

Preparation of model catalyst systems to optimize sustainable aviation fuel production via Fischer-Tropsch synthesis

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In the era of energy transition with the goal to lower greenhouse gas emissions and to overcome the impact on climate changes, the Power-to-Liquids (PtL) technology poses as a key potential solution, especially in the hard to abate aviation sector. Sustainable aviation fuel (SAF) may be produced through Fischer-Tropsch (FT) synthesis, the conversion of synthetic gas into long-chain hydrocarbons using iron or cobalt-based FT catalysts. The CARE-O-SENE consortium [1] that connects German and South African partners is driven to accelerate the development of cobalt-based FT catalysts for green and efficient production of SAF. The cobalt FT catalyst with oxidic supports have a nano-scale active phase with large mass specific surface area. However, nano-structuring and strong metal-support interaction would lead to deactivation with sintering and/or forming metal-support compounds (MSCs) [2-5]. Manganese promotion of cobalt was demonstrated to efficiently increase the production yield of SAF [6] and the presence of Mn^{2+} on the edge of manganese oxide structure has been hypothesized to interact with adsorbed carbon monoxide species [7]. Nevertheless, the role of Mn and the level of participation in the FT process is still under discussion.

The role of Mn promotion and support interaction in cobalt-based FT catalyst are the focus of this research. Model structures in the form of well-defined mixed oxide nanoparticles and reference materials have been prepared with various methods, here the surfactant-free benzyl alcohol synthesis route [8] is discussed. Subsequent deposition of these nanoparticles on various support materials yields model catalysts, which will be thoroughly studied using *ex-situ* and *in-situ* techniques. Amongst others, X-ray diffraction (XRD) [9], transmission electron microscopy (TEM), and X-ray absorption spectroscopy (XAS) at the CAT-ACT beamline of the KIT Light Source [10,11] were applied. XRD data confirmed the targeted spinel structures in the synthesized reference materials. The reduction behavior was traced on Co K and Mn K absorption edges under industrial relevant condition with XAS. The strength of Co-Mn interaction and the present of certain spinel structure could cause significantly different catalytic activity of model catalysts. The dedicated and controlled synthesis of reference materials, such as cobalt aluminates and manganese titanate and their characterization could close the knowledge gap between the fundamental research and industrial application. Furthermore, these insights can be transferred into deeper understanding with respect to Mn promotion, metal-support interaction, long-term stability and deactivation phenomena to improve the commercially relevant catalysts in the overall FT process to efficiently produce SAF.

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