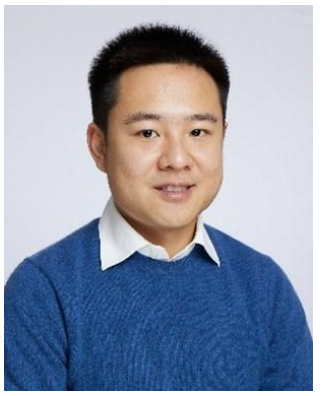
I²CNER Seminar Series

International Institute for Carbon-Neutral Energy Research (WPI-I²CNER)
Kyushu University

Title **Microwave-driven Catalysis Beyond Thermal Activation: Spatiotemporal Control for Energy-Efficient and Sustainable Polymer Upcycling**



Speaker Prof. Xiangyu Michael Jie
Department of Chemistry, School of Physical and Chemical Sciences (SPCS), Queen Mary University of London, UK

Time& Date 4:00 PM(JST), Wednesday, April 16th, 2025

Venue Hybrid (#217, Conference Room, I²CNER Bldg. 1, Ito Campus / Webinar)

Abstract

This talk explores how microwave (MW) irradiation interacts with catalytic materials and molecular systems to unlock energy-efficient chemical processes through MW-initiated or enhanced catalysis. While conventional MW research has largely focused on dielectric heating in insulators or polar molecules, recent experimental evidence suggests that MW-driven reactions can extend beyond traditional thermal activation. Although localised heating has been proposed as an explanation, the inherently non-equilibrium nature of these systems points to the involvement of yet-to-be-explored physicochemical mechanisms.

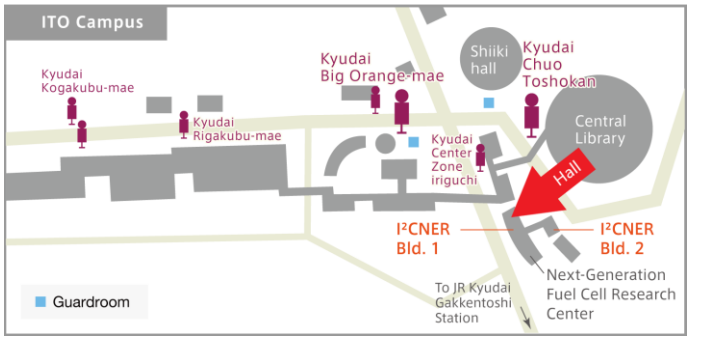
Our work aims to address fundamental questions about the interdependent dynamics between MW-responsive materials, interfacial architectures, and stable molecules during bond activation. By shedding light on these interactions, we seek to achieve precise spatiotemporal control over the formation of reactive intermediates using MW, guiding reaction pathways towards desired products with greater energy and atom efficiency. As a model system, we investigate polymer depolymerisation using tailored MW-active tandem catalysts, designed to enable spatiotemporal control within a single reactor. This approach facilitates the one-step conversion of diverse polymers into hydrogen, carbon nanomaterials, constituent monomers, or value-added chemicals, depending on catalyst selection and design. By circumventing multi-step processes and minimising energy waste, this method represents a more efficient alternative to conventional recycling strategies.

To probe MW-induced interfacial phenomena—including transient hotspots and non-thermal electronic effects that drive selective bond cleavage—we are developing advanced in-situ and ex-situ characterisation methodologies. Demonstrating the interdependent behaviour between MW and catalyst materials will enhance our ability to control the formation of highly reactive intermediates with precision. Ultimately, this will pave the way for more energy- and atom-efficient chemical transformations, such as establishing a robust framework for circular plastic economies, where waste polymers are systematically regenerated into high-purity feedstocks.

About the Speaker

Dr Michael Jie is a Senior Lecturer (Associate Professor) at the School of Physical and Chemical Sciences, Queen Mary University of London. Before joining QMUL, he held a Junior Research Fellowship at Merton College, Oxford, where he focused on developing microwave-initiated heterogeneous catalysis. Dr Jie completed his DPhil at the University of Oxford in 2019, with his early work contributing to low-carbon emission catalytic processes that have impacted the decarbonisation of fossil fuels. More recently, he has expanded his research to include waste resources upcycling using microwave catalysis. To date, he has published in international journals such as *Angewandte Chemie, Energy & Environmental Science*, and *Nature Catalysis*. His research efforts have also led to the global patenting of several innovative technologies through the PCT, gaining recognition from the wider chemical and scientific community, including *C&E News*, *Chemistry World*, and *The Times*. His work has also been acknowledged in prestigious forums such as the Royal Society of Chemistry's 10 Emerging Technologies of the Year for 2019 and 2021, and he received a Highly Commended distinction in the Vice-Chancellor's Innovation Award in 2020.

Currently, Jie's group focuses on designing microwave-active catalysts to enable a circular plastic economy through the one-step depolymerisation of waste plastics into monomers and value-added chemicals. His team also explores low-temperature CO_2 activation, sustainable aviation fuel (SAF) synthesis from biogas and biomass, and the production of functional materials from waste streams. Jie aims to bridge fundamental insights into microwave-material interactions with scalable solutions for decarbonisation and resource sustainability, demonstrating his commitment to advancing clean technologies for a zero-carbon future.



Registration https://forms.office.com/r/Pceay6fAZW

Host Prof. Shuntaro Tsubaki

Contact I²CNER・Q-PIT Office of Research Support Services, Research Support and Public Relations
TEL: +81 92 802-6935
Email: iq-kenkyu@jimu.kyushu-u.ac.jp