Karlsruher Institut für Technologie

Institut of Catalysis Research and Technology (IKFT)

Bachelor Thesis

Your contribution to stable Catalyst Systems for usage of CO_2 and renewable H_2!

Research field

- ☒ Catalyst Development
- ☐ Process Engineering
- ☐ Catalyst Deactivation

Ausrichtung

- ☒ Experimental
- ☐ Modeling/Simulation
- ☒ Literatur
- ☒ Lab Synthesis
- ☐ Plant Operation
- ☒ Material Characterization
- ☐ Development of Measurement Techniques

Studies

- ☒ Chemical Engineering
- ☒ Chemistry
- ☒ Material Science
- ☒ Physics
- ☐ Economical Engineering

Start

13.01.2025

Contact

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Motivation

The deactivation of copper/zinc-based catalyst materials in methanol synthesis is a challenge, especially with regard to future use with CO_2 and renewably generated H_2.[1–3] When investigating such deactivation phenomena, handling the systems under protective gas is essential in order to be able to separate measurement artifacts from processes that actually occur. In order to be able to prove this quantitatively, measurements of the oxidation state on the surface using XPS and other methods are necessary.

This is better than *Quanti*[4]: After training, your task will be to produce and independently measure Cu/Zn-based materials. In this way, you will contribute to improving the catalyst systems. In addition to scientific work, you can acquire a lot of knowledge with this work in our group.

- You learn how to handle materials under protective atmosphere
- You learn how to produce compounds under protective atmosphere
- You learn how to ensure quantitatively high-quality measurements
- You learn how to work in an interdisciplinary manner (chemists learn process engineering, CIW students learn laboratory synthesis)

[4] *Inorganic chemistry practical course on quantitative analysis at KIT*

References

(1) Warmuth, L.; Steurer, M.; Schild, D.; Zimina, A.; Grunwaldt, J.-D.; Pitter, S. Reversible and irreversible structural changes in Cu/ZnO/ZrO_2 catalysts during methanol synthesis. *ACS Appl. Mater. Interfaces* **2024**.

(2) Fichtl, M. B.; Schlereth, D.; Jacobsen, N.; Kasatkin, I.; Schumann, J.; Behrens, M.; Schlögl, R.; Hinrichsen, O. Kinetics of Deactivation on Cu/ZnO/Al_2O_3 Methanol Synthesis Catalysts. *Appl. Catal. A-Gen.* **2015**, *502*, 262–270. DOI: 10.1016/j.apcata.2015.06.014.

(3) Kung, H. H. Deactivation of methanol synthesis catalysts - a review. *Catal. Today* **1992**, *11* (4), 443–453. DOI: 10.1016/0920-5861(92)80037-N.

The work is divided into the following steps:

- Familiarization with the literature on detection limits in XPS and other methods
- Laboratory syntheses on a 100 mg scale under protective atmosphere
- Characterization of the materials obtained using XPS and other methods
- Determination of detection limits for our Cu-based catalyst systems

Notes

We offer excellent support and the opportunity to work in an interdisciplinary team on a future-oriented subject area. Independent work and the motivation to familiarize yourself with new subject areas are required. You can get more information from Lucas Warmuth at any time.

Prof. Dr.-Ing. Jörg Sauer