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Coach	**Supervisor(s)**	**Funding**
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Selective conversion of CO_2 into light olefins via tandem catalysis

Aim

Design of a highly selective catalyst for CO_2 hydrogenation to methanol to develop a tandem process with SAPO-34 to produce light olefins with minimal CO and alkane selectivity.

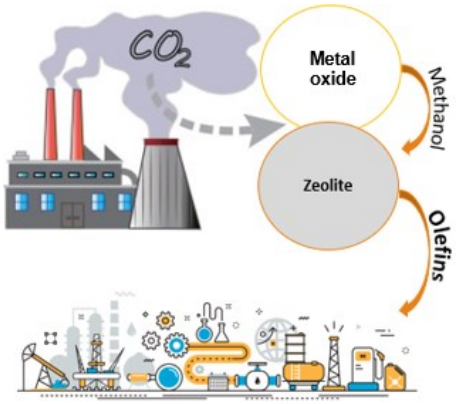
Justification

Carbon dioxide hydrogenation to light olefins via a methanol intermediate (C^2O) is a tandem process on well-designed multifunctional catalysts consisting of metal oxides and zeolites. This tandem process is a sustainable alternative to overcome the thermodynamic limitations of methanol synthesis and replace the energy-intensive steam-cracking units.

In the tandem process, methanol is considered a reactive intermediate that migrates to the zeolite pores where MTO takes place. So, the methanol synthesis thermodynamic equilibrium will be shifted to higher CO_2 conversion. The key challenge is the very different temperature requirement of the catalysts for CTM (200-250 ºC) and MTO (350-400 ºC) reactions. In methanol synthesis, high temperatures favor the undesirable RWGS reaction.

Optimized metal oxide catalysts such as $ZnZrO_x$ and $GaZrO_x$ show promising methanol selectivity at high reaction temperatures (>300 ºC) while small-pore zeolites such as SAPO-34 (3–4 Å) can convert methanol to light olefins.

The objective of this master thesis is to design promoted Zn-based catalysts for the selective conversion of CO_2 to methanol at elevated temperatures, >350 ˚C, and using this optimized catalyst in a single high-pressure reactor in combination with a commercial zeolite, SAPO-34 for lower olefin formation. The crucial target is to tune the reaction conditions and catalyst's properties to minimize CO formation, increase lower olefins selectivity, and decrease paraffin production. Characterization of the synthesized catalysts will be done using a wide range of available techniques such as TPR, TPD, XRD, and SEM to uncover structure-activity relationships.



Program

1. Literature study: CO_2 hydrogenation to methanol and tandem CO_2 hydrogenation to light olefins.
2. Synthesis and characterization of promoted zinc-based catalysts.
3. Testing of the novel catalysts and developing a tandem process by varying the oxide to zeolite ratio to increase olefin selectivity and reduce CO formation.

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