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Demand on Advanced Operando Characterization on Industrial Relevant Catalysts Using Combination of X-rays Based and Other Methods

Wednesday 28 August 2024 12:45 (15 minutes)

Advanced operando techniques like X-ray absorption spectroscopy (XAS) and X-ray diffraction (XRD) are powerful tools in field of catalysis to observe structural changes [1]. Certain limitations in catalyst mass, product formation and/or applicable pressure and temperature has to be considered. To extend the portfolio of reactions that can be investigated operando an infrastructure within CAT-ACT beamline at KIT Light Source [2] that allows using a high catalyst mass, high pressure and elevated temperatures is developed.

The key to achieve a substantial reduction of CO2 emissions is the use of renewable energy resources. One scenario is to produce sustainable energy carriers based on green H2 generated via water electrolysis and CO/CO2 provided via "carbon capture" processes or from local CO2-emission sources. One promising approach for renewable energy storage is "Power-to-Liquid"concept (www.spp2080.org). For instance, methanol is mostly produced from a fossil syngas as feedstock (CO, CO2 and H2), using a Cu/ZnO/Al2O3 catalysts (CZA). Switching to pure CO2 brings new challenges as CO2-hydrogenation is thermodynamically less favored compared to CO one, leads to higher water formation and deactivate the CZA catalyst. Using the approved high-pressure and high catalyst mass cell [3] the deactivation of the CZA catalysts were studied under industrial relevant conditions and the role of promoters [4] is uncovered. The hydrocarbons as a basic for the aviation fuel can be produced via Fischer-Tropsch synthesis (FTS) using suitable catalysts [5,6]. With adapted setup operando XAS and XRD studies during FTS were conducted. This studies served as a basis for the successful cooperation in frame of CARE-O-SENE consortium (https://care-o-sene.com/en) for the development of cobalt-based FT catalysts for production of sustainable aviation fuel (SAF). As a carbon-free energy carrier, H2 can be produced by reforming of methane [10]. The main drawbacks of common Ni based catalysts are coke deposition and sintering due to the high temperatures. The suitable continuous flow reactor was developed [13] and role of the Pt promoter was studied using the combination of XAS, XRD and Raman spectroscopic methods. This project has received funding from the EU Horizon 2020 Research and Innovation program (https://www.bike-msca.eu/).

The development of the specified catalytic setup suitable for the advanced operando methods is essential for systematic studies and together with dedicated synthesis could close the knowledge gap between the fundamental research and industrial application.

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I plan to submit also conference proceedings

No

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