Karlsruhe Institute of Technology

Institute for Chemical Technology
and Polymer Chemistry
Department Chemical Technology
Prof. Dr. Olaf Deutschmann

Bachelor- / Vertiefer- / Master Thesis in die field of Chemistry / Chemical engineering

Topic: Electrochemically enhanced low-temperature catalytic ammonia synthesis
Elektrochemisch unterstützte Niedertemperatur-Synthese von Ammoniak mittels Katalyse

Motivation

As an alternative to centralized Haber-Bosch synthesis, decentralized ammonia synthesis on a small scale is growing in interest. Avoiding high pressures lowers capital costs and electrochemical conversion allows NH_3 to be produced carbon-free. Research to date has been based on polarized proton-conducting ceramic electrochemical cells (PCCs) with steam electrolysis at the anode, an in-between proton-conducting ceramic membrane, and ammonia synthesis at the cathode. In practice, PCCs typically operate between 500°C and 700°C. Since the chemical equilibrium in ammonia synthesis decreases significantly with increasing temperature, low-temperature catalysis (400°C – 500°C) is required here. However, even with the best catalysts, synthesis is severely limited by kinetic limitations below 500°C. The electrochemical cells do produce ammonia, but only in small amounts ($\sim 10^{-9}$ molcm^{-2}s^{-1}).

Description of Work

Direct electrochemical activation of a novel catalyst support is expected to significantly increase the synthesis rate, which is kinetically limited by N_2 activation at low temperatures (400°C – 500°C). This project includes following tasks:

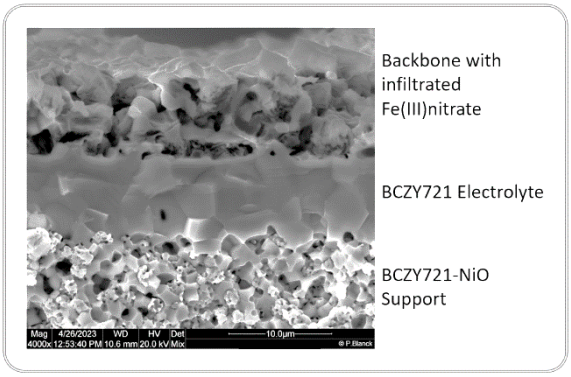

Figure 1: Morphological characterization of a PCC via SEM.

- the preparation of PCCs as a basis for the development of a catalytically active electrode based on BCZY with a suitable catalyst material.
- the electrochemical characterization of PCCs under suitable operating conditions via Electrochemical Impedance Spectroscopy (EIS) and the measurement of Current-Voltage-Power curves (IVW-curve).
- the morphological characterization via Scanning Electron Microscopy (SEM).
- the development and optimization of NH3 measurement downstream via Mass Spectrometry (MS) and an Ion Selective Electrode (ISE).
- the further development and optimization of the test rig.

The topic for the respective work is developed in a joint discussion and will be adapted individually!

Contact & Supervision

If interested, for scheduling and task creation feel free to contact:

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