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ICB PhD public presentations

UNIFYING CONCEPTS IN THE DESIGN OF REDUCIBLE OXIDES FOR GREEN METHANOL SYNTHESIS

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ETH Hönggerberg, HCI D 2 and on Zoom
(https://ethz.zoom.us/j/4829046491)

Project Summary: Transitioning the production of methanol, a key platform chemical and versatile energy carrier, from fossil to sustainable routes is vital for the chemical industry to achieve climate targets. However, the development of catalytic technologies for green methanol synthesis via CO2 hydrogenation often relies on scattered catalyst design approaches, leaving gaps in fundamental understanding of the materials used and hindering benchmarking efforts as well as subsequent upscaling and application, an extremely relevant problem for the emerging reducible oxide catalyst families based on indium-zirconium (InZrOx) and zinc-zirconium (ZnZrOx) oxides. To address these challenges, this presentation focuses on the development and outcomes of methodologies aimed to unify understanding behind CO2 hydrogenation tomethanol over reducible oxide catalysts. Firstly, a rigorous framework to investigate InZrOx and ZnZrOx materials prepared by a standardized flame spray pyrolysis synthesis platform is showcased, facilitating quantitative comparison between the two catalyst families and unraveling key descriptors defining analogies and differences in their reactivity. The impact of metal speciation, CO2 uptake capacity, oxygen vacancy quantity and stability, and hydrogen addition ability is evaluated. This is followed by a critical discussion of the kinetics of CO2 hydrogenation over reducible oxide catalysts. Assisted by accurate catalyst evaluation, in-depth characterization and mechanistic studies, the development of kinetic models applicable generally to reducible oxides and even metal-promoted systems is outlined. Finally, the application of these insights in a case study of catalyst upscaling is briefly discussed. The findings presented offer fundamental and practical design guidelines in a unified manner for the development of efficient catalysts to produce green methanol.

CV: Tangsheng Zou received his BA and MEng in Chemical Engineering from the University of Cambridge in 2019. After being awarded a scholarship by A*STAR Singapore in 2020, he started his doctoral studies in the same year in the Advanced Catalysis Engineering group led by Prof. Javier Pérez-Ramírez.