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Coach	**Supervisor(s)**	**Funding**
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Targeted synthesis of advanced Ni-based catalysts for CO_2 methanation

Aim

The project aims to develop Ni-based catalysts with enhanced air- and sulfur-tolerance for CO_2 methanation.

Justification

The European Green Deal roadmap outlines steps to become the first continent to reach climate neutrality by 2050. In the wake of the climate crisis, we face a challenging transition to a sustainable, affordable, and secure energy system. Synthetic methane can play an important role in this future energy system due to the large existing natural gas infrastructure. Ni-based catalysts show high efficiency in CO_2 hydrogenation to synthetic methane. One of the main disadvantages of Ni-based catalysts is deactivation by contaminants present in the process gas streams (i.e., oxygen in the industrial waste gas, sulfur in biogas, etc.). Catalysts with enhanced tolerance to poisoning allow eliminating expensive pre-treatment steps and increase the industrial applicability of synthetic methane production.

Figure 1. Portable reactor for the catalytic tests.

During this thesis, several promotors will be tested to enhance the stability of Ni-based catalysts. The catalyst design will be supported by computational catalysis work in the Saeys group. Synthesized catalysts will be characterized via SEM-EDX, N_2-physisorption, XRD, TPR/TPD, and H_2 pulse chemisorption. The performance of the catalysts will be tested on a dedicated portable fixed-bed reactor which allows co-feeding of real-world impurities and even field testing of the catalysts with industrial CO_2-streams (Figure 1). The economic viability of the production of synthetic methane will be evaluated by our partners at EnergyVille, using the state-of-the-art TIMES model. Throughout the thesis, the student will learn the state-of-the-art literature, analyse experimental data, present their results, and discuss with colleagues in the field of catalysis.

Program

1) **Literature analysis:** air/sulfur-tolerant Ni-based catalysts: catalysts, synthesis procedures, process conditions
2) **Design of the preparation procedure:** catalyst composition (e.g., promotors), precursors, support materials, and synthesis conditions.
3) **Characterization of the freshly prepared catalysts** via SEM-EDX, N_2 physisorption, TPR/TPD, and H_2-pulse chemisorption.
4) **Catalytic tests:** performance testing of the catalysts for CO_2 methanation in the presence of sulfur and oxygen.
5) Close interaction with computational catalysis modeling and economic evaluation.

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