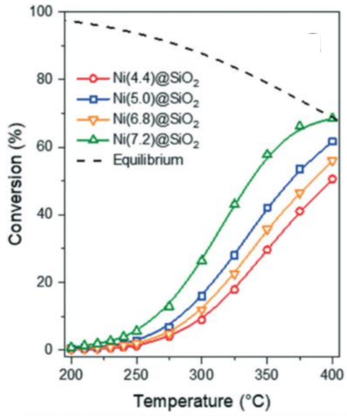
Inorganic Materials & Catalysis
Molecular Heterogeneous Catalysis
Research Project – Emiel Hensen/Jérôme Simons

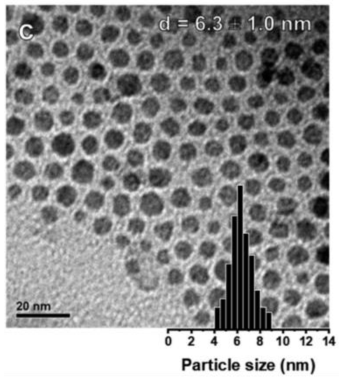
INORGANIC MATERIALS & CATALYSIS

Exploring the role of metal/reducible metal oxide surface combinations in catalysts for the Sabatier reaction

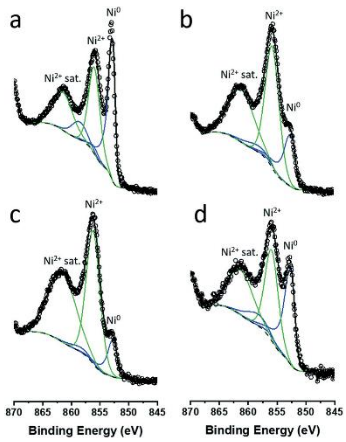
In order to store and transport intermittent and unpredictable renewable energy efficiently, the Power-to-Gas (PtG) concept has been targeted as a potential candidate for large-scale green energy storage. This concept includes the storage of energy in methane, obtained from the Sabatier reaction where CO_2 reacts with renewable H_2 (e.g. from water electrolysis). The produced methane can be injected directly into the existing natural gas infrastructure and therefore this reaction is targeted as a way to convert green electrical energy into high value chemical energy carriers. Current technology however does not offer sufficiently active and cheap (scalable) catalysts for promoting this reaction.



Recently, reducible oxide supports like ceria-zirconia oxides have received much attention due to their high oxygen storage capacity assisting CO_2 activation. The interplay between the Ni metal particles and ceria-zirconia support are essential for the production of methane and result in high CO_2 conversion and CH_4 selectivity [1]. As a next step, we wish to explore the wider utility of this concept by exploring alternative combinations of metal and reducible metal oxide supports. These catalysts will be extensively characterized for their performance in CO2 hydrogenation. A high-throughput setup will be available for rapid screening of the performance of catalysts. A high-pressure setup will be used to evaluate the performance of CO_2 hydrogenation at conditions deemed optimal for synthetic natural gas production. These catalysts will be characterized in more detail by XRD, XPS, Chemisorption, TPR, TEM and FTIR.



Within this project, you will be searching for an optimum catalyst for the conversion of CO_2 to methane by investigating the effect of metal/reducible metal oxide support interactions. Different catalyst preparation methods will be used, varying from simple impregnation to advanced colloidal techniques, to produce catalysts consisting of different active metals (Ni, Co), reducible metal oxides (e.g. In_2O_3, CeO_2) and supports (e.g. SiO_2, TiO_2, $Ce\text{-}ZrO_2$).



Learning goals:

- Become familiar with catalyst preparation and characterization methods that are highly relevant in both industry and academia.
- Construct relevant research questions and a working hypothesis.
- Build a research report based on the research topic and present the results in an oral contribution.

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[1] M.A.A. Aziz et al., *Green Chem.*, 2015, **17**, 2647

[2] W. Vrijburg et al., *Catal. Sci. Technol.*, 2019, **9**, 2578