Karlsruhe Institute of Technology

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Master's Thesis

Impact of Coating Morphology on Activity, Selectivity, and Stability of NH_3-SCO Catalysts

Background & Motivation

The transition toward low-carbon energy systems increases the relevance of carbon-free energy carriers, with ammonia emerging as a promising option due to its established production technologies and global infrastructure. In energy applications such as combustion, cracking, or fuel cells, unconverted ammonia must be minimized to avoid environmental and safety risks. Selective catalytic oxidation (NH_3-SCO) offers an effective route for converting excess ammonia into nitrogen and water.

NH_3-SCO catalysts typically use platinum-group or transition metals to achieve high activity while limiting byproducts such as nitrous oxide (N_2O). Beyond catalyst formulation, the morphology and uniformity of the catalytic coating strongly influence mass transport, surface accessibility, and reaction pathways. These effects are particularly pronounced in double-layer systems, where interactions between layers can significantly affect activity and selectivity. Understanding how coating methods govern catalyst structure and performance is therefore essential for developing efficient aftertreatment solutions for future ammonia-based energy applications.

Problem Statement

This thesis investigates how different coating processes influence the activity, selectivity, and stability of NH_3-SCO catalysts applied to planar support structures. The work focuses on developing, comparing, and optimizing coating strategies for single- and double-layer catalyst systems to achieve homogeneous, adherent, and porous catalytic films. Particular attention is given to understanding how coating morphology affects mass transfer, reactant-surface interactions, and overall catalytic efficiency.

For this purpose, the catalysts are first synthesized as powders and subsequently applied to planar supports using selected coating methods. The resulting layers are characterized by light and electron microscopy and evaluated under relevant reaction conditions. Catalytic tests are performed in a channel reactor, and the gaseous products are analyzed via Fourier-transform infrared (FTIR) spectroscopy. The goal is to identify correlations between coating quality, surface morphology, and catalytic performance, and to derive suitable optimization strategies for NH_3 exhaust-gas aftertreatment. The work integrates aspects of catalysis, materials science, reaction engineering, and analytical methods in an application-oriented research environment focused on sustainable technologies.

Contact & Supervision

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