-oil from Biomass Fast Pyrolysis

Hongwei Wu

Curtin University, Australia

Bio-oil from biomass fast pyrolysis is an important feedstock for the production of renewable fuels and green chemicals. Fast pyrolysis bio-oil generally contains a water-soluble fraction (excluding water), a water-insoluble fraction (i.e., pyrolytic lignin, PL), and water in a single phase. However, phase separation can occur during bio-oil transport, storage, and processing. In this study, a mixed solvent (MS) is developed based on the compositions of various fast pyrolysis biooils produced from a wide range of feedstocks and reactor systems. Experiments are then carried out to investigate the phase behavior of the PL/MS/water ternary system. Several ternary phase diagrams are constructed for PL and its fractions, and the PL solubilities in various MS/water mixtures are also estimated. A comparison of the results for various PL fractions indicates that the molecular weight of PL can affect the ternary phase diagram, with the PL of a lower molecular weight having a higher solubility in the same MS/water mixture. The presence of free sugar (i.e., levoglucosan, present in bio-oil as solute) also influences the ternary phase diagram of the PL/MS/system, but only at a low water content (i.e., < 20 wt %). The results suggest that such ternary diagrams may be potentially an important tool for predicting the phase separation of bio-oil, as a result of changes in the bio-oil chemistry in various processes (e.g., cold-water precipitation and aging).

Engineering thermochemistry to cope with challenges in carbon neutrality

Guangwen Xu

Key Laboratory on Resources Chemicals and Materials, Shenyang University of Chemical Technology, Shenyang, 110142, China

More than 90% of anthropogenic carbon emissions are from uses of organic carbon resources and carbonate minerals that cannot be abandoned any time soon. In this context, we have realized that the most effective strategy to cope with carbon-neutral challenges is to focus on a few super-emitters, which are all associated with heat-induced or heat-driven thermochemical reactions. To assist in reducing CO_2 emissions from these superemitters, we introduce an emerging interdisciplinary Engineering Thermochemistry (ETC) that focuses on heat-induced/driven thermochemical reactions and their engineering. Combined with some exemplary processes, we demonstrate how and why ETC can play a vital role in innovating CO_2 super-emitting processes to reduce energy consumption and carbon emissions substantially at the scale of several billion tons. The approaches discussed in this study can help governments and researchers to establish applicable policies and develop practical techniques to meet the challenges of CO_2 emission reductions toward a green and carbonneutral future.

PVFC Coupling System for Recovering High-Boiling Point Organics with High-Purity from Aqueous Solutions

Hongyun Wang[1], Chuncheng Li[2], Qian Xu[1], Changlin Liu[3], Zhonglin Zhang[1], Xiao Du[1], **Xiaogang Hao**[1,*], Guoqing Guan[3]

[1] Department of Chemical Engineering, Taiyuan University of Technology, Taiyuan 030024, China (xghao@tyut.edu.cn)

[2] Institute of Carbon Materials Science, Shanxi Datong University, Datong, Shanxi Province, China

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Selective recovery of valuable minor component with high-purity form from dilute aqueous solution is an interesting issue in the area of organophilic pervaporation. High boiling point organic compounds (HBOCs) with aromaticity can be recovered by poly(ether block amide) (PEBA-2533) membrane from dilute aqueous solutions as the products with high-purity using a pervaporation fractional condensation (PVFC) coupling system. In this study, the swelling behaviors of PEBA-2533 membrane in phenol, aniline, and furfural aqueous solutions were first investigated by experiments and molecular dynamics (MD) simulation. Then the high-purity phenol crystal and aniline were recovered with a high production rate from dilute aqueous solution by a PVFC coupling system. The crystallization mechanism of phenol under vacuum condition was discussed, and the crystallizer should be operated at an appropriate temperature in order to prevent water condensation in the phenol crystallizer. The perfect integration of high-performance PEBA-2533 membrane with the fractional condensation process yielded high production rate of 1222.5 g/(m2 h) as well as high recovery efficiency (86.5%) for recovering high-purity aniline in the first condenser when feed concentration and temperature were 1 wt % and 80℃, respectively. Finally, the (PEBA-2533/poly(vinylidene fluoride)(PVDF) composite pervaporation membrane was also prepared for recovering of high-purity aniline from dilute aqueous solution, and the resistance-in-series model was set up for the simulation of the present Pervaporation. The performance of the composite membrane for the removal of aniline from wastewater was also investigated using a batch (PVFC) experimental system, by which the concentration of the feed could be reduced to 550 ppm after 5.5 h of treatment, and accordingly, 65 wt% of the aniline in the feed was recovered in the first condenser as its high-purity form at an initial aniline concentration of 30,000 ppm.

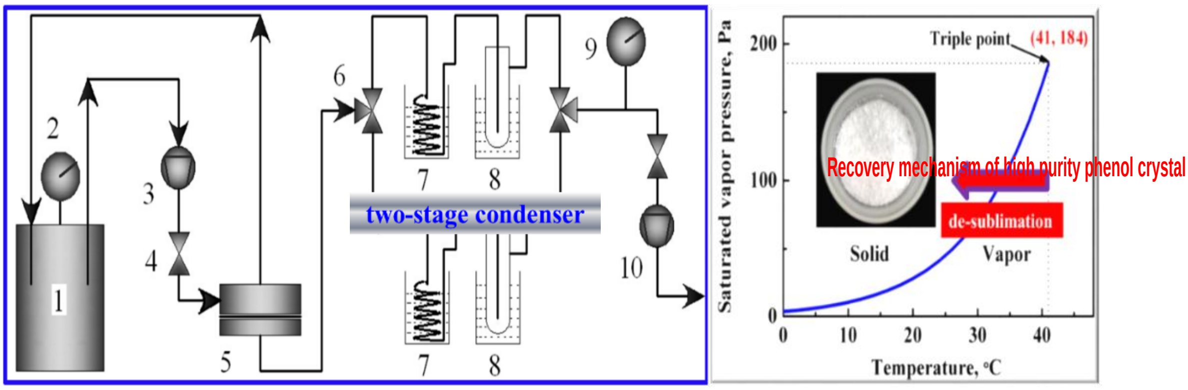
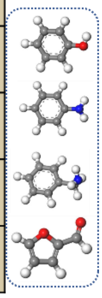


Figure 1 Schematic of the PVFC system: (1) Feed tank; (2) Thermometer; (3) Recirculation pump; (4) Valve; (5) Pervaporation module; (6) Three-way valve; (7) Condenser 1#; (8) Condenser 2#; (9) Vacuum meter; (10) Vacuum pump.

Table 1 Physical properties of aromatic compounds with high boiling points

Organics	Boiling point (°C)	Melting point (°C)	Saturated vapor pressure (kPa)	Solubility in water (wt%)	Remark
Phenol	181.8	40.1	0.055	~8.7	@ 25 °C
Aniline	184.8	-6.2	0.062	~3.6	@ 20 °C
Benzylamine	185	-30	1.6	/	@90°C
Furfural	161.7	-36.5	0.215	~8.3	@ 20 °C



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Acknowledgements

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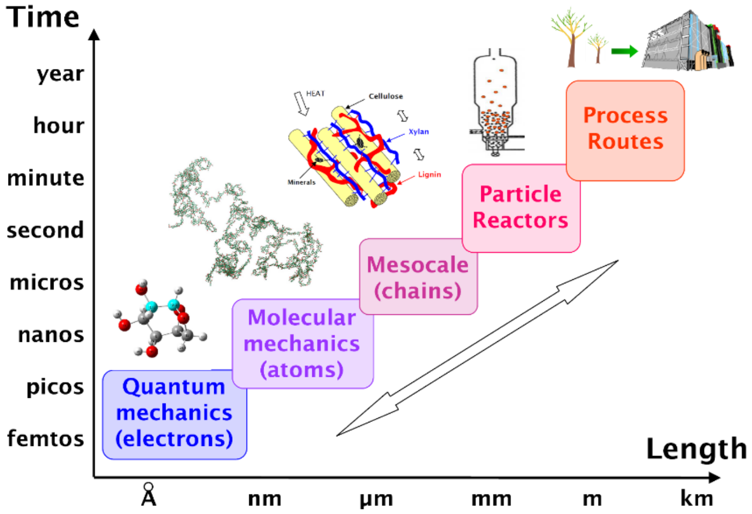
An overview on engineering thermochemistry in CNRS, Nancy, France

Yann Le Brech, Guillain Mauviel, Anthony Dufour*

Reactions and Chemical Engineering Laboratory, CNRS, University of Lorraine, ENSIC, 1 rue Grandville 54000 Nancy, France; (anthony.dufour@univ-lorraine.fr)

During this talk, I will first introduce our group at CNRS Nancy working on the thermochemical conversion of biomass and wastes.

Our research work deals with the main scales of investigation: from bioenergy routes to reactors, biomass particles and down to molecular mechanisms.



This talk will be structured based on these main scales of investigation, starting from “big scales” to smaller ones.

First, I will present our work on the environmental and technical-economical assessment of bioenergy routes with an example about purified H_2, heat and biochar production. These assessments are based on detailed modeling of thermochemical processes under Aspen Plus® software.

Then our pyrolysis and gasification reactors will be depicted. Our available reactors range from few milligrams to few kilograms of biomass treated, pressures up to 150 Bars and temperature up to 1000 ℃. We have different fixed, stirred, auger or fluidized bed reactors with various residence times of solid and gas.

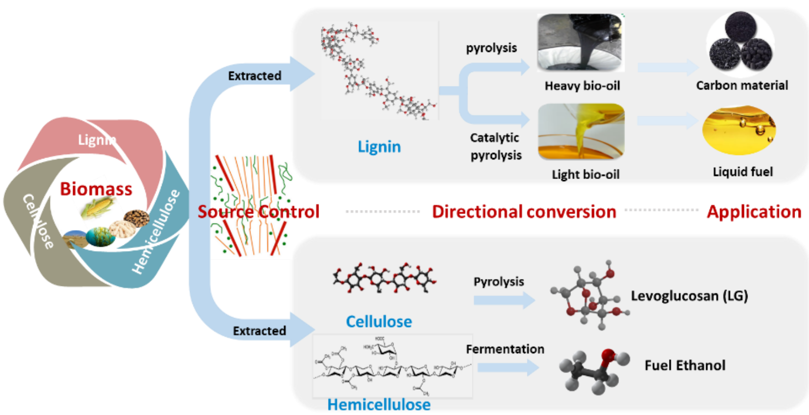
Concerning the mechanisms, I will briefly highlight how we study the main reactions (gas-phase or heterogeneous gas/solid) in tailored micro-reactors and with advanced analysis (like NMR or high resolution mass spectrometry).

Production of High-Quality Liquid Fuels, Carbon Materials and Syngas via Biomass Directional Conversion

Huiyan Zhang, Rui Xiao* (ruixiao@seu.edu.cn)

Key Laboratory of Energy Thermal Conversion and Control of Ministry of Education, School of Energy and Environment, Southeast University, Nanjing 210096, P.R. China

This paper conducts a systematic study on elucidating the mechanism of biomass catalytic pyrolysis, and proposing a novel approach of biomass resource pre-treatment coupled with selective deconstruction for thermal conversion. For oxygen-rich cellulose and hemicellulose components, a directed catalytic pyrolysis approach is introduced to achieve oxygen transfer, resulting in the production of clean oxygenated fuels such as alcohols and ethers. For carbon-rich lignin components, efforts are made to retain the inherent aromatic ring structure through oxygen-directed removal, leading to the preparation of high-quality hydrocarbon liquid fuels. For the utilization of geothermal heavy oil components, a multi-level porous carbon synthesis technology is developed, resulting in well-dispersed, uniform, amorphous carbon with abundant oxygen functional groups on the surface. When used as a supercapacitor electrode, it exhibits twice the capacitance of commercial carbon and extended cycling lifespan. For biomass feedstocks with high gasification activity, multi-site catalysts are developed, enabling integrated hydrogen-rich synthesis gas production with simultaneous hydrogen enrichment and decarbonization through directed catalytic gasification technology. This leads to the production of high-quality hydrogen-rich syngas, achieving the comprehensive utilization of all components. These novel concepts and technologies are applied in demonstration projects, promoting the clean and efficient utilization of biomass.



Chemical Product Engineering for Sustainable Development

Zhibing Zhang

Professor of Chemical Engineering and Co-Director of the China Institute, University of Birmingham, UK

Sustainability will be at the heart of all upcoming chemical processes in the following decades, aiming to achieve the net-zero objectives by the middle of this century. Within this context, Chemical Engineers have a pivotal role to play in driving sustainable development. They possess the capability to upscale new chemical processes from laboratory-scale to industrial dimensions, enhancing them for better economics, ecological friendliness, and energy efficiency.

A novel frontier within the realm of chemical engineering is Chemical Product Engineering. This domain merges the technical prowess and entrepreneurial acumen required to pioneer, formulate, and conceive new chemical and consumer products with high value. The focus lies in the development of functional products, placing particular emphasis on the product design and creation process.

My personal research revolves around the development and characterization of functional particulate products tailored for various applications, such as pharmaceuticals, nutraceuticals, agrochemicals, fabric care, and personal care. This research has successfully found industrial applications. Recent endeavours have centred on producing particulate or micro-sized systems that are more user-friendly and ecologically sound. The goal is to deliver functional active ingredients precisely when and where needed. This is achieved by substituting conventional petroleum-derived materials with plant-based alternatives that are on par with, or surpass, their performance, and by curtailing the use of microplastics in industrial products. The details of these accomplishments will be highlighted in the forthcoming presentation.

R&D and Application of Multi-source Organic Solid Wastes Pyrolysis

Qiang Lu

North China Electric Power University

Focusing on the key technological bottlenecks in the pyrolysis of multi-source organic solid wastes, this report covers the topics including the exploration of directional regulation mechanism of the pyrolysis process, development of core pyrolysis reactors with strong adaptability to raw materials, and the system integration and engineering demonstration of complete sets of pyrolysis technologies and equipment, which is of great significance in helping to achieve the carbon peaking and carbon neutrality goals of China and the Beautiful China Initiative.

Particle- to Reactor-scale CFD Simulation of Biomass Pyrolysis and ML-based Development of Reduced-order Models

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State Key Laboratory of Pulp and Paper Engineering, South China University of Technology, Guangzhou 510641, China

This report reports our CFD simulation work on particle- and reactor-scale biomass pyrolysis. Under the one-dimensional CFD modeling of intra-particle transport phenomena, the effects of pyrolysis reaction kinetics on heat transfer and product yields were first studied. The results clearly show that comprehensive but computationally affordable reaction kinetics are needed to give reasonable predictions of product yields and components. Then, the so-called particle-resolved direct numerical simulation was applied to study particle-scale biomass pyrolysis, showing that extra- and intra-particle transport phenomena should be simultaneously modeled. Later, Eulerian-Eulerian modeling of bubbling fluidized beds for biomass pyrolysis was presented to demonstrate the development of advanced sub-models for particle shrinkage and intra-particle heat conduction. The results show that if these two aspects are not considered, hydrodynamics and temperature profiles deviate much to experimental measurements. Afterwards, the work on using ML to develop zero-dimensional sub-models for particle- and reactor-scale CFD of biomass pyrolysis CFD from the results of one-dimensional modeling is introduced. The results show that the developed ML-based zero-dimensional sub-models have almost the same prediction accuracy but much less computational time. Finally, ML was employed to predict spatial and temporal evolutions of species of biomass pyrolysis in bubbling fluidized beds to show its applicability.

Numerical investigation of the volatiles distributor in a fluidized bed for biomass chemical looping combustion: model validation

Hao Luo[a,*] (haoluo@wust.edu.cn), Xiaobao Wang[a], Xiaoyun Li[b], Lan Yi[a], Anders Lyngfelt [b], Tobias Mattisson[b], Xiaoqin Wu[a], Qingang Xiong[c,*]

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The full combustible gas conversion in the fuel reactor of chemical looping combustion of biomass is critical for the inherent CO_2 capture advantage and negative CO_2 emission goal. However, due to the fast devolatilization process and limited injection ports of biomass, a local plume of volatiles would be formed and has limited contact with the oxygen carriers or reactive bed materials in the fluidized bed reactor. A novel concept called volatiles distributor (VD) has been proposed and investigated in a cold-flow fluidized bed, which shows that it is an effective and efficient solution to achieve even distribution of volatiles over the cross-section and thus improve the gas-solid contact in the fluidized bed reactor[1]. To get a better understanding of the influence of the VD on the hydrodynamics in the fluidized bed and gain more hints on the optimization and scale-up of the VD, a three-dimensional full-loop CFD simulation of a fluidized bed intensified with volatile distributors has been conducted by using an Eulerian multiphase granular model in this work. One homogenous drag model, i.e. the Gidaspow drag model[2] and two mesoscale drag models, i.e. the Filtered drag model[3] and the two-step EMMS/bubbling drag model[4], are evaluated with the experimental data of both vertical pressure profiles and horizontal gas concentration profiles. The results show that all three models can give reasonable predictions of pressure profiles and tracer gas (CO_2) concentration profiles when the fluidized bed is operated at a bubbling fluidization regime, while the two-step EMMS/bubbling drag predicts better during turbulent fluidization, indicating that the two-step EMMS/bubbling is the most applicable model for the investigated fluidized bed system. In addition, as compared to a fluidized bed without equipped with VD, the CFD simulations show that the mixing between simulated volatile and bed materials is enhanced when the fluidized bed is equipped with the VD. Therefore, the VD is an efficient way to solve the incomplete conversion of high-volatile fuels like biomass in fluidized bed systems.

Keywords: Drag model, Biomass chemical looping combustion; Fluidized bed; Volatiles distributor; Intensification;

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An asymmetric electrode matching reversible kinetics of oxygen reaction for a rechargeable Zn-air battery

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The development of zinc-air batteries (ZABs) is hindered by the sluggish kinetics of the oxygen reduction reaction (ORR) and the oxygen evolution reaction (OER) which occur in the complex interfaces between gaseous oxygen, liquid electrolyte and solid catalyst. A rational interface matching the multi-phase reaction kinetics is critically important. Herein, an asymmetric cathode has been designed and fabricated that the carbon nanotubes arrays (CNAs) encapsulating Co nanoparticles grown on carbon cloth is used as the aerophilic/hydrophobic side (AI-side) to match and catalyze the ORR kinetics, the other side that deposition of NiFe layered double hydroxide (NiFe-LDH) on the CNAs plays as aerophobic/hydrophilic side (AO-side) to accelerate the OER kinetics. The asymmetric electrode can well balance adsorption/desorption of O2 and OH- and facilitate the transport of gaseous and liquid reactants and products. Therefore, the efficiency of ORR and OER onto the corresponding catalytic sites of Co/CNAs and NiFe-LDH/CNAs are significantly enhanced. Consequently, the ZAB employing the asymmetric cathode can acquire a higher power density (236.26 mW cm^{-2}) and an excellent long-cycles (over 1920 cycles at 10 mA cm^{-2}) due to the enhanced kinetic and the improved reversibility of the charge-discharge reaction on the cathode benefiting from the aerophilic/hydrophilic interfacial construction on each side of electrode. The present study could explore a route to design the catalysts from the view of matching the multi-phase reaction characteristics.

Chemical looping for sustainable production of chemicals

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The current chemical industry is designed to work continuously, using cheap, petrochemical feedstock. Switching to renewable feedstock, whether it is bio-derived carbonaceous material, bio-CO_2, or renewable electricity, requires new decentralised and flexible operations, as all these resources are spatially distributed and available intermittently. Our work focuses on small-scale, dynamic processes, developing and employing new reaction and process pathways to produce key chemicals. This talk will present two such processes designed using a chemical looping approach where solid particles of metal oxides are the sole source of oxygen to catalytic reactions. In particular, I will discuss the chemical looping epoxidation (CLE) of ethylene to produce ethylene oxide (EO) and chemical looping oxidative dehydrogenation (CL-ODH) of ethanol to produce acetaldehyde.

Towards Circular Economy of Indonesian Biodiesel Industry

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Indonesia has a rapid growth of crude palm oil production in the last five years, with the number of 47 million tons in 2019. Domestic consumption only takes 32,3% of its total cumulative production, with the highest of utilization after food industry is for biodiesel making. In Indonesia, biodiesel is mixed with petroleum diesel at certain composition and widely used as a transportation fuel. As an alternative fuel, biodiesel has many advantages: it is derived from a renewable, domestic resource, it is biodegradable and non-toxic, also by utilizing biodiesel, we slowly relieving reliance on petroleum fuel imports. Even though it is considered as cleaner energy, biodiesel industries still face some challenges that needs to be addressed. Biodiesel process still uses homogeneous catalyst that will be wasted in the end of the process. High production of biodiesel also causes high supply of glycerine and it is necessary to find the downstream product from it to prevent market oversupply. Glycerine purification process produces distillation bottom product known as glycerine pitch which Government regulation in Indonesia categorized this waste as a hazardous waste that requires special treatment. These problems need to be solved to make biodiesel process cleaner and thus creating circular economy in biodiesel industries.