P&CP

PROGRAMME

论坛手册

International Forum on Pyrolysis and Catalytic Pyrolysis 2026

热解与催化热解国际专家学者论坛 2026

中国科学院大连化学物理研究所环境催化工程研究组
ENVIRONMENTAL CATALYSIS ENGINEERING, DICP, CAS
大连兴环能源科技有限公司
DALIAN XINGHUAN ENERGY TECHNOLOGY CO., LTD

Towards a world using only circular materials

可循环碳
终而复始

Welcome to P&CP 2026!

欢迎参加热解与催化热解国际专家学者论坛 2026

We are delighted to welcome you to Dalian for the *International Forum on Pyrolysis and Catalytic Pyrolysis 2026* (P&CP 2026).

P&CP 2026 focuses on the latest advances and challenges in converting circular carbon resources such as lignocellulosic biomass and end-of-life plastics, into sustainable and renewable fuels and chemicals through pyrolysis and catalytic pyrolysis, covering the entire spectrum from fundamental research to industrial demonstration.

We extend our sincere gratitude to all invited speakers for their valuable contributions. We believe this forum will foster meaningful dialogue and strengthen collaborations toward scientific and practical progress in the circular carbon domain.

We wish you a productive and enjoyable experience in P&CP 2026!

Chairs 召集人

Prof. Songbo He
DICP

Prof. Erik Heeres
University of Groningen

欢迎各位专家学者莅临中国大连，参加“热解与催化热解国际专家学者论坛 2026” 。

热解与催化热解国际专家学者论坛聚焦生物质和废塑料等可循环碳资源，探讨热解与催化转化技术制备可持续、可再生燃料与化学品的前沿进展与挑战。议题涵盖从基础研究到工业示范的全链条创新。

我们衷心感谢各位专家学者的积极参与。期待通过此次交流，凝聚共识、促进合作，共同推动可循环碳领域科研与应用的融合发展。

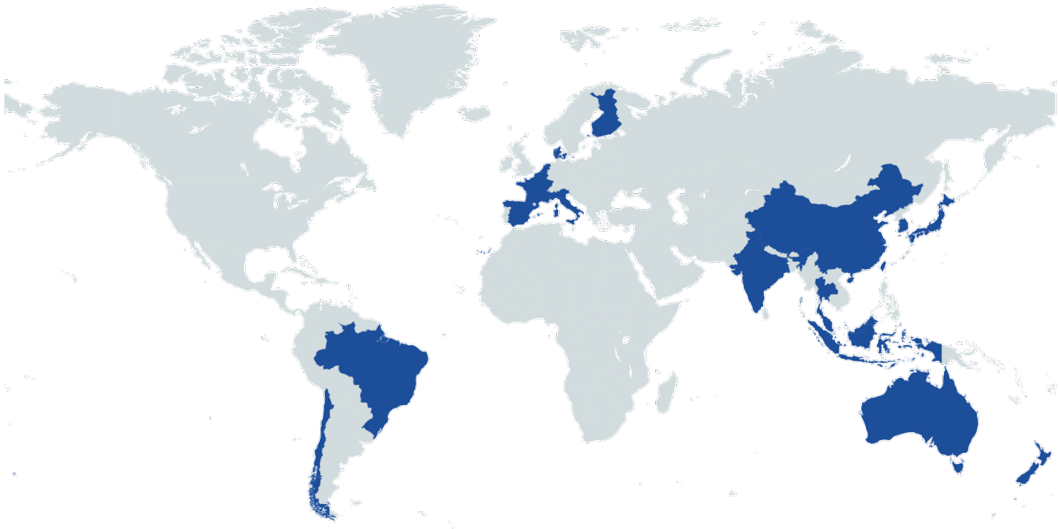
祝大家在本次论坛享受一段充实而愉快的学术时光！

Introduction

论坛介绍

The International Forum on Pyrolysis and Catalytic Pyrolysis (P&CP) invites leading experts from industry and distinguished scholars from academia to share their expertise and discuss theoretical and applied issues related to the pyrolysis and catalytic pyrolysis of circular carbon resources, contributing to the circular (bio) economy.

热解与催化热解国际专家学者论坛邀请工业界的顶尖专家和学术界的杰出学者分享他们的知识和经验，并讨论与可循环碳资源热解和催化热解相关的科学和技术问题，为循环（生物）经济做出贡献。



P&CP 2026 invited **30** experts from **18** countries across four continents, including Australia, Belgium, Brazil, Chile, China, Denmark, Finland, France, India, Indonesia, Italy, Japan, Malaysia, New Zealand, Spain, The Netherlands, Thailand, and South Korea.

热解与催化热解国际专家学者论坛2026邀请**30**名报告专家来自四大洲的**18**个国家，包括澳大利亚、比利时、巴西、智利、中国、丹麦、芬兰、法国、印度、印度尼西亚、意大利、日本、马来西亚、新西兰、西班牙、荷兰、泰国和韩国。

Among them, 9 Chinese experts come from **1** Chinese special administrative region, **1** Autonomous region, **2** direct-controlled municipalities, and **4** provinces in China, including Hong Kong, Shanghai, Tianjin, Fujian, Jiangsu, Shandong, Sichuan, Xizang, and Zhejiang.

其中九位中国专家分别来自中国的**1**个特别行政区、**1**个自治区、**2**个直辖市和**4**个省份，包括香港、上海、天津、福建、山东、四川、西藏和浙江。

We sincerely invite experts, scholars, business representatives, policymakers, and other stakeholders in circular carbon domain from around the world to participate in discussions on the frontiers of (catalytic) pyrolysis technology and to offer suggestions for achieving net-zero carbon goals.

我们诚挚邀请来自世界各地的专家、学者、企业代表、政策制定者以及循环碳领域的其他利益相关者参与关于（催化）热解技术前沿的讨论，并为实现净零碳目标提出建议。

The International Forum on Pyrolysis and Catalytic Pyrolysis is free to attend. Participants are encouraged to present their work in poster format to facilitate discussion and exchange.

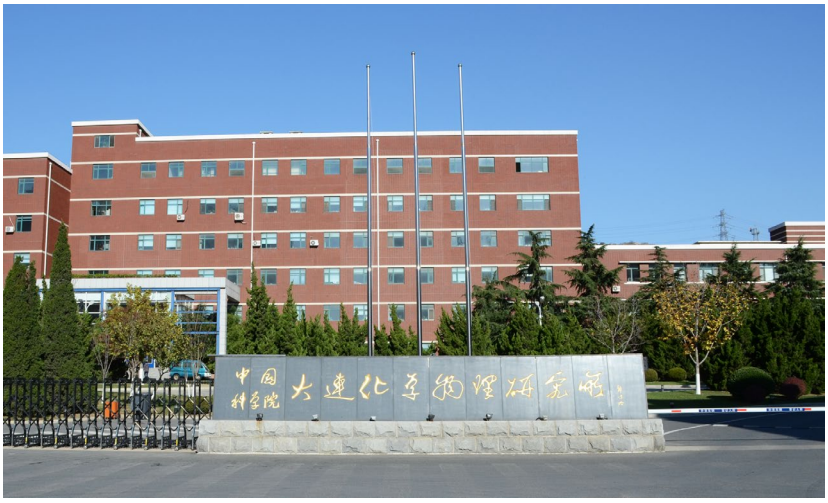
热解与催化热解国际专家学者论坛无注册费。建议参会者以墙报形式展示研究成果，以促进讨论和交流。

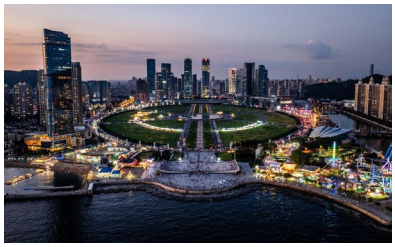
Forum address

论坛会址

Dalian Institute of Chemical Physics, CAS
中国科学院大连化学物理研究所

457 Zhongshan Road, Shahekou District, Dalian 116023, China
辽宁省大连市沙河口区中山路457号





Accommodation

专家入住酒店

Crowne Plaza Dalian Xinghai

大连星海皇冠假日酒店

60-1 Binhe Street, Shahekou District, Dalian 116001, China

辽宁省大连市沙河口区滨河街60-1号

Forum hall

论坛会场

Communication Center

Building No. 17

交流中心（17号楼）

Temporary wireless network at the forum hall
会场临时Wi-Fi
Wi-Fi/账号: NET2026
Password/密码: 20260126

DICP Campus

大连化学物理研究所园区

Topics

论坛主题

1. **Biomass to fuels:**
   Pyrolysis and catalytic upgrading

   生物质制燃料：热解与催化提质

2. **Biomass to chemicals:**
   Catalytic pyrolysis and hydropyrolysis

   生物质制化学品：催化热解与加氢热解

3. **Plastic pyrolysis and catalytic pyrolysis**

   塑料热解与催化热解

4. **Pilot and industrial demonstrations**

   中试和工业示范

Agenda
论坛日程

25 January SUN
- Arrival 到达
- Registration 注册
- Dinner 晚宴

26 January MON
- Opening Ceremony 开幕
- Forum 论坛
- Dinner 晚宴

27 January TUE
- Forum 论坛
- Dinner 晚宴

28 January WED
- Forum 论坛
- Closing Ceremony 闭幕
- Dinner 晚宴

Opening 开幕式

26 January
MON

Room 4, Communication Center
第四会议室，交流中心

8:15-8:30	**Arrival of all delegates** 到达会场
8:30-8:50	**Welcome address** 主办方致欢迎辞
8:50-9:20	**Special presentation for opening ceremony** 开幕式特别邀请报告 **Tao Zhang** Former Vice President of the Chinese Academy of Sciences Academician of the Chinese Academy of Sciences **张涛** 中国科学院原副院长 中国科学院院士
9:20-9:30	**Group photos** 合影

Closing 闭幕式

28 January
WED

Room 1-3, Communication Center
第1-3会议室，交流中心

15:00-15:30	**Summary of P&CP 2026** 总结和闭幕

Presentations
论坛报告

Plastic pyrolysis and catalytic pyrolysis

26 January
MON

Room 1-3, Communication Center
第1-3会议室，交流中心

On-site Manager: Weiling Piao
会场负责人：朴玮玲

Session Chair
Prof. Chunbao Xu

1	10:00-10:30	**Charles Chunbao Xu** City University of Hong Kong Hongkong, China	Microwave-assisted catalytic pyrolysis of plastic waste to produce aromatic-rich blendstock for SAF 利用微波辅助催化热解塑料废弃物制备富芳烃可持续航空燃料混合料
2	10:30-11:00	**Erik Heeres** University of Groningen The Netherlands	Improved H-ZSM-5 catalysts for aromatics (BTX) formation from polypropylene 改性H-ZSM-5催化剂催化聚丙烯制备芳烃（BTX）
3	11:00-11:30	**Young-Kwon Park** University of Seoul Republic of Korea	Production of aromatics via catalytic pyrolysis of organic waste under methane gas 甲烷气氛下有机废弃物催化热解制备芳烃
	11:30-13:30		**Lunch 午休** **Visit the DICP MUSEUM 所史馆参观**

Session Chair
Prof. Gartzen López

4	13:30-14:00	**Gartzen López** University of the Basque Country UPV/EHU Spain	Hydrogen rich gas production by continuous fast pyrolysis combined with in line catalytic reforming 连续快速热解耦合在线催化重整制备富氢气体
5	14:00-14:30	**Leilei Dai** Southeast University Nanjing, China	Chemical recycling of waste plastics through microwave-assisted pyrolysis 微波热解技术助力废塑料化学回收
6	14:30-15:00	**Shogo Kumagai** Tohoku University Japan	Analytical and applied pyrolysis approaches to chemical feedstock recovery from waste plastics 废塑料化学回收的分析与应用热解技术
	15:00-15:30		**Coffee Break 茶歇**

Session Chair
Prof. Anthony Dufour

7	15:30-16:00	**Anthony Dufour** CNRS, Université de Lorraine France	Controlling the conversion of waxes during plastic pyrolysis with a reflux 利用回流控制塑料热解过程中蜡的转化
8	16:00-16:30	**Yun Yu** Curtin University Australia	Formation and characterization of oil products from waste tyre pyrolysis in various reactor systems 不同反应系统中废轮胎热解油的生成规律与产物特性
9	16:30-17:00	**Ji Yang** Shanghai Jiao Tong University Shanghai, China	Electrified Joule-Heating Mediated Upcycling of Waste Plastics 电致焦耳热介导废塑料升级回收

Presentations
论坛报告

Biomass to fuels:
Pyrolysis and catalytic upgrading

Room 1-3, Communication Center
第1-3会议室，交流中心

On-site Manager: Wenjing Sun
会场负责人：孙文静

27 January
TUE

Session Chair
Prof. Alberto Wisniewski Jr.

1	8:30-9:00	**Alberto Wisniewski Jr.** Federal University of Sergipe Brazil	In-depth of the chemistry of bio-oils for understanding the feedstock and pyrolysis process 通过深入了解生物油的化学性质以理解原料和热解过程
2	9:00-9:30	**Lu Ding** East China University of Science and Technology, China	Gasification Technology in China: From fossil fuel to renewable energy 含碳原料气化技术：从化石原料到可再生能源
3	9:30-10:00 (NZST 14:30-15:00)	**Shusheng Pang*** University of Canterbury New Zealand	Biomass pretreatment and catalytic pyrolysis for improved liquid fuel and chemicals 生物质预处理和催化热解制备改进液体燃料和化学品
	10:00-10:30		**Coffee Break 茶歇**

* Online

Session Chair
Prof. Zhifeng Zheng

4	10:30-11:00	**Zhifeng Zheng** Xiamen University Xiamen, China	Hydrocarbon-rich fuels production by catalytic upgrading of biomass pyrolysis vapor 生物质及有机固体废弃物热化学转化制备燃料及功能材料
5	11:00-11:30	**Corinna Maria Grottola** CNR, Istituto di Scienze e Tecnologie per l'Energia e la Mobilità Sostenibili Italy	Biomass pyrolysis at Pymicolab: from fundamentals to product applications Pymicolab生物质热解研究：从基础到应用
6	11:30-12:00 (IST 9:00-9:30)	**Kaustubha Mohanty*** Indian Institute of Technology Guwahati India	Catalytic and non-catalytic co-pyrolysis of algae with dairy sludge: Ex-situ fed batch process for bio-oil production 藻类与乳业污泥的共热解和非原位催化与制备生物油
	12:00-13:30		**Lunch 午休** **Visit the Laboratory 实验室参观**

* Online

Presentations
论坛报告

Plastic pyrolysis and catalytic pyrolysis

Biomass to fuels:
Pyrolysis and catalytic upgrading

Pilot and industrial demonstrations

27 January
TUE

Room 1-3, Communication Center
第1-3会议室，交流中心

On-site Manager: Wenjing Sun
会场负责人：孙文静

Session Chair
Prof. Weiming Yi

7	**13:30-14:00**	**Weiming Yi** Shandong University of Technology Shandong, China	Pyrolysis behavior of biomass under flow-enhanced heat transfer 流动强化传热下生物质的热解行为
8	**14:00-14:30**	**Robbie Venderbosch** BTG Biomass Technology Group The Netherlands	Transform pyrolysis oil into a green crude oil: status and development 生物质热解油向绿色生物原油的转变：技术现状与发展趋势
	14:30-15:00		**Coffee Break 茶歇**

Session Chair
Dr. Niels Jan Schenk

9	**15:00-15:30**	**Niels Jan Schenk** BioBTX B.V. The Netherlands	Commercializing catalytic pyrolysis of waste polymers 废塑料催化裂解商业化之路
10	**15:30-16:00**	**André Heeres** Hanze University of Applied Sciences The Netherlands	Downstream processing of sustainable aromatics towards bioplastics 可持续芳烃制备生物质基塑料
11	**16:00-16:30 (GMT 8:00-8:30)**	**Dezhen Chen*** Tongji University Shanghai, China	Value-added utilization of wastes through pyrolysis: Principles, processes, and practices 废弃物热解高值化利用：原理、工艺、实践

* Online

Presentations
论坛报告

Biomass to chemicals:
Catalytic pyrolysis and hydropyrolysis

Room 1-3, Communication Center
第1-3会议室，交流中心

On-site Manager: Yanping Chen
会场负责人：陈艳平

28 January
WED

Session Chair
Prof. Anker Degn Jensen

1	**8:30-9:00**	**Anker Degn Jensen** Danmarks Tekniske Universitet Denmark	Overview of activities at DTU in pyrolysis related activities 丹麦技术大学（DTU）热解相关研究概述
2	**9:00-9:30**	**Tooran Khazraie Shoulaifar** Valmet Technologies Oy Finland	Advancing pyrolysis technologies at Valmet: Conversion of low-grade feedstock into valuable resources Valmet热解技术进展：将低品质原料转化为高价值资源
3	**9:30-10:00 (ICT 8:30-9:00)**	**Chanatip Samart*** Thammasat University Thailand	Reactive catalytic pyrolysis of palm kernel shell to high value chemicals 棕榈仁壳催化热解制备高值化学品
	10:00-10:30		**Coffee Break 茶歇**

* Online

Session Chair
Prof. Arshad Adam Salema

4	**10:30-11:00**	**Arshad Adam Salema** Monash University Malaysia Malaysia	Conventional and microwave pyrolysis with and without catalyst 使用催化剂和无催化剂的常规热解和微波热解
5	**11:00-11:30**	**Young-Min Kim** Daegu University Republic of Korea	The effective use of tandem micro-reactor on the catalytic co-pyrolysis of biomass and waste plastic 串联微反应器在生物质与废塑料催化共热解中的高效应用
6	**11:30-12:00**	**Shurong Wang** Zhejiang University Zhejiang, China	Thermochemical conversion of biomass and organic solid wastes: Toward the production of fuels and functional materials 生物质及有机固体废弃物热化学转化制备燃料及功能材料
	12:00-13:30		**Lunch 午休**

Presentations
论坛报告

Biomass to chemicals:
Catalytic pyrolysis and hydropyrolysis

Pilot and industrial demonstrations

28 January
WED

Room 1-3, Communication Center
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Session Chair
Prof. C.B. Rasrendra

7	**13:30-14:00**	**Carolus Borromeus Rasrendra** Bandung Institute of Technology Indonesia	Bio-Aromatics from renewable and waste carbon resources in Indonesia 印度尼西亚利用可再生与废弃碳资源生产生物基芳香烃
8	**14:00-14:30**	**Serguei Alejandro-Martín** Universidad del Bío-Bío Chile	Catalytic strategies for aromatic hydrocarbon production improvement during co-hydropyrolysis of biomass and plastics 生物质与塑料共加氢热解过程中提高芳烃产量的催化策略
9	**14:30-15:00 (CET, 9:30-10:00)**	**Balaji Sridharan*** Vlaamse Instelling voor Technologisch Onderzoek Belgium	Scaling up reductive lignin depolymerization: A sustainable pathway towards biomaterials and green chemicals 还原性木质素解聚工艺的放大：通往生物材料与绿色化学品的可持续路径

* Online

Microwave-assisted catalytic pyrolysis of plastic waste to produce aromatic-rich blendstock for SAF

利用微波辅助催化热解塑料废弃物制备富芳烃可持续航空燃料调和组分

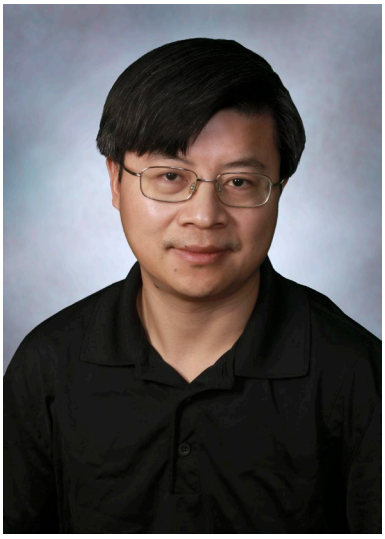
Charles Chunbao Xu
徐春保

School of Energy and Environment, City University of Hong Kong, China
E-mail: chunbaxu@cityu.edu.hk

Abstract
Driven by the accelerated global energy transition for carbon neutrality, the aviation sector has been proactively seeking decarbonization measures to reduce CO2 emission, nearly responsible for 2% of the total CO2 emission globally. Among all measures, using sustainable aviation fuels (SAFs) to substitute conventional jet fuels has been regarded as the most effective measure owing to its potential for reducing GHG emission by up to 80% without need for engine modification. Due to the abundant availability and the environmental threats of waste plastics, conversion of waste plastic into liquid fuels as potential SAF blendstock is under evaluation by ASTM. By microwave-assisted pyrolysis, waste polyolefin plastics can be converted into liquid fuels composed of straight-chain hydrocarbons and aromatics that may be used as jet fuel blendstocks. Nevertheless, this technology faces challenges in regulating the complex composition of plastic waste-derived oils. To address this challenge, in this work we investigated microwave-assisted catalytic pyrolysis of low-density polyethylene (PE) aiming to produce aromatic-rich blendstock for SAF. Effects of various process parameters have been investigated, including zeolite catalyst support, metal loading, catalyst reduction, zeolite pretreatment methods, and silica-alumina ratio of zeolite. It is concluded that remarkable catalytic performance of zeolite supported NiFe bimetallic catalysts stemmed from the synergy among in low Si/Al ratio of zeolite HY, high specific surface area induced by sulfuric acid pre-treatment, and efficient hydrogenation and aromatization capability of the Lewis acid active sites of the NiFe/Zeolite catalysts. The reduced Ni_2Fe_1/H_2SO_4-HY40 was selected as the most active catalyst. With this catalyst, long-chain wax products (largely formed in the catalyst-free runs) were completely converted into liquid oil products in the catalytic runs at an oil yield of 30.80 - 45.20 wt.%. More noteworthily, the content of aromatic hydrocarbons in the oils increased dramatically from 1.95% (without catalyst) to 93.75% (with the catalyst). In the catalytic runs, the obtained oils contain a high content (approx. 90%) of C_8-C_{16} aromatic hydrocarbons in the jet fuel range. Furthermore, the catalyst demonstrated good stability after four cycles of reuse followed by regeneration once, maintaining 91.05% aromatic hydrocarbon selectivity.

摘要
在全球能源转型推动下，航空业正积极寻求脱碳路径。可持续航空燃料（SAF）可在不改造发动机的前提下实现温室气体减排高达80%，成为重要发展方向。本研究基于微波辅助催化热解低密度聚乙烯，将废塑料转化为SAF调和组分。通过系统研究沸石载体类型、金属负载量、还原处理、酸预处理及硅铝比等因素的影响，发现采用低硅铝比HY沸石经硫酸预处理后负载Ni_2Fe_1的双金属催化剂性能最优，可实现长链蜡质完全转化为液体油（收率30.80–45.20 wt.%），并将芳烃含量从1.95%显著提升至93.75%。所得油品中近90%为C_8–C_{16}航煤范围芳烃。催化剂在四次再生循环后仍保持91.05%的芳烃选择性，表现出良好稳定性。

Prof. Charles Xu is currently Chair Professor of Advanced Biorefinery at School of Energy and Environment, City University of Hong Kong. He is Fellow of Canadian Academy of Engineering. He was a full professor and the NSERC/FPInnovations Industrial Research Chair in Forest Biorefinery at Western University, Canada. He has over 20 years of research experience in conversion of biomass and organic solid wastes (forestry/agricultural residues, food waste, municipal solid wastes, wastewater sludge, microalgae, etc.) into biofuels (sustainable aviation fuels, liquid transportation fuels, hydrogen) and green chemicals and biopolymer materials. With over 390 peer-reviewed papers published in journals, his work has received over 26,000 total citations with an H-index of 85 to date. He is recipient of the Excellent Research Award (1999) from the Japan Energy Society, the Syncrude Canadian Innovation Award (2011) and the Industrial Design and Practice Award (2019) from the Canadian Society of Chemical Engineers, the Changjiang Scholars Chair Professorship (2020) from the Ministry of Education of China, and the 2023 Humboldt Research Award from the Humboldt Foundation in Germany.



Prof. Charles Xu

Prof. Charles Xu 现任香港城市大学能源与环境学院先进生物炼制讲座教授、加拿大工程院院士。他曾任加拿大西安大略大学全职教授及加拿大自然科学与工程研究委员会（NSERC）/FPInnovations 林业生物炼制工业研究讲席教授。徐教授在生物质及有机固体废弃物（林业/农业残余物、餐厨垃圾、城市固体废弃物、污水污泥、微藻等）转化为生物燃料（可持续航空燃料、液体运输燃料、氢气）、绿色化学品及生物高分子材料领域拥有逾20年的研究经验。他已发表超过390篇同行评审期刊论文，总引用次数超过26,000次，H指数达85。徐教授曾荣获日本能源学会优秀研究奖（1999年）、加拿大化学工程师协会Syncrude加拿大创新奖（2011年）与工业设计与实践奖（2019年）、中国教育部长江学者讲座教授（2020年）以及德国洪堡基金会洪堡研究奖（2023年）。

Improved H-ZSM-5 catalysts for aromatics (BTX) formation from polypropylene

改性H-ZSM-5催化剂催化聚丙烯制备芳烃（BTX）

Erik Heeres

Green Chemical Reaction Engineering, Engineering and Technology Institute Groningen, University of Groningen, the Netherlands
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Abstract
Effective plastic waste recycling is a cornerstone of the circular economy, demanding technologies that are both efficient and selective. Catalytic pyrolysis stands out as a powerful chemical recycling strategy, enabling the conversion of plastic waste into high-value aromatics such as benzene, toluene, and xylene (BTX). In this work, we demonstrate the enhanced performance of Zn- and Cu-promoted H-ZSM-5 catalysts for the catalytic pyrolysis of n-hexane and polypropylene (PP) toward BTX production. Experiments were conducted in a fixed-bed reactor for n-hexane and in a double fluidized-bed reactor for PP at 550 ℃. The introduction of Zn and Cu markedly improved catalyst activity, selectivity, and stability. For n-hexane, the BTX yield increased more than threefold, from 4.6 wt% for the parent H-ZSM-5 to 14.8 wt% for Zn–Cu–ZSM-5 (Zn: 5%, Cu: 3.3%). Similarly, BTX yields from PP rose from 22.5 wt% to 34.4 wt% upon Zn–Cu promotion. Post-reaction analysis of catalysts used for n-hexane revealed a substantial reduction in coke formation, from 6.8% for Zn–ZSM-5 (Zn: 5%) to just 3% for Zn–Cu–ZSM-5, highlighting the beneficial role of Cu in suppressing coking. Although no catalyst deactivation was observed during PP conversion, characterization of the spent catalysts indicates pronounced structural and morphological evolution. Overall, these results underscore the strong potential of Zn–Cu–ZSM-5 catalysts for efficient and robust BTX production from plastic waste streams.

摘要
高效回收塑料废物是循环经济的基石，这要求兼具高效性与选择性的技术。催化热解作为一种强效的化学回收策略脱颖而出，能将塑料废物转化为苯、甲苯、二甲苯等高价值芳烃。本研究证明了锌、铜改性的H-ZSM-5催化剂在正己烷和聚丙烯催化热解制备芳烃中的性能提升。实验在550 ℃下进行，正己烷在固定床反应器中转化，聚丙烯在双流化床反应器中转化。锌和铜的引入显著改善了催化剂的活性、选择性和稳定性。对于正己烷，芳烃产率提升了三倍以上，从未改性H-ZSM-5的4.6 wt%提高至锌铜改性分子筛的14.8 wt%。同样，在锌铜改性后，聚丙烯的芳烃产率从22.5 wt%升至34.4 wt%。对正己烷反应后催化剂的分析表明，积碳形成大幅减少，从锌改性分子筛的6.8%降至锌铜改性分子的仅3%，凸显了铜在抑制积碳方面的积极作用。虽然在聚丙烯转化过程中未观察到催化剂失活，但使用后催化剂的表征显示出明显的结构与形貌演变。总之，这些结果充分表明锌铜改性H-ZSM-5催化剂在从塑料废物中高效、稳定生产芳烃方面具有巨大潜力。

Prof. Dr. Erik Heeres

Prof. Dr. Erik Heeres (25-06-1963) carried out his Ph.D. research at the University of Groningen on the development of novel homogeneous lanthanide catalysts for the conversion of unsaturated hydrocarbons and graduated in 1990. Afterward, he performed a post-doc at the University of Oxford in the group of Prof. J. M. Brown on asymmetric catalysis. From 1991-1999, he was employed at Shell Research B.V. (Amsterdam and Pernis, the Netherlands) and worked on a range of applied catalysis topics. Heeres joined the chemical engineering department of the University of Groningen in 1999 as an assistant professor. In 2003 he was appointed here as a full professor in green chemical reaction engineering. His research interests focus on the development of efficient catalytic technologies for circular carbon conversion. This involves the use of biomass for biofuels (catalytic pyrolysis, pyrolysis oil upgrading), platform chemicals (levulinic acid, hydroxymethylfurfural), and performance materials. Recently, the group started activities in the field of plastic recycling using pyrolysis technology. The group is actively involved in national and international consortia. Heeres is the (co-) author of more than 320 papers in international peer-reviewed journals and 15 patents in the field of (applied) catalysis and chemical reaction engineering. He is a member of the Koninklijke Hollandsche Maatschappij der Wetenschappen and the Netherlands Academy of Engineering.

Prof. Dr. Erik Heeres（生于1963年6月25日）于格罗宁根大学攻读博士学位期间，致力于开发用于不饱和烃转化的新型均相镧系催化剂，并于1990年获得博士学位。随后，他在牛津大学J. M. Brown教授课题组从事博士后研究，专注于不对称催化领域。1991年至1999年，他任职于壳牌研究有限公司（位于荷兰阿姆斯特丹和佩尔尼斯），从事多项应用催化课题的研究工作。1999年，Heeres加入格罗宁根大学化学工程系担任助理教授，并于2003年获聘为绿色化学反应工程正教授。他的研究致力于开发高效的催化技术以实现碳循环转化，重点包括生物质转化为生物燃料（催化热解、热解油提质）、平台化学品（乙酰丙酸、羟甲基糠醛）及高性能材料。近期，其课题组已开始利用热解技术开展塑料回收方向的研究。课题组积极参与国内外多个科研合作联盟。Heeres教授在（应用）催化和化学反应工程领域已发表国际同行评审论文320余篇，拥有15项专利，并是荷兰皇家艺术与科学学院及荷兰工程院院士。

Production of aromatics via catalytic pyrolysis of organic waste under methane gas

甲烷气氛下有机废弃物催化热解制备芳烃

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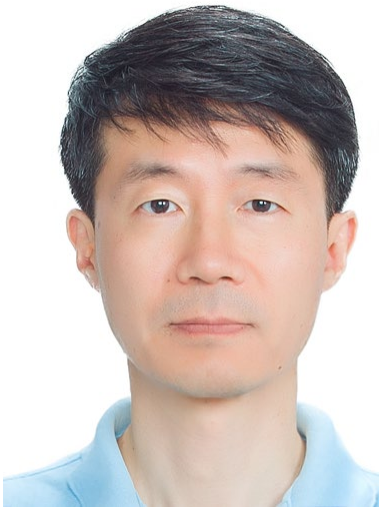
Abstract

This study explores the influence of methane on catalytic pyrolysis of plastic waste (polypropylene) to evaluate their potential toward the aromatic hydrocarbons with the Ga-modified ZSM-5 catalyst. Also the effect of pretreatment of catalyst such as reduction-oxidation process on the activity of catalysts was investigated. According to the results, the highest yield (39.5 wt%) of BTEX (benzene, toluene, xylene, and ethylbenzene) was achieved under CH_4 over reduction-oxidation Ga loaded catalyst among all tested conditions. The reduction-oxidation process not only promotes a significant reduction of the Ga-size but also induces its diffusion inside the pore, compared to non-treated Ga catalyst and reduced only Ga catalyst. This leads to the formation of highly active GaO^+ ionic species, balancing the Lewis/Brønsted ratio, thereby accelerating the aromatization reaction. A detailed reaction results with mechanism will be suggested.

摘要

本研究探索了甲烷对塑料废弃物（聚丙烯）催化热解的影响，旨在评估其在镓改性ZSM-5催化剂作用下生成芳烃的潜力，并考察了催化剂预处理（如还原-氧化过程）对催化活性的影响。结果表明，在所有实验条件中，经还原-氧化处理的镓改性催化剂在甲烷气氛下实现了最高的BTEX（苯、甲苯、乙苯和二甲苯）产率，达39.5 wt%。与未处理及仅还原处理的镓催化剂相比，还原-氧化过程不仅显著减小了镓物种的尺寸，还促使其向分子筛孔道内扩散。这形成了高活性的GaO^+离子物种，优化了路易斯酸与布朗斯特酸的比例，从而加速了芳构化反应。详细的反应结果与机理分析将在后续报告中呈现。

Prof. Young-Kwon Park is a Full Professor at the University of Seoul, Republic of Korea, and will serve as President of the Korea Society of Waste Management (2026-2028) and the Seoul Green Environment Center (2026). His research centers on the catalytic conversion of organic waste (e.g., biomass, plastics) via thermochemical processes and the transformation of global warming gases into valuable materials, aiming to develop sustainable waste valorization and carbon-neutral technologies. He holds key editorial roles in leading international journals, including Associate Editor for the Journal of Industrial and Engineering Chemistry and Editor-in-Chief for the Environment Section of the Korean Journal of Chemical Engineering. His recent work on catalytic pyrolysis, lignin depolymerization, and catalyst design has been published in high-impact journals such as Chemical Engineering Journal, Applied Catalysis B: Environment and Energy, and Bioresource Technology. In recognition of his contributions, Prof. Park was awarded a Medal of Honor in 2025 and elected as a Regular Member of the Korean Academy of Science and Technology.



Prof. Young-Kwon Park

Prof. Young-Kwon Park 是韩国首尔市立大学教授，担任韩国废物管理学会主席（2026–2028年）及首尔绿色环境中心主任（2026年）。他的研究聚焦于通过热化学过程（如热解、气化）催化转化生物质与塑料废物，并将温室气体转化为高价值材料，致力于发展可持续的废物资源化与碳中和技术。他在国际化工与环境领域担任多个重要期刊编辑，包括Journal of Industrial and Engineering Chemistry副主编及Korean Journal of Chemical Engineering环境栏目主编。近年来，其团队在木质素解聚、塑料催化热解制芳烃、以及负载型催化剂设计方面取得系列突破，相关成果发表于Chemical Engineering Journal、Applied Catalysis B、Bioresource Technology等顶级期刊。Prof. Park于2025年荣获大韩民国荣誉勋章，并当选为韩国科学技术院正式院士。

Hydrogen rich gas production by continuous fast pyrolysis combined with in line catalytic reforming

连续快速热解耦合在线催化重整制备富氢气体

Gartzen López

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Abstract

Summarizes most relevant results obtained in waste plastics conversion into a hydrogen rich stream by means of fast pyrolysis and in line catalytic steam reforming at the University of the Basque Country EHU. The experiments were performed in an original unit operating in continuous regime. The pyrolysis step was carried out in a conical spouted bed reactor under fast pyrolysis conditions. This reactor ensures an efficient conversion of different types of plastic into a volatile stream for their subsequent further transformation in the reforming reactor. Moreover, a fluidized bed reactor was proposed for the reforming of plastics derived stream. This reactor provides suitable contact with the catalysts and excellent heat transfer conditions.

In this presentation a wide variety of results obtained in the last 10 years in our research group are reported. The influence of steam reforming step main conditions, i.e., temperature, steam plastic (S/P) ratio and catalysts space time, was studied in the reforming of HDPE pyrolysis volatiles. Thus, the increase of these parameters improved process conversion and hydrogen production. Then, the flexibility of pyrolysis-steam reforming process was analyzed by studying the effect of feeding different types of polymers (HDPE, PP, PET, PS and a mixture) and biomass/plastics mixtures. Amongst the plastics studied polyolefins were those with better hydrogen productions potential. values in the 34% to 37% were obtained in the valorization of PP and HDPE. Biomass co-feeding gave way to lower hydrogen production, but the process demonstrated a remarkable interest for biomass and waste plastics joint valorization.

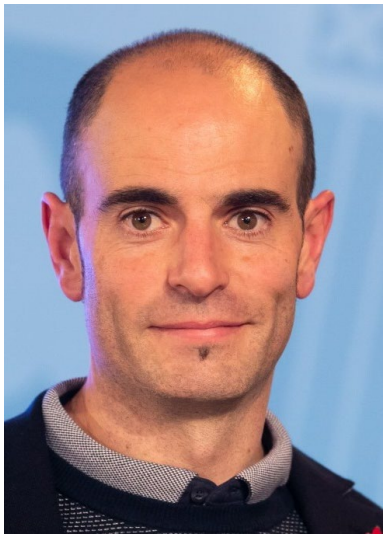
In order to improve the efficiency of the plastics pyrolysis-reforming process different strategies were studied. On the one hand, the performance of different catalysts was tested, the aim was to improve their activity and stability. On the other hand, the role played by oxygen feeding into the reforming reactor was evaluated. Finally, latest research lines associated with plastics conversion into hydrogen and syngas as sorption enhanced reforming and dry reforming were included.

摘要

总结了EHU在废塑料快速热解结合在线催化蒸汽重整制富氢气体方面的核心研究成果。实验采用连续运行装置，其中热解段在锥形喷动床反应器中实现塑料快速转化，产生的挥发分直接进入流化床重整反应器进行深度催化转化。该流化床系统具有良好的催化剂接触与传热性能。

近十年来，本研究系统探讨了重整温度、水蒸气/塑料比（S/P）及催化剂空时对高密度聚乙烯（HDPE）热解挥发分重整过程的影响，提高上述参数可显著促进转化率与氢气产率。研究同时比较了不同聚合物（HDPE、PP、PET、PS及其混合物）及生物质/塑料共处理时的产氢性能，其中聚烯烃表现最优，PP与HDPE的产氢率可达34%–37%。生物质共进料虽降低产氢量，但为生物质与废塑料协同转化提供了可行路径。

为提升过程效率，研究进一步评估了多种催化剂性能及其稳定性，并探讨了向重整反应器引入氧气的作用。此外，也涵盖了吸附强化重整、干重整等制氢/合成气的新研究方向。



Dr. Gartzen López

Dr. Gartzen López earned his Bachelor's degree in Chemical Engineering in 2003 and his PhD in 2008, both from the University of the Basque Country. Following the completion of his doctorate, he secured a full-time research position at the university. In 2019, he was awarded an Ikerbasque Research Fellow grant, and he currently holds the position of Research Associate Professor. His research focuses on several key areas: i) the pyrolysis and catalytic pyrolysis of biomass and waste plastics, ii) the gasification of waste for syngas production, iii) the valorization of plastics and biomass via pyrolysis coupled with in-line catalytic reforming for hydrogen production, and iv) the design and scale-up of spouted bed reactors. He has authored more than 170 papers in JCR-indexed journals and presented over 200 communications at conferences. His work has achieved an h-index of 73 and garnered more than 13,400 citations (Scopus). He has participated in more than 30 research projects, serving as the principal investigator for 7 of them, with total funding amounting to approximately 1.95 million euros. He has supervised 5 completed PhD theses and is currently advising 5 PhD students. Additionally, he serves as a guest editor for several JCR-indexed journals, including the Journal of Analytical and Applied Pyrolysis Energy and Resources, Particuology, Waste Disposal & Sustainable Energy, Catalysts, Processes, and Energies.

Dr. Gartzen López 于2003年和2008年先后在巴斯克大学获得化学工程学士学位和博士学位。毕业后留校担任全职研究员，并于2019年荣获伊克尔巴斯克研究员基金资助，现任该大学研究副教授。他的研究主要集中于以下几个方向：i）生物质与废弃塑料的热解及催化热解；ii）废弃物气化制合成气；iii）通过热解结合在线催化重整技术，将塑料和生物质转化为氢气，实现其高值化利用；iv）喷动床反应器的设计与放大。已在JCR期刊上发表论文170余篇，在各类学术会议上发表报告200多次。其研究成果的H指数为73，累计被引超过13,400次（Scopus数据）。他参与了30多个研究项目，其中作为项目负责人主持了7项，获得资助总额约195万欧元。他已指导完成5名博士研究生，目前正在指导5名博士生。此外，他还担任多家JCR期刊的特约编辑，包括the Journal of Analytical and Applied Pyrolysis Energy and Resources, Particuology, Waste Disposal & Sustainable Energy, Catalysts, Processes, and Energies。

Chemical recycling of waste plastics through microwave-assisted pyrolysis

微波热解技术助力废塑料化学回收

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Abstract

Thermochemical conversion offers an efficient route for the high-value utilization of waste plastics; however, the intrinsic complexity of process control, the difficulty in tailoring product distributions, and the relatively high energy consumption continue to hinder further technological advancement. Centered on the core scientific challenge of green, low-energy, and selective conversion of waste plastics, this study establishes a microwave-enhanced thermochemical conversion framework and systematically elucidates the regulatory roles of microwave fields in plastic cracking pathways, interfacial polarization behavior, and product distribution. In addition, microwave-responsive zeolite catalysts with hierarchically ordered macro–meso–microporous architectures have been developed, leading to pronounced improvements in target-product selectivity and catalyst lifetime. By constructing a microwave-responsive interfacial reaction microenvironment, precise energy coupling and synergistic intensification of PET depolymerization are achieved, advancing polyester chemical recycling toward high-value, high-efficiency, and environmentally benign pathways. Furthermore, an efficient heat-carrier utilization strategy is proposed, and a hybrid down-flow microwave pyrolysis reactor is developed and validated at the pilot scale. Collectively, this work provides critical theoretical foundations and enabling reactor technologies for the selective conversion of waste plastics into high-value chemicals.

摘要

废塑料热转化为废塑料高值化利用提供了高效途径，然而其过程调控复杂、产物分布难调控且能耗偏高，仍制约着技术的进一步发展。本研究围绕废塑料绿色低能定向转化的核心科学问题，构建了微波强化热转化体系，系统揭示了微波场对废塑料热裂解路径、界面极化行为与产物分布的调控规律；基于催化剂构效关系的定性定量描述，发展了具有层级有序大–介–微孔结构的微波响应分子筛催化剂，实现了目标产物选择性及催化剂寿命的显著提升；通过构建微波响应界面反应微环境，实现了 PET 解聚反应的能量精准耦合与协同强化，推动聚酯化学回收向高值、高效、绿色方向发展；并提出高效热载体利用模式，研制混动下行式微波热解反应器，完成中试装置的验证，为废塑料定向转化制高值化学品提供了重要的理论支撑与装备基础。

Prof. Leilei Dai is a professor at the School of Energy and Environment, Southeast University. His research focuses on the thermochemical conversion of organic solid waste. He has published over 100 papers in high-impact journals such as Nat. Rev. Mater., Prog. Energy Combust. Sci., and Appl. Catal., B, with more than 8,000 total citations and an H-index of 54. He is a Fellow of the International Association of Advanced Materials and has been listed among Stanford University's Global Top 2% Scientists for five consecutive years. He serves as associate editor of Sustainable Carbon Materials and Frontier in Chemical Engineering and as a editorial board member or guest editor for a few journals. His honors include the IAAM Scientist Medal and the Gold Medal at the Geneva International Exhibition of Inventions.

Prof. Leilei Dai
戴磊磊

戴磊磊，东南大学能源与环境学院青年首席教授、博导，国家高层次青年人才入选者。主要从事有机固体废弃物热化学转化相关研究，研究成果在Nat. Rev. Mater.、Prog. Energy Combust. Sci.、Appl. Catal., B等期刊发表SCI论文100余篇，文章总引用次数8000余次，H指数54，入选国际先进材料协会会士，连续5年入选斯坦福大学全球前2%顶尖科学家。参与编写英文专著2部，授权发明专利3件。担任Sustainable Carbon Materials等期刊副主编及多个期刊青年编委/客座编辑。主持国家自然科学基金委、科技部、南京市留学人员科技创新项目等多项研究项目，获国际先进材料协会科学家奖章、日内瓦专利展金奖等奖项。

Analytical and applied pyrolysis approaches to chemical feedstock recovery from waste plastics

废塑料化学回收的分析与应用热解技术

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Abstract

The world is moving toward carbon neutrality, and many countries aim to achieve carbon-neutral societies by around 2050. Meanwhile, the annual generation of waste plastics is increasing, and demand for plastic recycling is rapidly growing worldwide to enable the sustainable use of plastics. In this presentation, I will introduce the latest developments in my research on chemical feedstock recovery from waste plastics via pyrolysis and catalytic pyrolysis. Specifically, I will present (i) pyrolytic approaches we have developed to recover chemical feedstocks from hard-to-recycle plastics, such as poly(ethylene terephthalate) (PET) and polyurethane (PU) wastes; (ii) co-processing of waste plastics with vacuum residue, with a view toward integration into existing delayed coker units; and (iii) the development of advanced pyrolysis–gas chromatography (Py-GC) methods to support the design and optimization of pyrolytic recycling processes.

摘要

随着全球向碳中和目标迈进，许多国家致力于在2050年前实现碳中和。与此同时，全球每年产生的废塑料数量不断增长，为实现塑料的可持续利用，塑料回收需求在全球范围内迅速扩大。本次报告将介绍本人通过热解及催化热解技术从废塑料中回收化学原料的最新研究进展，具体包括：（1）针对聚对苯二甲酸乙二醇酯（PET）和聚氨酯（PU）等难回收塑料，开发的热解原料回收技术；（2）废塑料与减压渣油的共处理技术，并探索其与现有延迟焦化装置整合的可行性；（3）支持热解回收工艺设计与优化的先进热解–气相色谱（Py-GC）分析方法。

Dr. Kumagai is an Associate Professor at the Graduate School of Engineering, Tohoku University. He serves as an Editor of the Journal of Analytical and Applied Pyrolysis (Elsevier), a leading journal in the field of pyrolysis, and as an Associate Editor of the Journal of Material Cycles and Waste Management (Springer Nature). His research focuses on the development of plastic recycling technologies and on applied and analytical pyrolysis of polymeric materials, including plastics, lignocellulosic biomass, and petroleum-derived substances. Dr. Kumagai received his Ph.D. from Tohoku University in 2015 and joined Tohoku University immediately thereafter. In 2015, he was awarded the JSPS Ikushi Prize, one of Japan's most prestigious awards for doctoral researchers. He was also selected as one of the top 100 finalists in the 2017 Falling Walls Lab competition, chosen from over 3,000 candidates representing more than 50 countries. Dr. Kumagai has authored more than 170 research articles in SCI-indexed journals, contributed over 40 reviews and book chapters, and has filed more than 70 patent applications.

Dr. Kumagai

Dr. Kumagai 现任日本东北大学研究生院工学科副教授，担任热解领域权威期刊Journal of Analytical and Applied Pyrolysis（Elsevier）主编及Journal of Material Cycles and Waste Management（Springer Nature）副主编。其主要研究方向包括塑料回收技术开发、以及塑料、木质纤维素生物质与石油衍生聚合物材料的应用热解与分析热解。熊谷博士于2015年获得东北大学博士学位并留校任教，同年荣获日本学术振兴会（JSPS）育志奖（日本博士研究生最高荣誉之一）。2017年，他从全球50余个国家3000余名候选者中脱颖而出，入选“Falling Walls Lab”全球百强。迄今已在SCI期刊发表研究论文170余篇，撰写综述与专著章节40余篇，提交专利申请70余项。

Controling the conversion of waxes during plastic pyrolysis with a reflux

利用回流控制塑料热解过程中蜡的转化

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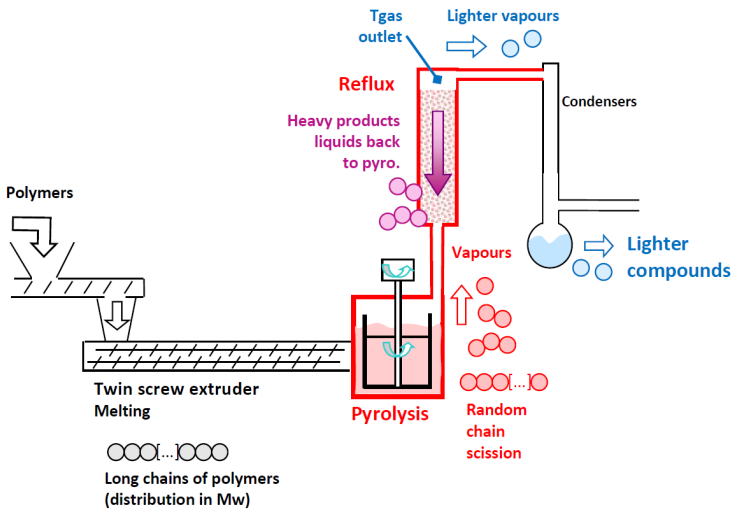
Abstract

One of the main issue of plastic pyrolysis is to control the composition of the liquid products (often presenting a broad distribution of molecular weight) and to reduce waxes. A reflux could promote the formation of lighter products by reducing waxes. Indeed, a reflux set at a lower temperature than the pyrolysis reactor can condensate the vapours of heavy molecular species which can be injected back into the pyrolysis reactor in order to undergo further depolymerisation reactions. Therefore, the temperature of the reflux may control the molecular weight distribution of the liquids. During this talk, we will present a novel continuous pilot reactor developed at CNRS Nancy combining: an extruder melt feeder, a stirred reactor, a reflux and a condensation train. We will show how the temperature of the reflux can impact the molecular weight distribution of liquid products for 2 complementary examples: PP and PS pyrolysis. The liquids were analyzed by GC/MS-FID, simulated distillation, high resolution mass spectrometry and a bench-top NMR. We will show how a reflux can properly control the molecular weight composition of the liquids.



摘要

塑料热解的核心挑战之一在于调控液体产物的组分分布（通常具有较宽的分子量范围）并减少蜡质生成。回流技术可通过降低蜡质含量促进轻质产物的形成。具体而言，在低于热解反应器温度下设置回流系统，可使重组分蒸气冷凝并重新注入反应器，进一步发生解聚反应。因此，回流温度可有效调控液体产物的分子量分布。本次报告将介绍法国国家科学研究中心（CNRS）南锡研究所开发的新型连续式中试反应装置，该装置集成了挤出熔融进料系统、搅拌反应器、回流装置及冷凝单元。通过聚丙烯（PP）和聚苯乙烯（PS）热解两个互补案例，阐释回流温度对液体产物分子量分布的影响机制。液体产物采用气相色谱-质谱/氢火焰离子化检测器（GC/MS-FID）、模拟蒸馏、高分辨质谱及台式核磁共振仪进行系统表征。实验表明，回流技术能够精准调控液体产物的分子量组成。

Dr. Anthony Dufour is a research professor at CNRS (The National Center for Scientific Research, Nancy, France) working on the thermochemical conversion of biomass and wastes. His main research interests are: fundamentals of biomass and plastics pyrolysis (by mass spectrometry, in-situ analysis, etc.), reactivity of carbons (towards oxidation reactions), catalysis for tar reforming or bio-oil hydrodeoxygenation, development of pyrolysis, liquefaction and gasification reactors, interdisciplinary assessment of bioenergy routes. He was instrumental in organizing several international symposiums. He currently work with various industrial companies on the development of pyrolysis or gasification processes. He served as an editor of Journal of Analytical & Applied Pyrolysis (Elsevier) from 2017 to 2020. He is currently executive editor of Energy & Fuels (American Chemical Society).

Dr. Anthony Dufour

Dr. Anthony Dufour 现任法国国家科学研究中心（CNRS）南锡研究所研究教授，主要从事生物质与废弃物的热化学转化研究。核心研究方向包括：生物质与塑料热解机理（基于质谱、原位分析等技术）、碳材料反应性（面向氧化反应）、焦油重整与生物油加氢脱氧催化、热解/液化/气化反应器开发，以及生物能源路径的跨学科评估。曾多次主导组织国际学术研讨会，目前与多家工业企业合作开展热解/气化工艺研发。2017至2020年担任《Journal of Analytical & Applied Pyrolysis》（Elsevier）期刊编辑，现任《Energy & Fuels》（美国化学会）执行编辑。

Formation and characterisation of oil products from waste tyre pyrolysis in various reactor systems

不同反应系统中废轮胎热解油的生成规律与产物特性

Yun Yu

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Abstract

Pyrolysis is a promising technology for converting waste tyres into high-quality oil, which can be used for low-carbon fuels and chemicals. However, existing studies face challenges in capturing highly volatile compounds like isoprene and accurately quantifying total oil yields. In this work, a recently developed method for trapping and analyzing volatiles was applied in different reactors—wire mesh (WMR), fixed bed, and fluidized bed. The WMR minimizes secondary reactions, allowing study of primary pyrolysis mechanisms.Pyrolysis in the WMR began around 250 ℃, with oil yield increasing with temperature and time, reaching ~47% at 600 ℃. The oil consisted mainly of limonene (60–65% selectivity) and isoprene (9%–13%) from natural rubber, along with toluene, ethylbenzene, and p-xylene (each 6%–10%) from synthetic rubber. Quantified compounds accounted for 94–97% of the oil.In the fixed bed, isoprene was only detected below 500 ℃, with selectivity dropping from ~16% at 250 ℃ to ~0.1% at 500 ℃. Limonene selectivity peaked near 49% at 400 ℃ before falling to ~14% at 600 ℃, while selectivities of toluene, p-xylene, and ethylbenzene rose with temperature. Similar trends were observed in the fluidized bed, but with slightly different selectivities. Total selectivity of key compounds decreased significantly with temperature in both fixed bed (72% to 52%) and fluidized bed (81% to 62%), much lower than in the WMR. These results indicate that isoprene and limonene become unstable above 400 ℃, leading to more high-molecular-weight compounds. The study provides new insights into primary and secondary pyrolysis mechanisms in different reactors, supporting the production of low-carbon fuels and chemicals from waste tyres.

摘要

热解是废轮胎资源化的有效手段，其油品可用于生产低碳燃料与化学品。然而现有研究在挥发性组分捕获和油品准确定量方面存在不足。本研究采用自主研发的挥发性组分捕集与分析方法，在WMR、固定床和流化床等多种反应器内开展实验。其中WMR可最大程度抑制二次反应，有助于探究热解一次反应机理。实验表明，热解起始温度约为250 ℃，油收率随温度升高而增加，600 ℃时达最高约47%。油中主要成分为天然橡胶衍生的柠檬烯（选择性60－65%）和异戊二烯（9－13%），以及合成橡胶衍生的甲苯、乙苯、对二甲苯（各占6－10%），已定量组分占总油品94－97%。在固定床中，异戊二烯仅在低于500 ° C时检出，其选择性从250 ℃的约16%降至500 ℃的0.1%；柠檬烯选择性在400 ℃达峰值约49%，600 ℃时降至约14%；而甲苯、对二甲苯和乙苯的选择性随温度上升。流化床结果趋势相似，但选择性略有不同。随着温度从250 ℃升至600 ℃，固定床与流化床中主要组分总选择性分别从72%降至52%、81%降至62%，均显著低于WMR。以上结果表明，异戊二烯和柠檬烯在400 ℃以上不稳定，易转化为更多高分子量产物。本研究从反应器角度揭示了废轮胎热解的一次与二次反应路径，为低碳燃料与化学品的定向制备提供了依据。

Dr. Yun Yu

Dr. Yun Yu is a Senior Lecturer in Chemical Engineering and Co-Leader of the High Temperature Lab in the WA School of Mines (WASM) at Curtin University. He has over 20 years of experience in thermochemical conversion of biomass and carbonaceous wastes (e.g., plastics, tyres) for low-carbon fuel and energy applications, including biochar, bio-oil and syngas production. Listed among the World's Top 2% Scientists (2021-2025) by Stanford University, he has published more than 110 journal papers with over 5,700 citations (H-index: 43). His contributions have been recognised through several awards, including an ARC Discovery Early Career Researcher Award (2012), Publons Peer Review Award (2018), Energy & Fuels Excellence in Review Award (2023), and Energy & Fuels Most Impactful Articles (2023). He also serves as Review and Perspectives Editor for Energy & Fuels and sits on the Editorial Boards of leading journals such as Journal of Analytical and Applied Pyrolysis. Dr Yu has collaborated extensively with various partners for developing advanced technologies for low-carbon fuel and energy applications. He has secured over A$10 million worth of research grants as Chief Investigator (CI) from various government (i.e., ARC, ARENA, CRC) and industry (i.e., Woodside, BHP, Rio Tinto) partners. Dr Yu has supervised 13 PhD students to successful completion, and has mentored 4 Research Associates (RA) and several Visiting Scholars.

Dr. Yun Yu 现任科廷大学西澳矿业学院的高级讲师兼高温实验室联合主任。他在生物质和含碳废弃物（如塑料、轮胎）的热化学转化领域拥有超过20年研究经验，致力于低碳燃料与能源应用，包括生物炭、生物油和合成气的生产。作为斯坦福大学评选的“全球前2%顶尖科学家”（2021–2025），他已发表110余篇期刊论文，被引超过5700次（H指数：43）。其学术贡献获得多项荣誉认可，包括澳大利亚研究理事会探索早期职业研究员奖（2012年）、Publons同行评审奖（2018年）、*Energy & Fuels* 杰出评审奖（2023年）及最具影响力论文奖（2023年）。他现任*Energy & Fuels* 期刊的综述与观点编辑，并担任 *Journal of Analytical and Applied Pyrolysis*等多个权威期刊编委。在科研合作方面，余云博士与各界伙伴合作开发低碳燃料与能源应用技术，作为首席研究员累计获得超1000万澳元科研经费，资助方涵盖政府机构（如澳大利亚研究理事会、澳大利亚可再生能源署、合作研究中心）和行业巨头（如伍德赛德、必和必拓、力拓）。他已指导13名博士生完成学位，并指导4名研究助理及多名访问学者。

Electrified Joule-Heating Mediated Upcycling of Waste Plastics

电致焦耳热介导废塑料升级回收

Ji Yang
杨寄

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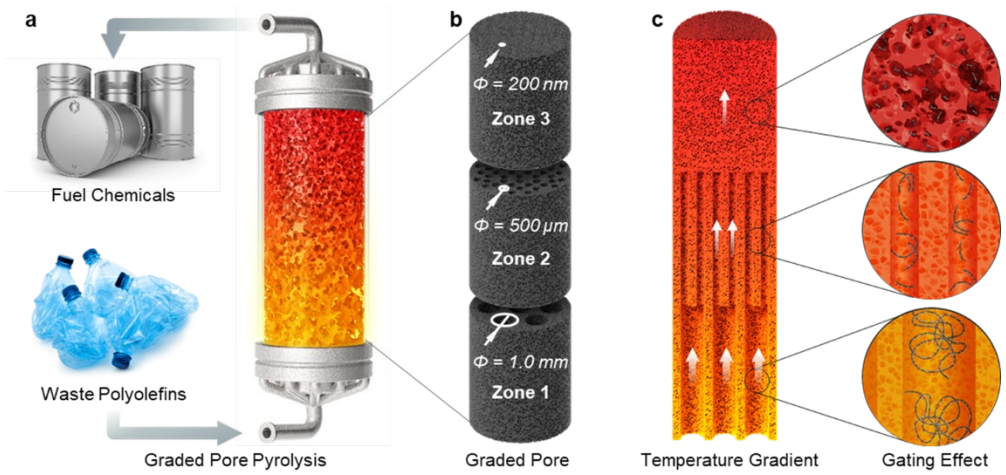
Abstract

The increasingly severe global plastic pollution crisis, with an estimated cumulative plastic waste projected to reach 26 billion tons by 2050, far exceeds the environmental carrying capacity. This study proposes and constructs a novel non-catalytic pyrolysis reactor featuring temperature and pore-size gradients, enabling precise regulation of the migration and cracking behavior of polyethylene pyrolysis intermediates. By introducing a “gating effect,” the design achieves molecular-level selective sieving and staged reactions, successfully synthesizing aviation fuel-range products (C_8–C_{18}) with a high yield of up to 65.9% for the first time without the need for catalysts. The reactor structure employs a macroscopically adjustable pore-size gradient combined with microsecond pulsed electric heating, balancing high-temperature cracking activity with process controllability. This approach significantly enhances the selectivity and stability of pyrolysis products, offering a novel and versatile technical pathway for the green and high-value conversion of waste plastics.



摘要

全球塑料污染问题日益严峻，预计到2050年塑料垃圾累积量将达260亿吨，远超环境承载能力。本研究提出并构建了一种具有温度与孔径梯度的新型非催化热解反应器，实现了对聚乙烯热解中间体迁移与裂解行为的精准调控。通过引入“门控效应”，该设计有效实现了分子级的选择性筛分与分段反应，首次在无需催化剂条件下高效合成航空燃料区间产物（C_8–C_{18}），最高产率达65.9%。反应器结构采用宏观可调控的孔径梯度配合微秒级脉冲电加热方式，兼顾高温裂解活性与反应过程可控性，显著提升了热解产物的选择性与稳定性，为废塑料的绿色高值转化提供了一种新颖而通用的技术路径。

Prof. Ji Yang
杨寄 教授

Prof. Ji Yang is currently an associate professor and doctoral supervisor at Shanghai Jiao Tong University, dedicated to research in catalytic materials and sustainable chemistry. He focuses on developing innovative catalysts and processes to address global energy and environmental challenges, with expertise encompassing catalytic and non-catalytic pyrolysis of polyolefins (plastics), high-value chemical conversion, and the design of special new materials. Dr. Yang obtained his Ph.D. from the Leibniz Institute for Catalysis in Germany (2017-2020) under Prof. Matthias Beller, following his M.S. from the Shanghai Institute of Organic Chemistry, CAS under the guidance of Prof Zheng Huang (2014-2017). He further enriched his research profile through postdoctoral training at the Leibniz Institute for Catalysis (2020-2021), Colorado State University (2021-2022), the University of Maryland (2022-2024), and Yale University (2024-2025). His work has been recognized with several honors, including the 2023 National Excellent Young Scientists Fund (Overseas), the 2023 Shanghai Leading Talent, the 2023 Shanghai Pujiang Scholar, the 2023 Shanghai Pudong New Area Mingzhu Elite Talent, and the 2020 Young Chemist Award from the Association of Chinese Chemistry and Chemical Engineering in Germany.

杨寄，现任上海交通大学副教授、博士生导师，长期致力于催化材料与可持续化学研究。他专注于开发创新催化剂及工艺以应对全球能源与环境挑战，研究专长涵盖聚烯烃（塑料）的催化与非催化热解、化学品高附加值转化以及特种新材料设计合成。杨寄在中国科学院上海有机化学研究所完成硕士学习（2014-2017年，导师:黄正教授）。而后于德国莱布尼茨催化研究所获得博士学位（2017-2020年，导师：Matthias Beller），随后在德国莱布尼茨催化研究所（2020-2021年），美国科罗拉多州立大学（2021-2022年，导师：Eugene Chen），马里兰大学/耶鲁大学（2022-2024年，导师：胡良兵教授）完成了多段博士后研究工作。其工作已获得多项荣誉认可，包括2023年国家优秀青年科学基金（海外）、2023年上海市领军人才、2023年上海市浦江学者及2020年留德华人化学化工协会青年化学奖。

In-depth of the chemistry of bio-oils for understanding the feedstock and pyrolysis process

通过深入了解生物油的化学性质以理解原料和热解过程

Alberto Wisniewski Jr

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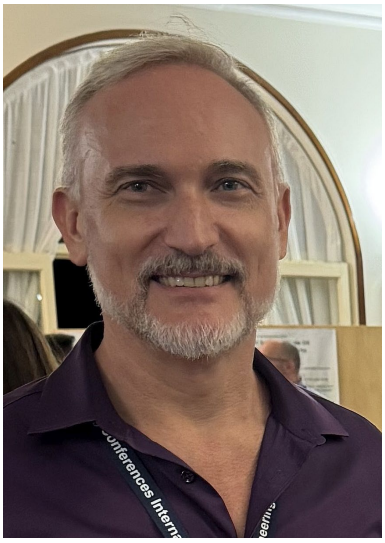
Abstract

Thermoconversion of waste biomasses arises as one of the most promisor processes to the production of renewables chemicals, hydrocarbons, contributing to the carbon sequestration in the form of biochar. Many challenges need to be awarded from biomass until to obtain a final product, and the experimental setups to test biomasses, catalysts, pyrolysis conditions, as well as comprehensive bio-oil characterization are fundamentals to the development of this research field. This presentation approaches how microscale pyrolysis experiments can be applied to the prediction of pyrolysis yields from waste biomasses such as coconut husk, cassava harvest biomass, palm oil, castor oil plant, catalytic upgrading ex-situ process, and co-pyrolysis of biomasses with waste plastics as PET and PP. The liquid product is advanced characterized using FT-Orbitrap MS among other analytical techniques to better understand the chemistry of products and the mechanisms behind the thermos-catalytic process. Thousands of renewable chemicals are revealed and demonstrated the power of energy from biomass.

摘要

废弃生物质的热化学转化是生产可再生化学品与碳氢化合物的重要途径，并可通过生物炭形式实现碳封存。从原料到终产品需克服诸多挑战，而建立用于测试生物质、催化剂、热解条件的实验体系，并对生物油进行全面表征，是推动该领域发展的关键基础。本报告将探讨如何通过微尺度热解实验，预测椰壳、木薯收获残余物、棕榈油、蓖麻油植物等废弃生物质的热解产物分布，并涵盖催化原位提质过程、生物质与废弃塑料（如PET、PP）的共热解研究。通过傅立叶变换轨道阱质谱（FT-Orbitrap MS）等分析技术对液体产物进行深入表征，以揭示产物化学组成及其热催化反应机理。研究揭示了数千种可再生化学品的存在，展现了生物质能源的巨大潜力。



Prof. Dr. Alberto Wisniewski Jr

Prof. Dr. Alberto Wisniewski Jr earned his bachelor's degree in Chemistry in 2001 and his master's in Organic Chemistry from the Federal University of Paraná, Brazil in 2003. He completed his PhD in Analytical Chemistry at the Federal University of Santa Catarina, Brazil in 2009, followed by a postdoctoral fellowship at the University of Zaragoza, Spain in 2014. He has been a professor for 15 years at the Federal University of Sergipe, where he leads the Petroleum and Energy from Biomass research group. He has extensive experience in applying Analytical Chemistry to the study of bio-products from biomass pyrolysis, as well as in the organic geochemistry of crude oils. He is also a co-founder of the startup Bio Carbon Brazil, which focuses on producing biochar and bio-oil. He is a member of the Brazilian Chemistry Society and the Brazilian Society of Mass Spectrometry, currently serving as Social Director (2023-2025) of the latter, and as General Secretary of the Latin American Association of Organic Geochemistry (ALAGO).

Prof. Dr. Alberto Wisniewski Jr 于2001年获巴西巴拉那联邦大学化学学士学位，2003年获有机化学硕士学位,2009年获巴西圣卡塔琳娜联邦大学分析化学博士学位，2014年在西班牙萨拉戈萨大学完成博士后研究。现任巴西塞尔希培联邦大学教授并领导生物质石油与能源研究组，拥有15年教学与科研经验。研究方向包括分析化学在生物质热解产物表征中的应用，以及原油有机地球化学。他是巴西生物碳初创公司（Bio Carbon Brazil）联合创始人，专注于生物炭与生物油生产。现任巴西化学会、巴西质谱学会会员，2023－2025年担任巴西质谱学会社会事务理事，并担任拉丁美洲有机地球化学协会（ALAGO）秘书长。

Gasification Technology in China: From fossil fuel to renewable energy
含碳原料气化技术：从化石原料到可再生能源

Ding Lu
丁路

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[2]Engineering Research Center of Resource Utilization of Carbon-containing Waste with Carbon Neutrality, Ministry of Education, China

Abstract
Gasification technology for carbon-containing feedstocks is a core technology enabling the efficient and low-carbon utilization of carbonaceous substances such as coal, biomass, and refinery residues. China's coal gasification technology has evolved from technology introduction and absorption to independent innovation. The Opposed Multi-Burner (OMB) coal gasification technology, through innovations such as impinging flow for enhanced mixing, optimized refractory lining structure, and black water energy recovery, has significantly improved carbon conversion and energy efficiency. It has achieved industrial application on an ultra-large scale (4,000 tons per day) and leads the world in market share. Furthermore, biomass and waste gasification technologies have addressed issues such as high tar content and low conversion efficiency through the coupling of fixed-bed and non-catalytic partial oxidation processes, and have advanced the demonstration of green methanol projects. Gasification of refinery residues has enabled highly efficient hydrogen production while reducing energy consumption and pollution. In the future, gasification technology will develop toward safer, more efficient, cleaner, and smarter directions. Integrated with AI technology, it will promote the resource utilization of multi-source organic solid waste and contribute to the achievement of carbon neutrality goals.

摘要
含碳原料气化技术是实现煤、生物质、炼油残渣等含碳物质高效低碳利用的核心技术。我国煤气化技术经历了从技术引进吸收到自主创新的发展历程，其中对置式多喷嘴煤气化技术通过撞击流强化混合、优化耐火衬里结构及黑水能量回收等创新，显著提升了碳转化率与能效，实现了超大规模（单炉日处理4000吨级）工业应用，并在全球市场占有率位居领先。此外，生物质及废弃物气化技术通过固定床与非催化部分氧化工艺耦合等方式，有效解决了焦油含量高、转化效率低等问题，并推动了绿色甲醇项目的示范进展。炼油残渣气化技术则在实现高效制氢的同时，显著降低了能耗与污染。未来，气化技术将朝着更安全、高效、清洁、智能的方向发展，结合人工智能技术，推动多源有机固废的资源化利用，助力碳中和目标的实现。

Prof. Lu Ding
丁路 教授

Prof. Dr. Ding Lu is Professor from ECUST, working as Deputy Director of the Engineering Research Center for Zero-Carbon Utilization of Carbon-Containing Waste Resources, Ministry of Education; Distinguished Expert of the "Overseas Talent Program" of the China Association for Science and Technology. Serves as Deputy Editor-in-Chief of International Journal of Coal Science and Technology, and as Editorial Board Member or Special Issue Editor for international journals such as Applied Energy, Fuel, and Energy. Long-term engagement in applied fundamental research and technological development related to biomass/coal gasification. Selected successively for national-level overseas high-level youth talent programs, Shanghai's overseas high-level talent projects, and Jiangxi Province's "Double Thousand Plan" (short-term). Principal Investigator for key international cooperation projects under the National Key R&D Program, general projects of the National Natural Science Foundation of China, and projects under the Ministry of Science and Technology's Key R&D Program. To date, has published over 160 papers in journals such as Nature Communications and Fuel.

丁路，华东理工大学教授，任含碳废弃物资源化零碳利用教育部工程研究中心副主任，中国科协“海智计划”特聘专家。担任International Journal of Coal Science and Technology副主编，Applied Energy、Fuel、Energy等国际期刊编委、特刊编辑。长期从事生物质/煤气化的应用基础研究与技术开发工作。先后入选国家海外高层次青年人才计划、上海市海外高层次人才项目、江西省双千短期计划。主持国家重点研发计划政府间重点专项、国家自然科学基金面上项目、科技部重点研发计划课题等项目。截至目前在Nature Communications、Fuel等期刊共发表论文100余篇，以第一完成人获2023年上海市自然科学奖二等奖，开发了撬装式生物质气化发电体系。所在的华东理工大学洁净煤技术研究所团队是国际上唯一一家拥有水煤浆气化、粉煤气化、富甲烷气非催化转化等工程化技术的研发机构，成功开发国内首套具有自主知识产权的大型煤气化技术，打破国外技术垄断，建成全世界单炉处理能力（日处理煤4000吨级）最大的煤气化装置。

Biomass Pretreatment and Catalytic Pyrolysis for Improved Liquid Fuel and Chemicals

生物质预处理及催化热解以提高液体燃料和化学品的品质

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Abstract
It is well known that the bio-oil from biomass pyrolysis has complex composition and thus requires extensive upgrading for it to be used as liquid fuel or chemicals. The upgrading process involves high pressure and application of catalysts, and is in most cases costly. This presentation provides review on recent development of biomass pretreatment and catalytic pyrolysis of biomass for improving the bio-oil quality with target to produce better grade liquid fuel or chemicals. Achievements and challenges are discussed, and future studies are recommended.

摘要
众所周知，由生物质热解产生的生物油成分复杂，因此需要经过复杂的提质处理才能作为液体燃料或化学品使用。提质过程通常涉及高压和催化剂的应用，因此成本较高。本报告综述了近期在生物质预处理和催化热解方面的研究进展，旨在改善液体产物的质量，以用来作为液体燃料或化学品。报告将讨论最近本领域取得的成果与面临的挑战，并对未来的研究提出建议。

Prof. Dr. Shusheng Pang is professor in the Department of Chemical and Process Engineering and Co-Director of the Wood technology Research Centre at University of Canterbury, New Zealand. Professor Pang is the Fellow of Engineering New Zealand and Fellow of the International Academy of Wood Science (IAWS). He is also the Chair of IAWS Academy Board and member of Executive Committee (https://www.iaws-web.org/). Recently, he was elected to the Foundation Fellow of International Academy of Drying Science and Technology (www.iradstm.org). His research includes biomass energy and biofuel with focus on biomass gasification and pyrolysis for liquid and gaseous fuels as well as CO_2 capture and utilization. He also has strong interests in drying of wood and wood-based materials. He has published over 250 papers in high-ranking international journals with citation of more than 10000 times and h-index of 47 (google scholar).

Prof. Shusheng Pang
庞树声 教授

庞树声，博士，新西兰工程院院士以及国际木材科学学院（IAWS）院士，新西兰坎特伯雷大学化学与过程工程系教授，同时担任木材技术研究中心联合主任。他现任IAWS学术委员会主席及执行委员会委员。
最近，他当选为国际干燥科学与技术学院创始院士。他的研究领域包括生物质能源与生物燃料，主要专注生物质气化和热解以生产液体和气体燃料，以及二氧化碳捕集与利用。他还对木材及木基材料的干燥进行了深入的研究。他已在国际学术期刊发表论文超过250篇，总引用次数超过10,000次，谷歌学术h指数为47。有关庞教授的更多信息，请访问：
https://profiles.canterbury.ac.nz/Shusheng-Pang

Hydrocarbon-rich Fuels Production by Catalytic Upgrading of Biomass Pyrolysis Vapor

生物质热解气催化提质制备富烃燃料

Zhifeng Zheng
郑志锋

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Abstract
Biomass pyrolysis oil, as a complex liquid with high water content, high acidity, high oxygen content, low calorific value, instability and corrosiveness, poses significant challenges for direct utilization. Catalytic conversion for upgrading is its primary utilization method. Compared to liquid-phase upgrading technologies such as direct hydrodeoxygenation, catalytic upgrading of biomass pyrolysis vapor has outstanding advantages such as high efficiency, short process flow, and great potential for cost reduction, as catalytic conversion is carried out while the pyrolysis oil is still in the gas phase at high temperature. It is one of the most promising methods for preparing hydrocarbon fuels in the future. This presentation systematically shows the core challenges of catalytic upgrading of biomass pyrolysis vapor to prepare hydrocarbon fuels, including catalyst design and preparation, catalytic formation mechanism of hydrocarbons (especially aromatic hydrocarbons, alkanes, and alkenes), regulation of hydrocarbon product selectivity, and gas-phase catalytic upgrading of co-pyrolysis gas from hydrogen-rich feedstocks. It focuses on analyzing catalyst deactivation, carbon deposition, product selectivity regulation, and co-pyrolysis catalytic mechanism, aiming to provide theoretical basis and data support for the preparation of hydrocarbon-rich fuels from biomass pyrolysis.

摘要
生物质热解油作为一种高含水、高酸、高氧、低热值、不稳定、易腐蚀的复杂液体，直接利用困难很大，通过催化转化提质是其最主要的利用方法。其中直接加氢脱氧等液相提质技术相比，生物质热解气催化提质因热解油还处于高温状态时就进行催化转化，具有效率高、流程短、成本下降潜力大等突出优势，是未来最具有发展潜力的制备烃类燃料方法之一。本论文较系统地研究了催化剂的设计与制备、烃类（尤其是芳烃、烷烃、烯烃）催化形成机理、烃类产物选择性的调控、富氢原料共热解气气相催化提质等生物质热解气催化提质制备烃类燃料的核心难点，着重分析了催化剂失活、积碳、产物选择性调控与共热解催化机制，以期为生物质热解制备富烃燃料提供理论基础与数据支撑。

Prof. Zhifeng Zheng
郑志锋 教授

Prof. Dr. Shusheng Pang is a distinguished professor of Minjiang Scholar, a professor at the Nanqiang Key Position of Xiamen University, the chairman of the Fujian Provincial New Energy Technology Industry Promotion Association, the director of innovation platforms such as the sub-center of the National Energy User-Side Energy Storage Innovation and Research Center (in preparation) and the Fujian Provincial New Energy Industry Technology Development Base, an honorary researcher of the Jiageng Innovation Laboratory, and a leader of disciplines and teams. He is primarily engaged in research and development, as well as policy research, in the fields of energy storage technology, batteries and their key material technologies, and biomass energy. He has published more than 280 papers, obtained more than 20 authorized patents, and formulated 2 national standards. His scientific research achievements have been transformed in provinces such as Fujian, Jiangsu, Yunnan, and Anhui, creating significant economic and social benefits. The project "Key Technologies and Industrialization of High-Efficiency Pyrolysis Co-production of Agricultural and Forestry Biomass" won the first prize of the 2024 Yunnan Provincial Science and Technology Progress Award (ranked first) and received three second prizes from the National Forestry and Grassland Administration, Yunnan Province, and other provincial and ministerial-level science and technology awards.

郑志锋，闽江学者特聘教授、厦门大学南强重点岗位教授，福建省新能源科技产业促进会理事长，国家能源用户侧储能创新研发中心（筹）分中心、福建省新能源产业技术开发基地等创新平台主任，嘉庚创新实验室荣誉研究员，学科与团队带头人。主要从事储能技术、电池及其关键材料技术、生物质能源等方面的研究开发与政策研究工作。发表论文280余篇，授权专利20余项，制订国家标准2项，科研成果已在福建、江苏、云南、安徽等省进行了转化，创造了显著的经济和社会效益。“农林生物质高效热解联产关键技术及产业化”项目获2024年云南省科学技术进步一等奖（排名第 1），获国家林草局、云南省等省部级科技二等奖3项。

Biomass pyrolysis at Pymicolab: from fundamentals to product applications

Pymicolab 生物质热解研究：从基础到应用

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Abstract

The global economy remains predominantly dependent on fossil-based, non-renewable raw materials and energy sources, which account for approximately 81.5% of primary energy consumption worldwide. In Europe, despite the decarbonization policies, industrial sectors, such as chemical, steel, and transportation industries, remain heavily based on oil and coal, which account for respectively 58% and 52% of both energy sources and process feedstocks. Alongside this structural dependency, an emerging global challenge is the sustainable management of nitrogen and carbon cycles, which is crucial for mitigating climate impacts, enhancing production system efficiency, and ensuring ecosystem resilience. The transition toward a bio-economy and the EU 2030 target of 42.5% renewable energy require enhanced utilization of biomass and alternative renewable resources. Pyrolysis is a mature technology suitable for large-scale processing of lignocellulosic feedstocks, offering a pathway to produce biochar, bio-oil, and permanent gases for biofuels and biomaterials (biochar). However, challenges such as feedstock variability, heterogeneous mixtures, and the valorization of low-quality or contaminated biomass limit process efficiency and product quality. Additionally, the interaction between organic and inorganic biomass components, along with operational parameters, significantly affects pyrolysis outcomes. Advanced characterization, process modeling, and control strategies are therefore essential to ensure flexibility and reliability within bio-based value chains.

For this purpose, in the presentation, experimental investigations conducted at CNR-STEMS using laboratory-scale pyrolysis reactors on various lignocellulosic biomasses are presented. These studies evaluated the pyrolysis tests, considering: the effect of inherent and contaminant-derived inorganics; the effect of temperature (in the range 300–700 ℃); and different carrier gases (nitrogen, CO_2, steam, or a mixture of them). All these factors affect both the yields and the properties of the pyrolysis products, including potential toxicity concerns associated with the resulting materials. A detailed characterization of the products is carried out to guide steering the process toward the production of bio-oil and/or biochar with tailored properties (porosity, surface chemistry). Finally, possible biochar applications in different sectors are shown, such as soil conditioner, ammonia adsorbent, or filler for composite materials, adding value to the sustainability of the pyrolysis in a bio-based value chain.

摘要

当前全球经济仍高度依赖化石能源，推动生物质等可再生资源高效利用对能源转型至关重要。热解技术可将生物质转化为生物炭、生物油等高值产品，但原料差异、工艺参数及污染物等因素制约其应用效果。本研究通过实验室热解实验，系统探究温度、载气及原料特性对产物分布与性能的影响，实现生物油与生物炭的可控制备。所得生物炭在土壤改良、污染吸附及复合材料等领域展现出良好应用潜力，为构建可持续生物基价值链提供了技术支撑。

Dr. Corinna Maria Grottola

Dr. Corinna Maria Grottola is a researcher at CNR-STEMS, and her scientific expertise lies in thermochemical conversion processes of biomass. Her research is primarily focused on the detailed characterization of biomass pyrolysis through physico-chemical analyses of pyrolysis products, with particular emphasis on the valorization, characterization, and applications of biochar. She has worked and collaborated with international institutes, has held leadership and coordination roles in European COST projects, she is currently involved in EIC-Pathfinder project, and has received various grants supported by COST Action and the Combustion Institute; as well as awards, including poster presentation award at 24th International Conference on Analytical and Applied Pyrolysis, 19-23 May 2024, Beijing (China).

Dr. Corinna Maria Grottola 任职于意大利国家研究委员会可持续能源与交通科技研究所（CNR-STEMS）。主要研究方向为生物质热化学转化，致力于通过热解产物的理化特性分析，系统研究生物质热解过程，并重点开发生物炭的高值应用。她具有丰富的国际合作经验，曾主持或参与多项欧盟COST项目，目前承担EIC-Pathfinder项目课题，并获得COST行动及燃烧学会的多项资助。其研究成果获“第24届分析与应用热解国际会议”（2024年5月，北京）墙报展示奖。

Catalytic and non-catalytic co-pyrolysis of algae with dairy sludge: Ex-situ fed batch process for bio-oil production

藻类与乳业污泥的共热解和非原位催化与制备生物油

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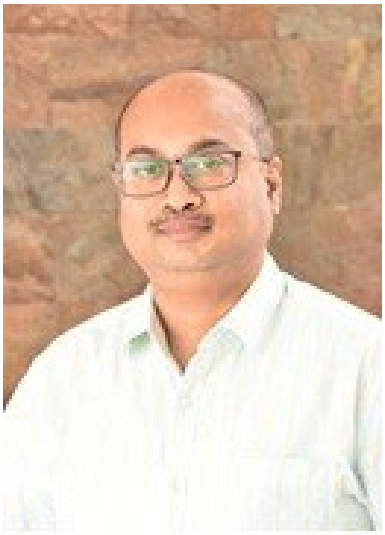
Abstract

Bio-oil generated through biomass pyrolysis has emerged as a promising alternative to conventional fossil fuels. However, the high production cost of algal feedstock limits its large-scale application in pyrolysis, while the low heating value and high ash content of dairy sludge diminish its suitability as a single feedstock. Co-pyrolysis of microalgae with dairy sludge offers a strategic approach to overcoming these individual limitations and enhancing process performance. In the present study, co-pyrolysis was carried out in a fixed-bed reactor to investigate the interactions between microalgae and dairy sludge, assess product distribution, and determine the extent of synergistic effects. The maximum bio-oil yield of 21.45% was obtained at 550 ℃ with a heating rate of 20 ℃ /min and a residence time of 60 min. The co-pyrolysis process exhibited synergy between the protein- and lipid-rich microalgal biomass and the organic components of dairy sludge. Under non-catalytic conditions, co-pyrolysis generated a higher bio-oil yield with reduced nitrogenous compounds and aromatics compared to the bio-oils obtained from the individual feedstocks. The addition of H-ZSM-5 altered the product distribution, producing a bio-oil yield of 18.76% while significantly increasing hydrocarbons and esters and reducing nitrogen-containing compounds. The proposed reaction pathways indicate that H-ZSM-5 promotes the formation of nitriles via amide dehydration and decreases cyclic nitrogenous compounds through denitrogenation reactions. Characterization of the spent catalyst revealed coke deposition and partial structural modification. The catalytic process enhanced deoxygenation, decarboxylation, and dehydration reactions, observed by an increased H/C ratio and reduced O/C ratio in the resulting bio-oil. Thermal distillation of the catalytic pyrolysis bio-oil further demonstrated an increased proportion of heavy naphtha and gas-oil fractions, reflecting a higher presence of hydrocarbons, fatty acids, and esters. Overall, the results indicate that co-pyrolysis, particularly with H-ZSM-5 can effectively improve bio-oil quality.

摘要

生物质与乳业污泥共热解可协同提升生物油产率与品质。本研究在固定床反应器中考察了该共热解过程，在550 ℃条件下获得21.45%的最高生物油产率，并证实了两者间的协同效应。与非催化过程相比，H-ZSM-5催化剂虽使生物油产率略降至18.76%，但显著提升了烃类与酯类含量，同时降低了含氮化合物。催化过程促进了脱氧、脱羧等反应，改善了生物油的H/C与O/C比。热蒸馏分析进一步显示，催化所得生物油中重质馏分比例增加。研究表明，H-ZSM-5催化共热解是提升生物油品质的有效途径。

Prof. Kaustubha Mohanty has obtained his PhD degree in Chemical Engineering from Indian Institute Technology Kharagpur and is currently working as a Professor of Chemical Engineering department at Indian Institute Technology Guwahati. His key research areas are biofuels, biological wastewater treatment, membrane technology, microalgae biorefinery, biomass pyrolysis and water-energy nexus. He has published more than 250 research papers in peer-reviewed journals. He is serving the Editorial Boards of various journals such as Renewable Energy, Renewable & Sustainable Energy Review, ACS ES&T Water, ACS ES&T Engineering, Journal of Analytical and Applied Pyrolysis, Biomass Conversion & Biorefinery and Journal of Institution of Engineers (India) Series: E. He is a Fellow of Royal Society of Chemistry (UK), Fellow of International Association of Advanced Materials (Sweden), Fellow of Biotech Research Society of India, Fellow of Institution of Engineers (India) and Fellow of Indian Institute of Chemical Engineers. Scholar GPS has ranked him as the top 0.5% of the Scholars in the discipline of Chemical Engineering and specialties of Bioenergy, Biomass and Pyrolysis.



Prof. Kaustubha Mohanty

Prof. Kaustubha Mohanty 在印度理工学院克勒格布尔分校获得化学工程博士学位，现任印度理工学院古瓦哈提分校化学工程系教授。其主要研究领域包括生物燃料、废水生物处理、膜技术、微藻生物精炼、生物质热解及水-能源关联方向。他已在同行评审期刊上发表研究论文250余篇，并担任 Renewable Energy, Renewable & Sustainable Energy Review, ACS ES&T Water, ACS ES&T Engineering, Journal of Analytical and Applied Pyrolysis, Biomass Conversion & Biorefinery and Journal of Institution of Engineers (India) Series: E 等多个期刊的编委。他是英国皇家化学会、瑞典国际先进材料协会、印度生物技术研究学会、印度工程师学会及印度化学工程师学会的会士。据Scholar GPS数据统计，他在化学工程学科及生物能源、生物质与热解专业领域中位列全球前0.5%的学者。

High-value hydrocarbon fuels produced by pyrolysis-hydrodeoxygenation of waste straw

秸秆热解-加氢催化定向转化烃类燃油研究

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江霞

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Abstract
The urgent demand for renewable energy has intensified efforts to develop lignocellulosic bio-oil as a sustainable alternative to fossil fuels. Pyrolysis followed by hydrodeoxygenation (HDO) is a promising and industrially relevant approach that transforms waste biomass first into bio-oil and then into value-added biofuel. However, the oxygen-containing functional groups in bio-oil are prone to forming coke during HDO, leading to catalyst deactivation-a major challenge at the industrial scale. Here, we report a continuous, two-stage process to convert waste straw into high-value hydrocarbon fuels. This process involves co-pyrolysis with hydrogen-enriched waste plastics, followed by HDO of the resulting bio-oil. At Sichuan University, we have produced hydrocarbon fuels from waste straw via this pyrolysis-HDO route, and the products meet the National VI Emission Standard. Ultimately, the successful implementation of this project will provide technical principles for the large-scale, low-carbon treatment and efficient resource utilization of waste straw.

摘要
废弃秸秆大规模生产汽柴油等高值燃油的关键核心技术亟需攻关。针对秸秆热化学转化过程中含氧活性基团易发生缩聚副反应、催化剂结焦失活导致转化效率低的难题，本研究提出“富氢”废塑料协同秸秆共热解氢转移解聚-热解油催化加氢重构定向转化汽柴油的新思路。本研发打通秸秆快速热解-热解液沸腾床加氢脱氧-脱氧液固定床加氢提质制汽柴油全链条关键技术，在川大建成吨级生物质制汽柴油成套装置，产品达国六调和标准。本技术链条将为废弃秸秆规模化处理及高值化工程利用提供技术原理。

Prof. Xia Jiang
江霞 教授

Xia Jiang is a professor and a doctoral supervisor of Sichuan University. She was selected as a Cheung Kong Professor of the Ministry of Education of China and served as the executive vice President of Carbon Neutral Future Technology College of Sichuan University. The research area of Xia Jiang is mainly engaged in biomass energy-carbon capture and utilization (BECCUS), especially bio-fuel, bio-hydrogen, and carbon-based functional materials. She presided National Key R&D Program of China, " A set of technologies and equipment for gasoline and diesel oil production from waste straw" and ” Key technologies and equipment for hydrogen production from refractory biodegradable waste with plasma assisted”. As the working expert leader, she compiled the Ministry of Education's "Carbon Neutral Science and Technology Innovation Action Plan for Colleges and Universities", edited the first systematic textbook, "Introduction to Carbon Neutral Technology" in China.

江霞，教授、博士生导师，四川大学碳中和未来技术学院常务副院长，教育部重要人才计划特聘教授、教育部新世纪优秀人才计划、四川省学术和技术带头人，担任教育部《高等学校碳中和科技创新行动计划》工作组组长、教育部资源碳中和关键核心技术集成攻关大平台常务副主任、教育部碳中和未来产业领域虚拟教研室负责人、教育部资源碳中和学科创新111引智基地常务副主任、四川省碳中和技术创新中心常务副主任。

主要从事生物质能源及废弃碳资源高值转化应用基础研究，主持国家重点研发计划重点专项项目2项、国家自然科学基金重点项目1项等国家及省部级项目20余项，发表SCI论文150余篇，授权发明专利40余件，其中国际发明专利5件，编写行业标准9件，获四川省科技进步一等奖1项（排名第一）。牵头教育部战略性新兴领域“十四五”高等教育碳中和未来产业教材团队负责人，主编全国首本《碳中和技术概论》系统性教材，服务碳中和人才培养和科技创新。

Transform pyrolysis oil into a green crude oil: status and development.

生物质热解油向绿色生物原油的转变：技术现状与发展趋势

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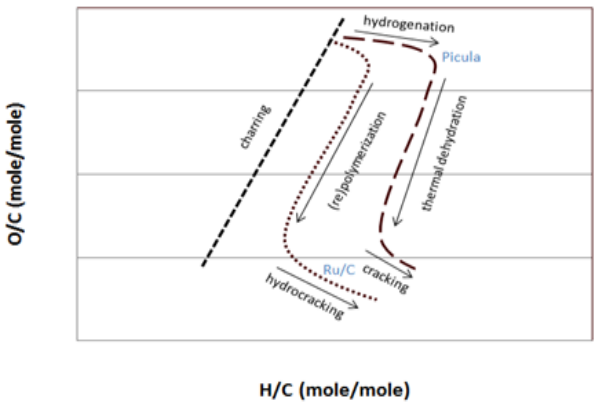
Abstract

The use of liquids derived from the pyrolysis of biomass is restricted, amongst others, due to the reactive nature of the unsaturated compounds. Of specific concern are the carbonylic groups and the doubled bonds, present or created by defragmenting the holocellulose and the lignin compounds. From 2006 onwards, BTG developed the so-called stabilization of pyrolysis oils. The aim of this process is to hydrogenate the aldehydes in the oils (including the carbohydrates) to reduce its reactivity. So-called stabilized pyrolysis oils ('SPO') are produced that show significantly improved characteristics. On a macroscopic level these include a lower charring tendency, lower carbonyl content, and lower water content. An efficient catalyst is developed for the stabilization, and proper process conditions are established to cost effectively convert these pyrolysis oils into stabilised oils. Simultaneously, a series of new end applications are explored, ranging from a precursor to fuels or chemicals, as well as to use it in co-refining options. Experimental work suggests that SPO can be used as such in existing refinery hydrotreaters (commercial catalysts, similar process conditions) to yield oxygen-free products in the gasoline, kerosene, and marine diesel range.In this presentation the progress over the last 20 years is summarised. Insights will be provided in the process parameters and mass balance and the specific characteristics of these oils as pure materials, intermediates and final products. Challenges will be addressed, ongoing activities in this field further detailed and pathways elucidated to bring this technology into the market.



摘要

生物质热解液因含不饱和化合物而活性过高，应用受限。BTG开发的稳定化工艺通过加氢降低其反应活性，显著改善了油品的结焦倾向、羰基及含水量。已开发出高效催化剂与适宜工艺，可经济生产稳定化油品。实验表明，该油品可直接在现有炼油加氢装置中加工，生产无氧燃料。本报告将总结该技术二十年进展，阐述工艺特性与产品应用，分析挑战并展望产业化路径。

Dr. R.H. (Robbie) Venderbosch

Dr. R.H. (Robbie) Venderbosch conducted his Ph.D. research at the University of Twente on the role of clusters in gas – solids reactors. He then finalized a post-doc at the same university on the fast pyrolysis of biomass, where after he joined BTG Biomass Technology Group B.V. Here he is working on a range of topics related to fast pyrolysis, hydrogenation reactions, sugar-based chemistry, supercritical gasification in water, production of chemicals from biomass (derivatives), electrochemical applications and more. His research interest concerns bio-based applications, with emphasis on heterogeneous catalysis in relation to chemical reaction engineering, and specific focus on all kinds of possibilities to bridge the gap between biomass related activities and petrochemical engineering. He is co-author of around 80 papers in international peer reviewed journals, approx. 15 patents in the field of biomass (applications) and ~ 10 book chapters.

Dr. R.H. (Robbie) Venderbosch 现任职于荷兰BTG生物质技术集团有限公司（BTG Biomass Technology Group B.V）。他在特温特大学攻读博士学位期间，主要从事气固反应器中团簇作用的研究。随后，他在同一所大学完成了生物质快速热解方向的博士后研究，之后加入了BTG生物质技术集团有限公司。目前，他的工作涉及快速热解、加氢反应、糖化学、水相超临界气化、生物质（衍生物）制化学品、电化学应用等一系列课题。他的研究兴趣集中在生物基应用领域，尤其关注与化学反应工程相关的多相催化，并特别致力于探索弥合生物质相关活动与石油化工工程之间差距的各种可能途径。他在国际同行评审期刊上合作发表了约80篇论文，拥有生物质（应用）领域约15项专利，并撰写了约10个图书章节。

Pyrolysis behavior of biomass under flow-enhanced heat transfer

固体热载体循环加热的下降管式快速热解液化技术：流动强化传热下的生物质热解规律研究

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Abstract

The development and utilization of lignocellulosic biomass is an important way to promote circular agriculture and a low-carbon economy. In response to the problems of low energy density and added value of biomass, research on the fast pyrolysis of biomass to produce bio-oil has been carried out, including studies on pyrolysis mechanisms, regulation laws, equipment, and process development. Firstly, the biomass de-volatilization performance during flash pyrolysis was investigated. The kinetic models of typical biomass, such as corn stalks, were obtained, and it was confirmed that the kinetic parameters under flash heating conditions are independent of the heating rate. Subsequently, based on the self-developed rapid pyrolysis technology using ceramic ball heating, research was conducted on the flow and heat transfer characteristics of mixed particles in the down-tube reactor. The results indicate that there is good consistency between the CFD-DEM results and the PIV experimental results. Among them, reactor parameters such as tube type and angle can regulate the flow and heat transfer behavior. However, the radial "seepage phenomenon" existing between the particles limits the further enhancement of heat transfer through flow. To address this issue, the inverted "V"-shaped downcomer was modified into an "S"-shaped one, significantly enhancing the contact frequency and mixing intensity between particles and meeting the high heating rate requirement for rapid pyrolysis. Finally, the heat transfer-reaction coupling model was established. Heat conduction and convection were the main energy sources for biomass, each accounting for approximately 45%. The temperature of the ceramic balls is the dominant factor affecting the pyrolysis process, followed by collision probability and particle diameter. When the temperature is 600 ℃, the time required for pyrolysis is 1.2 seconds. Based on the aforementioned research, series innovative down-tube reactor utilizing solid heat carrier circulation heating for biomass pyrolysis has been developed.

摘要

生物质资源的开发利用是实现循环农业和低碳经济的重要途径，更是达成碳中和目标的重要助力。针对木质纤维素类生物质能量密度低、高附加值难等问题，开展了生物质快速热解液化研究，包括热解机理、调控规律以及相关的装备与工艺等。首先开展了生物质闪速热解液化脱挥发分研究，获得了玉米秸秆等典型生物质的动力学模型，证实了闪速加热条件下的动力学参数与升温速率无关。随后，基于自主研发的陶瓷球加热生物质快速热解技术，开展了下降管反应器内的混合颗粒流动特性与换热规律研究。结果表明，CFD-DEM流动模拟结果与PIV实验结果具有较好的一致性。其中，管型、角度、内构件等反应器参数可调控混合颗粒的流动与换热行为，但颗粒间存在的径向“渗流现象”限制了流动对换热的进一步强化。针对此问题，通过增加下降管回折次数进行流动调控，并基于此将倒“V”型下降管改进为“S”型下降管，显著增强了颗粒间的接触频率与混合强度，保障了快速热解的高升温速率需求。最后，构建了包含热解气挥发、生物炭生成及水分蒸发过程的传热-反应耦合模型。导热与对流是生物质颗粒能量的主要来源，占比均为45%左右。其中，陶瓷球温度是影响热解过程的主导因素，碰撞概率、颗粒半径的影响次之。当温度为600 ℃时，热解所需时间为1.2s。基于上述研究，创制了系列固体热载体循环加热的下降管式热解成套装备，确保了生物油的组分稳定与目标产物富集。其中，生物油得率可达60%以上，生物油组分差异率小于3%。

Prof. Dr. Weiming Yi is a professor in the College of Agricultural Engineering and Food Science, Shandong University of Technology. He is a former vice president of Shandong University of Technology, a distinguished Expert of Taishan Scholars Shandong Province, director of the Shandong Research Center of Engineering and Technology for Clean Energy, a member of the Combustion Branch of the Chinese Society of Engineering Thermophysics, and vice president of the Chinese Society of Agricultural Engineering. Pioneering research has been carried out in the fields of biomass pyrolysis and anaerobic digestion, and the research achievements have been applied, achieving economic and social benefits. Currently, he is the principal investigator of Key Projects of National Natural Science Foundation of China. He have also completed over ten projects, including National Key Research and Development Program of China, Key Project and Thematic Project of 863 Program, and the National Natural Science Foundation of China.

Prof. Weiming Yi
易维明 教授

易维明，博士，二级教授，山东理工大学原副校长，山东省泰山学者特聘专家，山东省清洁能源工程技术研究中心主任，中国工程热物理学会燃烧分会委员，中国农业工程学会副理事长。在生物质热解、厌氧发酵等领域开展了开拓性研究，科研成果得到应用，取得了经济和社会效益。目前主持国家自然科学基金重点基金项目1项。主持完成国家重点研发计划项目、国家863重点项目和主题项目课题、国家自然科学基金等项目10余项。

Commercializing catalytic pyrolysis of waste polymers

废塑料催化裂解商业化之路

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Abstract

The base chemicals industry is a crucial pillar for all manufacturing because base chemicals are literally the building blocks for fine chemicals and high-performance materials and products made of base chemicals appear in key manufacturing industries such as food products, chemicals and chemical products, machinery and equipment, and motor vehicles. Therefore, greening the base chemicals will result in greening all carbon-based products. BioBTX focusses on the production of base chemicals using catalytic pyrolysis using Integrated Cascading Catalytic Pyrolysis (ICCP).

In this presentation, focus will be on catalyst research and development for catalytic pyrolysis of highly contaminated mixed waste plastics from the perspective of technology scale-up and commercialisation. Refinery integration of the BioBTX product requires specifics on boiling point range and effective catalytic conversion of impurities such as oxygenates. Moreover, commercial operations requires sufficient catalyst stability against components such as water, chlorine, sulphur and nitrogen. To achieve these goals, BioBTX has setup a complete infrastructure for catalyst R&D and is collaborating with world leading companies and research institutes.

摘要

基础化学品行业是所有制造业的基石，它们是精细化学品和高性能材料的构建单元，广泛应用于食品、化工产品、机械设备及汽车等关键制造领域。因此，基础化学品的绿色化将推动所有碳基产品的绿色转型。BioBTX致力于通过集成级联催化裂解（ICCP）技术，以催化裂解工艺生产基础化学品。

本次报告将从技术放大与商业化的视角，重点探讨针对高污染混合废塑料催化裂解的催化剂研发工作。为使 BioBTX 产品能够顺利整合至现有炼化体系，必须严格控制产物的沸程范围，并实现含氧化合物等杂质的高效催化转化。此外，商业化运行要求催化剂对水、氯、硫、氮等组分具备足够的稳定性。为实现这些目标，BioBTX已建立完整的催化剂研发体系，并与全球领先企业和研究机构展开合作。

Dr. Niels J. Schenk

Dr. Niels J. Schenk is Director of Research & Development at BioBTX, where he leads the development and scale-up of catalytic pyrolysis technologies that convert waste plastics and biomass into renewable aromatics. With more than twelve years of experience in ICCP technology and advanced thermo-chemical processes, he has played a central role in translating BioBTX's innovations from laboratory research to pilot and demonstration scale.

Niels holds a Master's in Organic Chemistry from Leiden University and a PhD in Energy and Environmental Sciences from the University of Groningen. His early work included contributing to the OECD Environmental Outlook and participating in the IIASA Young Scientists Summer Program, where he gained foundational experience in integrated energy-materials modeling and climate-related systems analysis.

Before joining BioBTX, he worked as a consultant supporting sustainability initiatives in the chemicals sector. Since 2012 he has led BioBTX's R&D organization, where he has overseen core technology development, conceptual design of pilot and demonstration plants, and guided senior professionals in process development & catalyst development.

Niels is recognized for bridging scientific insight with practical engineering, and for driving innovations that enable a more circular and low-carbon chemicals industry.

Dr. Niels J. Schenk 现任 BioBTX 研发总监，负责领导将废塑料和生物质转化为可再生芳烃的催化裂解技术开发与放大工作。他在 ICCP 技术及先进热化学工艺领域拥有超过十二年的经验，是推动 BioBTX 技术创新从实验室走向中试及示范规模的核心人物。于莱顿大学获得有机化学硕士学位，并在格罗宁根大学取得能源与环境科学博士学位。其早期工作包括参与经合组织（OECD）环境展望项目以及国际应用系统分析研究所（IIASA）青年科学家暑期项目，在这些工作中他积累了能源-材料整合建模及气候相关系统分析的基础经验。在加入 BioBTX 之前，他曾担任顾问，支持化工领域的可持续发展项目。自 2012 年起，他负责领导 BioBTX 的研发团队，主导核心技术开发、中试及示范装置的概念设计，并指导工艺开发与催化剂研发领域的高级专业人员。他因其在科学洞见与工程实践之间架设桥梁，以及推动循环经济与低碳化工行业创新发展的贡献而广受认可。

Downstream processing of sustainable aromatics towards bioplastics

可持续芳烃制备生物质基塑料

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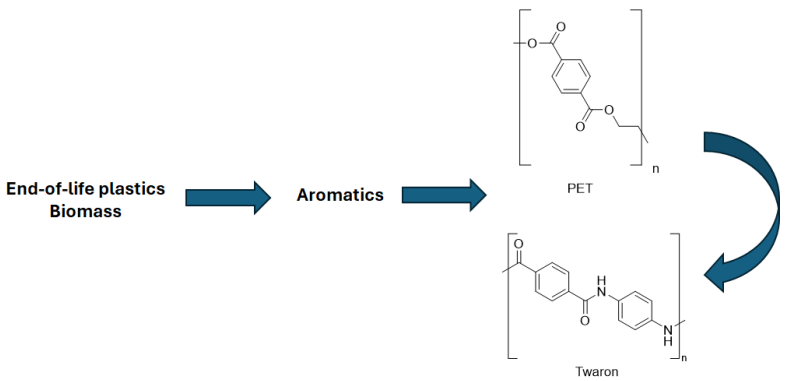
Abstract
Aromatics such as benzene, toluene, and xylenes (BTX) are key intermediates for the plastic industry. To meet the requirements of a circular economy, new sustainable routes towards BTX are essential to achieve a full transition. Catalytic pyrolysis of end-of-life plastics/biomass is an excellent approach not only to keep “aromatics” in the loop but also to compensate for materials (containing aromatics) lost during production, utilization, and collection/sorting. In the presentation, we will discuss the downstream processing of sustainable BTX, obtained by catalytic pyrolysis, into PET and the polyaramid Twaron (Kevlar), and the upcycling of contaminated PET streams into Twaron.



摘要
苯、甲苯和二甲苯（BTX）等芳香烃是塑料工业的关键原料中间体。为满足循环经济的要求，必须开发新型可持续的BTX生产路径以实现全面转型。通过对废弃塑料/生物质进行催化热解，不仅能实现"芳香烃"的循环利用，还可弥补其在生产、使用及回收分选过程中的损耗，是一种极具前景的解决方案。本报告将探讨如何将通过催化热解获得的可持续BTX，经下游加工转化为聚对苯二甲酸乙二醇酯（PET）及聚芳酰胺Twaron（凯夫拉纤维），并进一步阐述受污染的PET料流升级回收制备Twaron的技术路径。

Prof. André Heeres (1966) is a professor at the Hanze University of Applied Sciences in Groningen, The Netherlands. His chemistry group is active in the de-fossilization of the chemical industry (renewable carbon). Main topics are the synthesis of biobased products (a.o. biopolymers) and the recycling and upcycling of (bio)polymers/plastics. André is (co)inventor of > 15 patents and one of the founders of the company BioBTX. He was awarded the Groene Groninger prize in 2021.

Prof. André Heeres （生于1966年），现任荷兰格罗宁根汉斯应用科学大学教授。其研究团队致力于化工行业去化石燃料化（可再生碳）领域，主要研究方向包括生物基产品（如生物聚合物）的合成，以及（生物）聚合物/塑料的回收与升级再造。安德烈是超过15项专利的（共同）发明人，也是BioBTX公司的创始人之一，并于2021年荣获“绿色格罗宁根奖”。

Prof. André Heeres

Value-added utilization of wastes through pyrolysis: Principles, processes, and practices

废弃物热解高值化利用：原理、工艺、实践

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Abstract

Unlike biomass, heterogeneous solid wastes consist of variable components, with uneven size and shape, making them difficult to achieve value-added conversion through pyrolysis or catalytic pyrolysis as biomass does. After more than a decade of researches, we have developed an integrated "pyrolysis + post-treatment" technology that utilizes hot pyrolysis char for online catalytic reforming of condensable volatiles to obtain upgraded oil, or catalytically cracks tar to produce high-calorific value fuel gas or hydrogen-enriched syngas. For oil production scenarios, viscous tar can be converted into high-calorific value-added oil with a viscosity of less than 5 cP, with or without the addition of extra catalysts. In gas production scenarios, the fuel gas with calorific value greater than 10 MJ/Nm^3 can be obtained with air as gasifying agent, while the syngas with H_2 concentration close to 60%, and the CH_4 concentration less than 3% can be obtained when using H_2O reforming with the addition of extra catalyst at temperature lower than 900 ℃. We have developed highly efficient heat and mass transfer pyrolysis equipment combining external and internal heating, as well as pyrolysis-char self-catalytic reactor, which have been applied in county-level waste-to-energy generation, heat supply for ceramsite kilns, treatment of high-salt content sludge, and resource recovery of countryside municipal solid wastes, where will be introduced in this speech.

摘要

固废与生物质不同，具有组分多变、尺寸和形状不均匀的特点，难以像生物质那样通过热解或者催化热解实现高值化。经过十余年的研究我们开发了一种利用炽热热解炭在线催化重整可凝性挥发分获得提质油以及将焦油催化裂解制备高热值燃气或者富氢合成气的“热解+后处理”一体化新技术。针对制油场景、在添加或者不添加催化剂的条件下将粘稠焦油转化为粘度低于5cP的高热值油；在制备燃气的场景下，以空气为气化剂燃气热值可＞10 MJ/Nm^3，大幅超过了常规空气气化的热值；在制备合成气的场景下，在≦900 ℃、自产热解炭和外部催化剂共同作用下合成气中H_2浓度达60%，且CH_4浓度低于3%。开发了外热-内热结合的高效传热传质热解装备和热解-炭自催化重整装备，已经应用于县域垃圾发电、陶粒窑供热、高含盐污泥的处理以及县域垃圾的资源化，本文将介绍这些案例。

Prof. Dezhen Chen
陈德珍 教授

Dezhen Chen is a professor in Thermal & Environmental Engineering Institute at Tongji University.
She is an Associate Editor of the Waste Management journal of Elsevier, an editorial board member of Detritus and Environmental Sanitation Engineering (in Chinese). She is a SAP (Scientific advisory panel) member of the International Waste Working Group (www.iwwg.eu), and in the framework of this association, she is also a key member of the IWWG-Task Group on Thermal Treatments. She is an expert in the Waste Management Association of China's Rural Waste Management Professional Committee, and a think-tank expert on chemical and waste environmental management at the Basel Convention Regional Centre for Asia and the Pacific. She was listed in the top 2% of the world's top scientists in 2022, 2023 and 2024, and is the author of more than 200 scientific papers published in international or domestic scientific journals.
She has rich research experiences in field of waste to energy through pyrolysis to obtain value-added energy products. She has been the scientific responsible and the team leader for more than 10 Governmental projects about waste-to-energy and waste to resources. In particular, she and her team finished more than 50 consulting or technology R&D projects in the past 10 years. Her patented pyrolysis - reforming technology has received industrialization support from the National Innovation Center par excellence of China. She acted as co-chair of Symposium on Energy from Biomass and Waste 2022, 2024. She acts as a referee for MIT Technology Review Innovators Under 35, etc. In 2024 she obtained China Association of Invention and Innovation Award for Inventive Entrepreneurship - Individual Award(2024-CAIR067) and the First Prize of the Environmental Protection Science and Technology Award(2024-J-1-06-G2).

陈德珍，同济大学热能与环境工程研究所教授，博导，前任所长。上海市多源固废协同处理和能源化工程技术研究中心副主任。她任Waste Management（Elsevier，Q1，中科院二区）副主编，《Detritus》（IWWG会刊）和《环境卫生工程》的编委。是国际废物工作组（www.iwwg.eu）科学顾问小组（SAP）的成员，也是该协会框架下热处理任务小组的核心成员。担任中环协村镇垃圾处理专委会专家委员，巴塞尔公约亚太区域中心化学品和废物管理领域智库专家。在国际或国内科学期刊上发表了200多篇科学论文，近三年均入选全球前2%顶尖科学家榜单。
她在废物热解转化研究领域拥有丰富的经验。曾支持完成科技部863项目、重点研发计划课题、自然科学基金、上海市科委重大专项等项目10余项；她和团队在过去10年里还完成了50多个咨询或技术研发项目。发明的热解定向重整技术获得长三角国创中心的产业化扶植。她担任威尼斯固废和生物质能源会议联合主席(2022年和2024)。并担任过“MIT Technology Review Innovators Under 35“评委。2024年，她获得了中国发明协会发明创业奖-人物奖（2024-CAIR067）和环境保护科学技术奖科技成果奖一等奖（2024-J-1-06-G2）。

Overview of activities at DTU in pyrolysis related activities

丹麦技术大学（DTU）热解相关研究概述

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Abstract

The presentation will give an overview of recent activities at DTU-Chemical Engineering within the broader area of pyrolysis involving 1) High pressure catalytic hydropyrolysis of biomass to directly produce a fully deoxygenated liquid fuel; 2) High pressure catalytic hydropyrolysis of plastics; 3) Atmospheric pressure catalytic pyrolysis and hydropyrolysis of biomass; 4) Pyrolysis of waste and its integration with cement production. Furthermore upgrading of biomass pyrolysis oil by catalytic hydrotreating in both traditional trickle bed reactors and a novel slurry reactor will be discussed.

摘要

本次报告将概述丹麦技术大学化学工程系在热解领域的最新研究进展，主要包括：1）生物质高压催化加氢热解直接制备完全脱氧液体燃料；2）塑料高压催化加氢热解；3）生物质常压催化热解与加氢热解；4）废弃物热解及其与水泥生产的协同处理。此外，还将探讨在传统滴流床反应器与新型浆态床反应器中通过催化加氢处理对生物质热解油进行提质改性的相关研究。

Prof. Anker Degn Jensen

Prof. Anker Degn Jensen is professor of catalysis and catalytic process engineering at the Department of Chemical & Biochemical Engineering, The Technical University of Denmark (DTU). His research interests are within heterogeneous catalysis in energy conversion, environmental applications and chemicals synthesis. Current topics include e.g. syngas to methanol, methanol to jet fuel, conversion of biomass to fuels and chemicals via pyrolysis, plasma assisted catalysis and flue gas cleaning (e.g. NO_x, N_2O). He has published >260 peer-reviewed journal articles with ~15,000 citations and has a H-index of 61 (WoS). He has received several prizes for his research among other from the Foundation of His Royal Highness Prince Henrik of Denmark and the Jorck Foundation. He is Knight of the Order of Dannebrog by Her Royal Majesty Queen Margrethe II. He has supervised more than 60 PhD students and more than 370 BSc/BEng and MSc students.

Prof. Anker Degn Jensen 现任丹麦技术大学（DTU）化学与生物化学工程系催化与催化过程工程教授。他的研究聚焦于多相催化在能源转化、环境应用及化学品合成等领域的应用。目前的研究主题主要包括：合成气制甲醇、甲醇制航空燃料、生物质通过热解转化为燃料和化学品、等离子体辅助催化以及烟气净化（如氮氧化物、一氧化二氮处理）等。他已发表超过260篇同行评审期刊论文，累计被引用约15,000次，Web of Science H指数为61。他曾获多项研究奖项，包括丹麦亨里克亲王殿下基金会和约尔克基金会颁发的荣誉。此外，他被玛格丽特二世女王陛下授予丹尼布洛勋章骑士称号。他已指导超过60名博士研究生以及370余名本科与硕士研究生。

Advancing pyrolysis technologies at Valmet: Conversion of low-grade feedstock into valuable resources

Valmet 热解技术进展：将低品质原料转化为高价值资源

Tooran Khazraie Shoulaifar

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Abstract

For over two decades, Valmet has been at the forefront of developing innovative technologies to produce pyrolysis oil through fast pyrolysis. This commitment to excellence began with the commissioning of Valmet's first plant delivery in 2012, marking a significant milestone in the journey. Recognizing the inherent challenges of conventional fast pyrolysis oil, such as high acidity, elevated oxygen content, and high water content, a mission to enhance oil quality through catalytic fast pyrolysis started. Initial investigations involved catalyst screening at the laboratory scale, progressing to bench-scale trials of selected catalysts. The promising outcomes of these studies propelled the development consortium to conduct further experiments at the pilot scale, with a feeding rate of 20 kg/h. The results & findings matched expectations, leading to the construction and commissioning of the largest pilot plant with a 400 kg/h feeding rate in Tampere, Finland, showing Valmet's dedication and investment in technology development.

Since 2020, Valmet has begun exploring the chemical recycling of plastics, starting with polystyrene and subsequently expanding to the pyrolysis of mixed plastic waste. In cooperation with technology partners, Valmet has conducted pilot-scale pyrolysis of polystyrene, and several investigations into the pyrolysis of mixed plastic waste are ongoing.

In 2023, the first biomass catalytic fast pyrolysis trials were initiated at Tampere's pilot plant, which yielded encouraging results. At the upcoming P&CP 2026 Symposium, Valmet will present its findings on the development of catalytic fast pyrolysis and recent trials. Additionally, the presentation will include findings on the post-treatment process of the oil through hydrodeoxygenation, performed in collaboration with technology partners. The initially low oxygen content in the original catalytic fast pyrolysis oil results in more efficient oxygen removal via hydrodeoxygenation. The goal is to produce upgraded oil similar to hydrocarbons in the range of gasoline and diesel. This work not only signifies a technological leap in pyrolysis oil production but also highlights our commitment to advancing sustainable product manufacturing through pyrolysis route.

摘要

二十多年来，Valmet公司专注于通过快速热解技术生产热解油的研发。2012年首套工业化装置的交付是该技术发展的重要里程碑。为改善传统热解油的高酸度、高氧含量与高含水量等问题，公司启动了催化快速热解研发计划。

研发从实验室催化剂筛选开始，经台架试验后推进至20公斤/小时的中试，最终在芬兰坦佩雷建成了400公斤/小时的全球最大催化快速热解中试装置。

自2020年起，公司拓展至塑料化学回收，已完成聚苯乙烯的中试热解，并开展混合废塑料热解研究。2023年，生物质催化快速热解中试取得积极进展，所获低氧含量热解油经加氢脱氧后可产出类汽柴油烃类油品，标志着该技术在可持续产品制造路径上的重要进展。

Dr. Tooran Khazraie Shoulaifar

Dr. Tooran Khazraie Shoulaifar is a chemical engineer with over 10 years of experience in the chemical and energy industries. She holds a Ph.D. in Chemical Engineering from Åbo Akademi University, Finland, with a specialization in thermochemical conversion processes, including the pyrolysis of biomass and plastics. Tooran has worked extensively in R&D, focusing on process design, pilot-scale experimentation, and the sustainable utilization of resources. She has published her research in peer-reviewed journals and actively collaborates with industry and academia to advance solutions for the circular economy. Her current research focuses on developing innovative thermal conversion technologies to transform waste into valuable resources.

Dr. Tooran Khazraie Shoulaifar 是一名拥有超过十年化工与能源行业经验的化学工程师。她毕业于芬兰奥博学术大学，获化学工程博士学位，研究方向包括生物质和塑料热解在内的热化学转化工艺。托兰在研发领域经验丰富，专注于工艺设计、中试实验与资源可持续利用。其研究成果已在多家同行评审期刊上发表，并积极与工业界和学术界合作，共同推动循环经济解决方案。她当前的研究重点是开发创新的热转化技术，将废弃物转化为高价值资源。

Reactive catalytic pyrolysis of palm kernel shell to high value chemicals

棕榈仁壳催化热解制备高值化学品

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Abstract

Catalytic fast pyrolysis is one of the most promising techniques for the production of bio-oils. Generally, pyrolysis is carried out in an inert atmosphere; however, reactive catalytic pyrolysis has emerged as a challenging technique for achieving high catalytic efficiency. Herein, NiCe/CN catalysts with different Ni:Ce ratios were developed, and their catalytic efficiency in the catalytic fast pyrolysis of palm kernel shells in a CO_2 atmosphere was evaluated. The effects of reaction conditions, including reaction temperature (400–600 ℃) and ratio of Ni:Ce (10:0, 10:1, 10:3, 10:5, and 10:10), on product yields were studied using both in-situ and ex-situ studies. NiCe/CN50 exhibited enhanced oxygen removal efficiency owing to the presence of oxygen vacancies in CeO_x. In addition, the acidic site of the catalyst promoted the demethoxylation of highly selective alkylphenol. The presence of Ce promoted the Bouduard reaction ($C + CO_2 \rightarrow 2CO$), which reduced coke deposition on the spent catalyst. Our results indicate that the NiCe/CN50 catalyst exhibited good catalytic efficiency, with highly selective production of alkylphenol and acetic acid, and low deactivation. Therefore, NiCe/CN50 can be used as an alternative catalyst for phenol production from biomass via fast catalytic pyrolysis.

摘要

催化快速热解是生产生物油最具前景的技术之一。热解过程通常在惰性气氛中进行，而催化热解技术作为一种能够实现高催化效率的挑战性方法，近年来逐渐受到关注。本研究通过制备不同镍铈比例（Ni:Ce）的NiCe/CN催化剂，评估了其在CO_2气氛中对棕榈仁壳进行催化快速热解的催化效率，并通过原位与非原位研究探讨了反应温度（400–600 ℃）和镍铈比例（10:0、10:1、10:3、10:5和10:10）对产物收率的影响。研究结果表明，NiCe/CN50催化剂因CeOx中氧空位的存在而表现出更高的脱氧效率，其酸性位点进一步促进了高选择性烷基酚的脱甲氧基化反应。铈的引入促进了布杜阿尔反应（$C + CO_2 \rightarrow 2CO$），有效降低了废催化剂上的积碳。综合来看，NiCe/CN50催化剂展现出良好的催化效率，能够高选择性地生成烷基酚和乙酸，且失活程度较低，因此可作为生物质通过快速催化热解制备酚类化合物的潜在替代催化剂。

Prof. Chanatip Samart is an Associate Professor and Head of the Department of Chemistry at Thammasat University, with his promotion to full professor currently pending official royal appointment. His research primarily focuses on pyrolysis, heterogeneous catalysis, and biomass conversion. In addition to his academic role, he serves as an editorial board member for several international journals, including Carbon Resources Conversion, Journal of Metals Materials and Minerals, and Discover Applied Sciences. He is also active in academic dissemination, maintaining a personal webpage to share his research and professional activities.

Prof. Chanatip Samart 现任泰国国立法政大学化学系的副教授兼系主任，其正式教授职称正在等待皇家任命批准。他的研究主要集中于热解、多相催化与生物质转化领域。除学术职务外，他还担任多个国际期刊的编委，包括Carbon Resources Conversion，Journal of Metals Materials and Minerals 以及Discover Applied Science。他亦积极从事学术交流，并通过个人网页分享其研究进展与专业活动。

Prof. Chanatip Samart

Conventional and microwave pyrolysis with and without catalyst

使用催化剂和无催化剂的常规热解和微波热解

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Abstract

Energy plays a vital role in the socio-economic and industrial development of any nation. Simultaneously, the energy supply sector (such as petroleum, oil, and gas industries) is the largest contributor to global emissions. In line with decarbonization efforts, industries are accelerating the deployment of low-carbon technologies to develop sustainable methods for converting renewable resources, such as biomass, into value-added products. The present work aims to provide an evolution of conventional and microwave pyrolysis research, focusing on system development and product quality. A variety of feedstocks were analyzed, and catalysts were applied for thermogravimetric analyzer, conventional, and microwave pyrolysis. The thermogravimetric analysis (TGA) of biomass under a CO_2 environment revealed a two-stage thermal degradation process: pyrolysis (Stage I) and gasification (Stage II). The kinetic analysis highlighted the impact of catalysts on the activation energy, with a notable reduction in Stage II, resulting in accelerated gasification reactions. Empty fruit bunch (EFB) biomass is the most promising feedstock among the biomasses tested, followed by palm kernel shell (PKS) and coconut shell (CS). The work aimed to investigate the effect of CO_2 gasification of various biomasses using a conventional electrically heated lab-scale fixed-bed reactor. The study assessed syngas yield and quality under different key operating conditions, including temperatures, with and without catalysts (dolomite and olivine). The findings revealed EFB as one of the consistently produced high syngas yields, with dolomite showing high effectiveness in maximizing tar-to-syngas conversion. Finally, the microwave pyrolysis/gasification of biomass was explored. The fundamental dielectric properties influenced by temperature that govern the MW processing are presented. The challenges faced in scaling up the MW technology for biomass processing are also presented.

摘要

能源是国家发展的核心动力，但其供应环节也是全球碳排放的主要来源。为实现低碳转型，开发生物质等可再生资源的高值化利用技术至关重要。本研究系统对比传统热解与微波热解技术，重点分析反应系统优化与产物调控策略。通过热重分析发现，生物质在CO_2气氛下经历热解（第一阶段）与气化（第二阶段）两阶段转化，催化剂可显著降低第二阶段活化能并加速气化反应。在多种生物质中，空果串（EFB）表现最优。采用固定床反应器考察CO_2气化过程表明，白云石催化剂可有效促进焦油向合成气转化。研究还探讨了微波热解/气化技术，解析温度对介电特性及反应过程的影响，并指出规模化应用面临的挑战。

Dr. Arshad Adam Salema

Dr. Arshad Adam Salema is an Associate Professor and Course Director of the Master of Applied Engineering program at Monash University, Malaysia, standing at the forefront with a relentless passion for renewable and sustainable energy solutions. He earned his Ph.D. and Master's from the Universiti Teknologi Malaysia, a Bachelor's degree in Chemical Engineering from the University of Pune, India, and worked as a postdoctoral fellow at the University of New Brunswick, Canada. Dr. Salema is actively engaged with both industrial and government projects. His collaborations span diverse sectors, including transportation, the palm oil industry, oil and gas, waste management, bioenergy, and the Ministry. Dr. Arshad has published more than 70 articles in reputable journals and conferences, with a Google h-index of 27. He is a registered Chartered Engineer and a member of the Institution of Engineers, India, as well as a Graduate Engineer with the Board of Engineers, Malaysia. His work focuses on biomass, sustainable fuels and chemicals, thermochemical conversion, microwave processing, waste management, and energy materials. He has received multiple awards, including the Vice-Chancellor's Teaching Excellence Award 2025, Dean's Education Teaching Excellence Award 2025, and Pro-Vice Chancellor Research Engagement and Impact Award 2023. Dr Salema continues to develop research that bridges science, engineering, and policy, with a strong commitment to sustainable development and the translation of research into practical, industry-ready solutions.

Dr. Arshad Adam Salema 现任马来西亚莫纳什大学副教授及应用工程硕士项目主任，长期致力于可再生与可持续能源领域的前沿研究。他于马来西亚理工大学获得博士学位与硕士学位，在印度浦那大学获得化学工程学士学位，并于加拿大新不伦瑞克大学从事博士后研究。萨勒马博士积极承担工业界与政府合作项目，合作领域涵盖交通运输、棕榈油产业、石油天然气、废弃物管理、生物能源及政府部门。他已在知名期刊与学术会议上发表论文70余篇，谷歌学术H指数为27。他是印度工程师学会特许工程师、马来西亚工程师委员会注册工程师，并担任多个专业组织成员。其研究方向涵盖生物质转化、可持续燃料与化学品、热化学转化、微波处理技术、废弃物管理及能源材料开发。曾获2025年度副校长优秀教学奖、2025年度院长教育卓越教学奖及2023年度副校长研究影响力奖等多项荣誉。萨勒马博士持续致力于推动跨学科研究，融合科学、工程与政策视角，以坚定的可持续发展理念推动科研成果向产业应用转化。

The effective use of tandem micro-reactor on the catalytic co-pyrolysis of biomass and waste plastic

串联微反应器在生物质与废塑料催化共热解中的高效应用

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Abstract

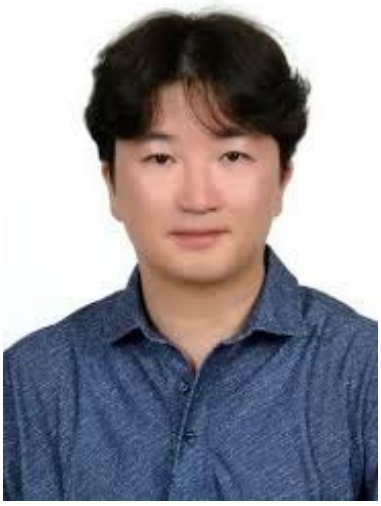
Py-GC/MS is recognized as one of the most indispensable analytical platforms in pyrolysis research and has been extensively employed, together with thermogravimetric analysis (TGA), as a core tool for investigating thermal decomposition behavior. In recent years, the development and implementation of a tandem micro-reactor system have significantly advanced studies on both in situ and ex situ catalytic pyrolysis of biomass, plastics, and their blended feedstocks. Moreover, the introduction of a high-pressure flow controller has enabled systematic investigation of pyrolysis reactions under high-pressure hydrogen atmospheres, reaching pressures of up to approximately 3 MPa. These advancements have expanded the experimental capability of analytical pyrolysis, allowing more precise control of reaction environments and deeper insight into reaction pathways. In this presentation, the operating principles and key functionalities of the tandem micro-reactor will be comprehensively introduced, followed by representative case studies demonstrating its application to various catalytic pyrolysis systems.

摘要

Py-GC/MS技术是热解研究中不可或缺的分析平台之一，常与热重分析联用，成为探究热分解行为的重要工具。近年来，串联微反应器系统的开发与应用显著推进了生物质、塑料及其混合原料的原位与非原位催化热解研究。此外，高压流量控制器的引入使得在高压氢气气氛（压力可达约3 MPa）下系统研究热解反应成为可能。这些进展拓展了分析热解的实验能力，实现了对反应环境更精确的控制，并为反应路径的深入解析提供了新途径。本报告将系统介绍串联微反应器的工作原理与核心功能，并结合典型案例展示其在多种催化热解体系中的应用实践。

Prof. Young-Min Kim is a professor in the Energy System Engineering at Daegu University, Republic of Korea. His research interests focus on analytical pyrolysis, thermal conversion of biomass and plastic wastes, environmental and polymer analysis using Py-GC/MS, and the development of advanced analytical methodologies for environmental applications. He has published numerous peer-reviewed articles and has been actively involved in academia–industry collaborative research, including advanced microplastic analysis and thermal treatment technologies.

Prof. Young-Min Kim 现任韩国大邱大学能源系统工程学教授。他的研究主要聚焦于分析热解、生物质与废塑料的热转化、利用Py-GC/MS进行环境与聚合物分析，以及开发面向环境应用的先进分析技术。他已发表大量同行评审论文，并积极投身于产学研合作研究，涵盖先进微塑料分析及热处理技术等领域。



Prof. Young-Min Kim

Thermochemical conversion of biomass and organic solid wastes: Toward the production of fuels and functional materials

生物质及有机固体废弃物热化学转化制备燃料及功能材料

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Abstract
This research focuses on addressing the low utilization efficiency of biomass—our only carbon-containing renewable resource for large-scale liquid fuel and functional material production—amid the urgent transition to renewable energy. To this end, we proposed an integrated thermochemical and catalytic conversion strategy for biomass and organic solid wastes like waste plastics, supported by machine learning optimization. Key technologies include torrefaction pretreatment and N/O-doped biochar catalysts to boost phenolic bio-oil production, automated ML models that identified Zn-loaded zeolites as optimal for BTX synthesis, and a distillation-coupled upgrading approach for bio-oil fractionation and refinement. We also achieved synergistic conversion by co-processing biomass with high H/C waste plastics, such as a low-temperature hydrothermal process for PET that produces high-purity hydrogen, and developed high-performance biomass-derived carbon materials for supercapacitors, sodium-ion batteries, and environmental remediation. his work realizes high-value utilization of biomass and plastic wastes through multi-path integration, providing a sustainable and scalable solution for carbon resource recycling and supporting the global low-carbon energy transition.

摘要
本研究旨在解决生物质（我们大规模生产液体燃料和功能性材料的唯一含碳可再生资源）利用率低的问题，以应对向可再生能源的紧迫转型。为此，我们提出了一种集成的热化学和催化转化策略，用于生物质和有机固体废物（如废塑料）的处理，并借助机器学习优化。关键技术包括通过热解预处理和氮/氧掺杂生物炭催化剂来提高酚类生物油的产量，通过自动化的机器学习模型确定负载锌的沸石是合成苯、甲苯和二甲苯的最佳选择，以及采用蒸馏耦合升级方法对生物油进行分馏和精炼。我们还通过共处理生物质与高氢碳比的废塑料实现了协同转化，例如在低温水热条件下处理聚对苯二甲酸乙二醇酯（PET）以生产高纯度氢气，并开发了高性能的生物质衍生碳材料用于超级电容器、钠离子电池和环境修复。这项工作通过多路径整合实现了生物质和塑料废弃物的高价值利用，为碳资源回收提供了可持续且可扩展的解决方案，助力全球低碳能源转型。

Shurong Wang is currently a Distinguished Professor at Zhejiang University. Concurrently, he holds the positions of Vice President at Shenyang University of Chemical Technology and Deputy Director of the State Key Laboratory of Clean Energy Utilization. He is a fellow of Royal Society of Chemistry and serves Editor-in-Chief of Journal of Analytical and Applied Pyrolysis. His primary research focus centers on the thermo-chemical conversion of biomass and organic solid wastes into high-quality liquid fuels, value-added chemicals and functional materials.

王树荣，浙江大学特聘教授。同时，他还担任沈阳化工大学副校长以及能源高效清洁利用全国重点实验室副主任。他是英国皇家化学会会士，并担任Journal of Analytical and Applied Pyrolysis主编。他的主要研究方向集中在将生物质和有机固体废物通过热化学转化成高品质液体燃料、高附加值化学品和功能材料。

Prof. Shurong Wang
王树荣 教授

Bio-Aromatics from renewable and waste carbon resources in Indonesia

印度尼西亚利用可再生与废弃碳资源生产生物基芳香烃

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Abstract

Indonesia possesses abundant biomass resources, particularly from the palm oil industry, that offer significant potential as sustainable feedstocks for the production of bio-aromatic chemicals. In addition to lignocellulosic residues such as empty fruit bunches (EFB), a wide range of biomass and waste-derived feedstocks—including agricultural residues, forestry by-products, and heterogeneous waste oils—can serve as renewable carbon sources for aromatic compounds such as BTX and related intermediates. Research conducted by the Center of Catalysis and Reaction Engineering Group (CARE ITB) at Institut Teknologi Bandung focuses on the development of integrated catalytic conversion pathways. These include thermochemical processing (e.g., pyrolysis and hydrothermal routes) followed by catalytic upgrading using tailored solid catalysts, notably modified zeolites and multifunctional metal–acid systems. The studies demonstrate that appropriate catalyst and reactor design can promote deoxygenation, cracking, and aromatization reactions, while mitigating coke formation and accommodating the inherent variability of biomass and waste-oil feedstocks. Overall, this work highlights the strategic role of palm-based biomass and other renewable or waste carbon sources for bio-aromatics production and supports the development of robust process concepts relevant for pilot-scale demonstration and future industrial implementation within a circular, low-carbon chemical industry

摘要

印度尼西亚拥有丰富的生物质资源，特别是来自棕榈油产业的资源，为生产生物基芳香化学品提供了重要的可持续原料潜力。除了如空果串（EFB）等木质纤维素残渣外，包括农业残留物、林业副产品以及成分复杂的废弃油脂在内的多种生物质和废弃物衍生原料，均可作为生产苯、甲苯、二甲苯（BTX）及其相关中间体等芳香化合物的可再生碳源。由万隆理工学院催化与反应工程中心团队（CARE ITB）开展的研究，聚焦于开发一体化的催化转化路径，包括热化学处理（例如，热解与水热法），以及随后使用特定设计的固体催化剂（特别是改性沸石和多功能金属-酸性位催化剂体系）进行的催化提质。研究表明，合适的催化剂和反应器设计能够促进脱氧、裂解和芳构化反应，同时抑制结焦，并适应生物质和废弃油脂原料固有的成分波动性。总而言之，本研究凸显了棕榈基生物质及其他可再生或废弃碳源在生产生物基芳香烃方面的战略作用，并支持了在循环、低碳的化学工业框架内，开发适用于中试示范及未来工业应用的稳健工艺概念。

Dr. C.B. Rasrendra is the Chair of the Undergraduate Chemical Engineering Program at Institut Teknologi Bandung (ITB), Indonesia. He earned his PhD under the supervision of Prof. H.J. Heeres at University of Groningen, with a research focus on Platform Chemicals from Biomass. His expertise lies in catalysis for renewable chemicals and sustainable fuel technologies, with strong emphasis on the catalytic conversion of bio-based feedstocks and low-carbon resources into sustainable fuels and value-added chemicals. His research covers the development of hydrotreating, isomerization, and upgrading catalysts for applications in sustainable fuel production, as well as oil and gas refining and refinery integration to support the energy transition. He is actively involved in national “Merah Putih” catalyst programs, encompassing process scale-up, downstreaming (hilirisasi), and commercialization of indigenous catalysts from laboratory research to pilot and industrial implementation. Dr. Rasrendra works closely with industry, government, and international partners to accelerate low-carbon development and circular-economy transitions in Indonesia.

Dr. C.B. Rasrendra

Dr. C.B. Rasrendra 现任印度尼西亚万隆理工学院（Institut Teknologi Bandung, ITB）化学工程本科项目主席。他在荷兰格罗宁根大学（University of Groningen）获得了博士学位，师从 H.J. Heeres 教授，其博士研究专注于从生物质平台化合物的转化与制备。他的核心研究领域涵盖可再生能源化学品与可持续燃料技术相关的催化过程，尤其擅长基于生物质的原料和低碳资源的催化转化，以生产可持续燃料和高附加值化学品。他的研究工作包括开发用于可持续燃料生产的加氢处理、异构化和提质增效催化剂，并涉及石油天然气炼制及炼厂一体化技术，以支持能源转型。此外，他积极参与印度尼西亚国家“Merah Putih”催化剂计划，致力于推动本土催化剂从实验室研发到中试及产业化实施的工艺放大、下游产业链延伸与商业化进程。他与工业界、政府机构及国际伙伴紧密合作，共同加速印度尼西亚的低碳发展和循环经济转型

Catalytic strategies for aromatic hydrocarbon production improvement during co-hydropyrolysis of biomass and plastics

生物质与塑料共加氢热解过程中提高芳烃产量的催化策略

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Abstract

Catalytic hydropyrolysis is a promising technology for converting lignocellulosic materials and plastics into valuable platform compounds. This study presents an integrated strategy combining torrefaction pre-treatment of Chilean Oak (ChO) with catalytic co-hydropyrolysis to maximize the selectivity of mono-aromatic hydrocarbons (MAHs). The torrefaction of ChO modified its composition, reducing hemicellulose and increasing lignin content, which enhanced the lignin-carbohydrate complex formation and improved pyrolysis control, thus leading to a product profile rich in phenols, ketones, and furans with minimal acid content.

The second focus was on enhancing MAH formation via hydrodeoxygenation (HDO) during catalytic hydropyrolysis. Ga- and Zn-supported modified Chilean natural zeolite catalysts were evaluated. The Zn-based catalyst, with a balanced Lewis/Brønsted acid site ratio, showed superior performance, yielding up to 64% MAH in biomass/plastic mixtures, whereas the Ga-based catalyst mainly produced phenols. The acid-site balance proved critical: a Lewis/Brønsted ratio near 1 promoted Diels-Alder cycloaddition for MAH formation, while a low ratio favoured aromatic ring opening and aliphatic hydrocarbon production.

Additionally, a Ni-based catalyst derived from a metal-organic framework (MOF) was tested. This catalyst, featuring an alumina-carbonaceous matrix with nickel nanoparticles, increased aromatic hydrocarbon yield to 71.5% (including 63.5% monoaromatics) under optimised conditions: 86% catalyst weight, 550 ℃, 150 psi H_2, and a 2:1 LDPE/ChO ratio. The catalyst reduced oxygenated compounds and enhanced both aliphatic and aromatic hydrocarbons.

In summary, torrefaction pre-treatment effectively stabilises biomass and improves product quality, while tailored acid-site catalysts, especially Zn-supported zeolites and MOF-derived Ni catalysts, provide efficient pathways for maximising MAH production from the co-hydropyrolysis of biomass and plastic wastes.

摘要

催化加氢热解技术可将木质纤维素与塑料转化为高价值平台化合物。本研究提出将智利橡木烘焙预处理与催化共加氢热解相结合的集成策略，旨在最大化单环芳香烃（MAHs）的选择性。烘焙改变了原料组成，减少半纤维素、增加木质素含量，从而促进木质素-碳水化合物复合物形成，提升热解可控性，得到富含酚类、酮类和呋喃类且酸含量极低的产品。研究进一步通过催化加氢热解中的加氢脱氧反应提升MAHs产率。评估了镓与锌负载的改性天然沸石催化剂，其中锌基催化剂因具有平衡的路易斯酸/布朗斯特酸位点比例，性能更优，在生物质/塑料混合物中MAHs产率可达64%，而镓基催化剂主要生成酚类。酸位点平衡至关重要：路易斯酸/布朗斯特酸比例接近1有利于狄尔斯-阿尔德环加成反应生成MAHs，比例过低则促进芳环开环形成脂肪烃。此外，研究测试了一种金属有机骨架衍生的镍基催化剂。该催化剂在氧化铝-碳基质上负载镍纳米颗粒，在优化条件下（催化剂占比86%、热解温度550 ℃、氢气压力150 psi、低密度聚乙烯/智利橡木比例2:1）可将芳烃产率提高至71.5%，其中单环芳烃占63.5%，同时降低含氧化合物、提高脂肪烃与芳烃产量。烘焙预处理可有效稳定生物质并改善产品质量，而具有定制化酸位点的催化剂，特别是锌负载沸石与MOF衍生镍催化剂，为生物质与废塑料共加氢热解高效生产MAHs提供了可行路径。

Dr. Serguei Alejandro-Martín

Dr. Serguei Alejandro-Martín is an Associate Professor in the Department of Process Engineering and Bioproducts at Universidad del Bío-Bío, Chile, and serves as Director of the Doctoral Program in Engineering of Sustainable Materials and Processes. He earned his PhD in Engineering Sciences with a focus on Chemical Engineering from Universidad de Concepción, Chile, where his dissertation centered on the advanced oxidation of volatile organic compounds using Chilean natural zeolites under the supervision of Dr. Claudio Zaror. He also holds an MBA, a Diploma in Management, and a Bachelor's degree in Chemical Engineering from Universidad Central de las Villas, Cuba. He conducted two doctoral research stays at Paul Sabatier University III (Toulouse, France) and three postdoctoral stays at Aston University (Birmingham, United Kingdom). He founded and coordinates the Gas Chromatography and Analytical Pyrolysis Laboratory at Universidad del Bío-Bío. Since joining the university in 2015, he has supervised several undergraduate theses, two postgraduate theses, and is currently advising four doctoral candidates. Under his leadership, the doctoral program he directs achieved national accreditation in 2023. His research focuses on the thermochemical conversion of lignocellulosic and plastic residues via catalytic co-hydropyrolysis, with emphasis on waste valorization, the design and production of supported metal catalysts based on natural zeolites and metal-organic frameworks, and the generation of value-added chemicals and alternative biofuels. Over the past five years, he has published more than 20 articles in Q1 journals and has been awarded several national research projects funded by the Chilean National Research and Development Agency.

Dr. Serguei Alejandro-Martín 现任智利比奥比奥大学工艺与生物制品系副教授，并担任可持续材料与工艺工程博士项目主任。他于智利康塞普西翁大学获得化学工程博士学位，博士课题为利用智利天然沸石进行挥发性有机物的高级氧化，导师为Claudio Zaror博士。他还拥有古巴中央大学工商管理硕士学位、管理文凭及化学工程学士学位。他曾赴法国图卢兹第三大学（保罗·萨巴蒂埃大学）进行两次博士研究访问，并在英国阿斯顿大学完成三次博士后研究。他是比奥比奥大学气相色谱与分析热解实验室的创始人与负责人。自2015年入职以来，他已指导多项化学工程本科生课题、两篇硕士论文，目前正指导四篇博士论文。他主持的博士项目在2023年获得国家认证。其研究方向聚焦于木质纤维素与塑料废弃物的热化学转化，重点包括催化共加氢热解工艺、基于天然沸石和金属有机框架的负载型金属催化剂设计，以及高附加值化学品与替代生物燃料的制备。近五年来，他已在SCI一区期刊发表论文20余篇，并主持多项智利国家研究与发展局资助的科研项目。

Scaling up reductive lignin depolymerization: A sustainable pathway towards biomaterials and green chemicals

还原性木质素解聚工艺的放大：通往生物材料与绿色化学品的可持续路径

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Abstract

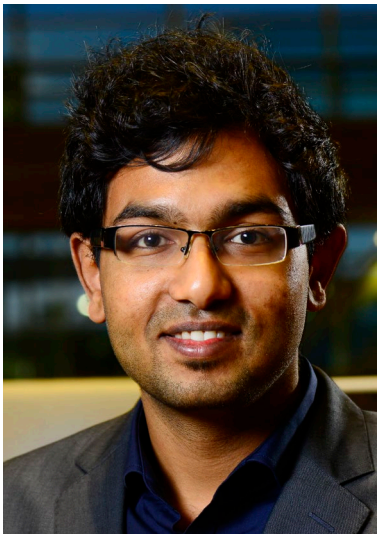
Lignin-first biorefineries highlight the potential of lignin's aromatic-rich structure for producing high-value green chemicals. A key step in lignin valorization is depolymerization, which converts the complex biopolymer into monomers, dimers, and oligomers, with product functionality governed by catalyst and process conditions. While reductive depolymerization has advanced significantly, it has largely been demonstrated at small (mg–g) semi-continuous scales using wood feedstocks. Integrating this technology with existing biorefineries (e.g., kraft, hydrolysis, and organosolv) is therefore critical.

Here, we demonstrate long-term continuous reductive depolymerization of lignins from commercial biorefineries at lab scale and its successful scale-up to two fully operational LignoValue pilot units at VITO (Belgium). Lab-scale experiments were performed in a continuously operated packed-bed reactor containing 15–30 g of Pd/Al_2O_3 or Ru/Al_2O_3. The effects of temperature (200-250 °C), lignin concentration (5–40 wt.% in methanol), feed rate (25-100 mL h^{-1}), and catalyst selection were systematically studied. The resulting depolymerized lignin oil (DLO) was characterized by GC-MS/FID, NMR (13C, 31P, 2D HSQC), GPC, and CHN analysis.

Continuous depolymerization of hydrolysis and organosolv lignins was sustained for over 100 h time-on-stream at 235 ℃ using Pd/Al_2O_3 and methanol, resulting in a pronounced reduction in molecular weight and carbon efficiencies exceeding 90%, with minimal coke or gas formation. The process was further validated at pilot scale, operating for over 200 h with performance comparable to the lab-scale system. DLO was subsequently used as a precursor for biopolymers (polyurethane foams and epoxy resins) and as a source of monomeric alkylphenols (e.g., propyl guaiacol and dihydrosinapyl alcohol), enhancing overall techno-economic viability. Finally, an extensive techno-economic analysis was conducted to identify key cost drivers and guide future improvements to the technology.

摘要

木质素生物精炼突显了其富含芳香族结构在生产高价值化学品方面的潜力，而解聚作为其价值化的关键步骤，可将复杂生物聚合物转化为功能性产物。尽管还原解聚已取得显著进展，但其应用此前主要局限于毫克至克级的木质原料半连续工艺。比利时VITO研究院实现了对商业生物精炼木质素的长期连续还原解聚，并成功从实验室放大至两套全规模运行的LignoValue中试装置。实验室采用填充15–30克Pd/Al_2O_3或Ru/Al_2O_3的连续反应器，系统研究了温度、浓度、进料速率与催化剂的影响。在235 ℃下使用Pd/Al_2O_3连续解聚水解与有机溶剂木质素超过100小时，实现分子量显著降低、碳效率超90%且几乎无结焦/产气。中试规模连续运行超200小时，性能与实验室一致。所得解聚木质素油可成功用作生物聚合物前体及单体烷基酚来源，提升了工艺经济性。最终的技术经济分析明确了关键成本因素，为技术优化提供了方向。



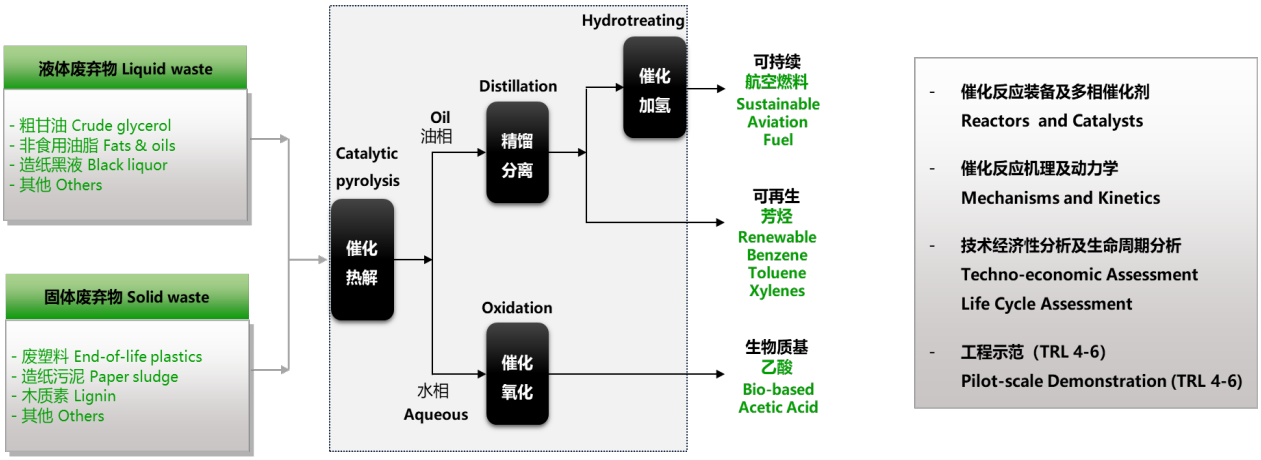
Dr. Balaji Sridharan

Dr. Balaji Sridharan obtained his master's degree in Energy and Process Technology from TU Delft and obtained his PhD from the University of Groningen (RUG) in the Netherlands, where he worked on the conversion of lignocellulosic biomass to biofuels under the supervision of Erik Heeres and Robbie Vanderbosch (from Biomass Technology Group (BTG), NL). In August of 2023, he joined Flemish Institute for Technological Research (VITO) and has been involved in the continuous catalytic depolymerization of Lignin and its scale up to pilot scale. His interests lie in the use of heterogeneous catalysis in thermochemical approaches to valorize lignin and biopolymers.

Dr. Balaji Sridharan 在代尔夫特理工大学获得能源与过程技术硕士学位，并在荷兰格罗宁根大学取得博士学位。攻读博士期间，他在埃里克·赫雷斯和罗比·范德博施（来自荷兰BTG生物质技术集团）的指导下，从事木质纤维素生物质制备生物燃料的转化研究。2023年8月，他加入弗拉芒技术研究院，致力于木质素的连续催化解聚技术开发及其向中试规模的放大研究。他的研究兴趣聚焦于运用多相催化技术，通过热化学方法实现木质素及生物聚合物的高值化利用。

中国科学院大连化学物理研究所
DALIAN INSTITUTE OF CHEMICAL PHYSICS, CHINESE ACADEMY OF SCIENCES
环境催化工程研究组
ENVIRONMENTAL CATALYSIS ENGINEERING

环境催化工程研究组（DNL0902）成立于1999年，隶属于洁净能源国家实验室(筹)，主要开展固液废弃物资源化领域可持续催化反应、多相催化剂、催化反应装备和集成技术的应用基础研究，聚焦国家双碳目标的重大战略和解决企业节能减排的经济需求。



Environmental Catalysis Engineering group (DNL0902) was founded in 1999 and is affiliated to the Dalian National Laboratory for Clean Energy. We conduct applied fundamental research in the circular carbon domain, focusing on sustainable catalysis reactions, heterogeneous catalysts, catalytic reactor engineering, and industrial demonstration. We contribute our sustainable catalysis expertise to the United Nations Sustainable Development Goals (SDGs 7 & 13).

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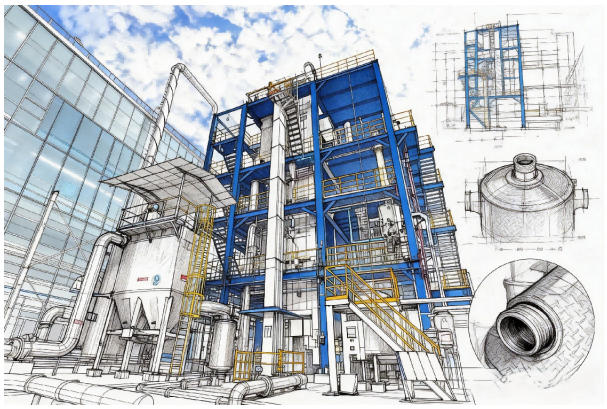
大连兴环能源科技

DALIAN XINGHUAN ENERGY TECHNOLOGY CO., LTD

大连兴环能源科技成立于2023年，聚焦废塑料热化学催化升级技术研发和产业化，规划建设约200万吨/年生产能力的区域化废塑料化学回收基地，生产可持续、可再生燃料和化学品如石脑油、芳烃和可持续航空燃料组分。兴环能源致力于将废塑料转化为可嵌入主流工业体系的“城市碳矿”，为国家“双碳”目标与全球循环经济提供关键产业支撑。



Dalian Xinghuan Energy Technology, established in 2023, develops scalable systems for the pyrolytic and catalytic upcycling of waste plastics. With a projected regional deployment capacity of approximately 2 million tons per year, its platform produces downstream-compatible intermediates, including naphtha-range hydrocarbons, aromatic-rich fractions, and jet-fuel-range hydrocarbons. Xinghuan aims to transform waste plastics into industrial feedstocks at scale, contributing to global decarbonization in line with the UN Sustainable Development Goals.

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P&CP

热解与催化热解

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