## Bachelor Thesis:

**Performance of Au/ZnO Catalysts During Green Synthesis of Methanol from CO\textsubscript{2}/H\textsubscript{2} at High Conversion**

### Project Description:

Methanol synthesis from CO\textsubscript{2} and H\textsubscript{2} generated from renewable energies (CO\textsubscript{2} + 3 H\textsubscript{2} → CH\textsubscript{3}OH + H\textsubscript{2}O) is an efficient approach for storing excess electric power (e.g., from wind and photovoltaics) and at the same time reduce CO\textsubscript{2} emissions.

We recently found out that Au/ZnO catalysts are at least comparably active as the commercial benchmark Cu/ZnO catalyst; in addition they show a lower tendency for the undesired formation of CO via the reverse water gas shift reaction (CO\textsubscript{2} + H\textsubscript{2} → CO + H\textsubscript{2}O). Furthermore, these catalysts are more stable than the Cu/ZnO catalyst, at least at low reactant conversion (CO\textsubscript{2} conversion < 3 %). This makes these catalyst highly attractive for small scale applications.

To learn more about performance of these catalysts under realistic conditions, we plan to systematically examine changes in activity (initial activation phase and possible deactivation) and selectivity (\(\Delta\text{MeOH}/\Delta\text{CO}_2\)) for methanol synthesis from CO\textsubscript{2}/H\textsubscript{2} (1:3) at different conversions increasing from 5% up to close to equilibrium conditions. This will be achieved by controlled variation in the space velocity (gas volume flow rate : catalyst volume) during reaction at 220 - 240\textdegree C and pressures between 5 and 50 bar. For benchmarking, the standard Cu/ZnO will be examined under identical conditions. Possible accumulation of carbon containing deposits during reaction on both catalysts, which may affect their stability, shall be examined by a combination of temperature programmed desorption and oxidation (TPD and TPO) analysis.

Variations in the adlayer composition during reaction shall be followed using diffuse reflectance FTIR combined with time on-stream mass-spectrometry under up to similar reaction conditions to those used in kinetic micro-reactor. This way we also learn about adsorption characteristics of CO and other surface intermediates.

In addition to the planned research project, the student will become familiar in modern catalysis research and experimental methods in the area of gas phase Heterogeneous Catalysis.

### Target Group:

Students of Chemistry, Chemistry & Management or CiW

### Contact:

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