I2CNER Seminar

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

Title

Tracking the structure of catalysts during birth, work and deactivation/reactivation: Snapshots synchrotron-based in-situ and operando spectroscopy

Speaker

Prof. Jan-Dierk Grunwaldt
Institute for Chemical Technology and Polymer Chemistry (ITCP),
Karlsruhe Institute of Technology (KIT), Germany

Time& Date

4:30 PM(JST), Wednesday, January 15th, 2025

Abstract

The toolbox for advanced and operando characterization of heterogeneous catalysts has rapidly increased in recent years. This is important because identifying the active site in heterogeneous catalysts and its structure is a demanding task. Catalysts are dynamic entities and depend on the embedding matrix, the surrounding fluid and last but not least the location in the catalytic reactor. Bridging the different time and length scales in heterogeneous catalysis is a challenge at the interface of spectroscopy, model system design, modelling and chemical engineering. This review aims to illustrate this approach with examples from emission reduction for clean air and sustainable production of CO_2-neutral fuels and chemicals.

For example, noble metal catalysts play a key role in the removal of pollutants such as CO, methane, VOCs or residual ammonia. Deactivation and reactivation processes are fundamental, and the dynamics of the noble metal structure can be exploited to increase efficiency and lifetime. However, not only the active site but also the porous network, the shaping and the concentration profiles in the reactor are crucial, making it an excellent showcase for bridging the different scales of complexity in catalysis. This is also part of the Collaborative Research Centre CRC1441 (TrackAct, www.trackact.kit.edu).

Another challenge comes with the development of Power-to-X processes: The simple CO_2-methanation as an exothermic reaction does not appear as simple as often described when looking in a spatially resolved manner. Additionally, Fe-Ni-catalysts are not only bimetallic but also bifunctional improving activity and selectivity as well as stability against H_2 dropouts. Both methanol and Fischer-Tropsch synthesis including the production of higher alcohols require high pressure studies, also when using *operando* spectroscopy. In addition, the use of model catalysts instead of industrial catalysts is needed to answer specific questions like promoter effects – a particular challenge tackled in the projects of the SPP2080 (www.spp2080.org). The examples will show that *operando* spectroscopy has become an indispensable tool in catalysis and that further challenges and exciting work lie ahead.

About the Speaker

Jan-Dierk Grunwaldt is a full professor and director at Karlsruhe Institute of Technology (KIT), Germany. He obtained his PhD at ETH Zürich in 1998 under the supervision of Prof. A. Baiker and worked as project manager at Topsoe (Lyngby, Denmark), a company that has pioneered in-situ and operando spectroscopy. Afterwards, he acted as a group leader and lecturer between 2001 and 2007 at the Institute of Chemical and Bioengineering at ETH Zürich. Since then he has strongly collaborated with various synchrotron facilities around the world. In 2008, he started as full professor at the Department of Chemical and Biochemical Engineering, DTU, Lyngby, Denmark. Since 2010, he has been a full professor in chemical technology and catalysis at KIT. He is also an adjunct professor at DTU and has recently been a guest professor at the University of Padua. He is leader of the collaboration research centre “TrackAct” (www.trackact.kit.edu), the DFG priority program SPP2080 (www.spp2080.org), steering borad member in CARE-O-SENE (www.care-o-sene.com), and task area in the data inititiative DAPHNE4NFDI (www.daphne4nfdi.de). He works in a number of committees both in catalysis (GeCatS, EFCATS, IACS) and synchrotron radiation and is editor/guest editor of several journals and chairman of various conferences.

Registration https://zoom.us/webinar/register/WN_wfLG6LlrQPyxRxZha2ROSg

Host Prof. Nobutaka Maeda

Contact
Research Support and Public Relations
TEL: +81 92 802-6935
Email: iq-kenkyu@jimu.kyushu-u.ac.jp