Chemical Technology

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

NiSn as coking-resistant cathode catalyst for the high-temperature H_2O/CO_2 co-electrolysis

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Motivation & Challenges

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- By opting for the ambitious ''Energiewende" strategy, Germany´s government decided to substitute nuclear plants by renewable energy sources. However, these are subjected to unforeseeable seasonal and climatic fluctuations
- Innovative energy storage strategies are required for grid-balancing
- Electricity can be stored in gaseous form such as in H_2 or H_2+CO (syngas) via electrolysis (Power-to-Gas) and transformed e.g. into fuels (Power-to-Liquid)
- HT co-electrolysis of H_2O and CO_2 appears to be a promising technology
- Activity and stability of Ni-cermets should be improved. Ni percolation and carbon formation at high pressure can lead to catalyst degradation
- NiSn as alternative coking resistant cathode material; reversible phase formation in the presence of high water content is challenging

SOEC working principle & possible products

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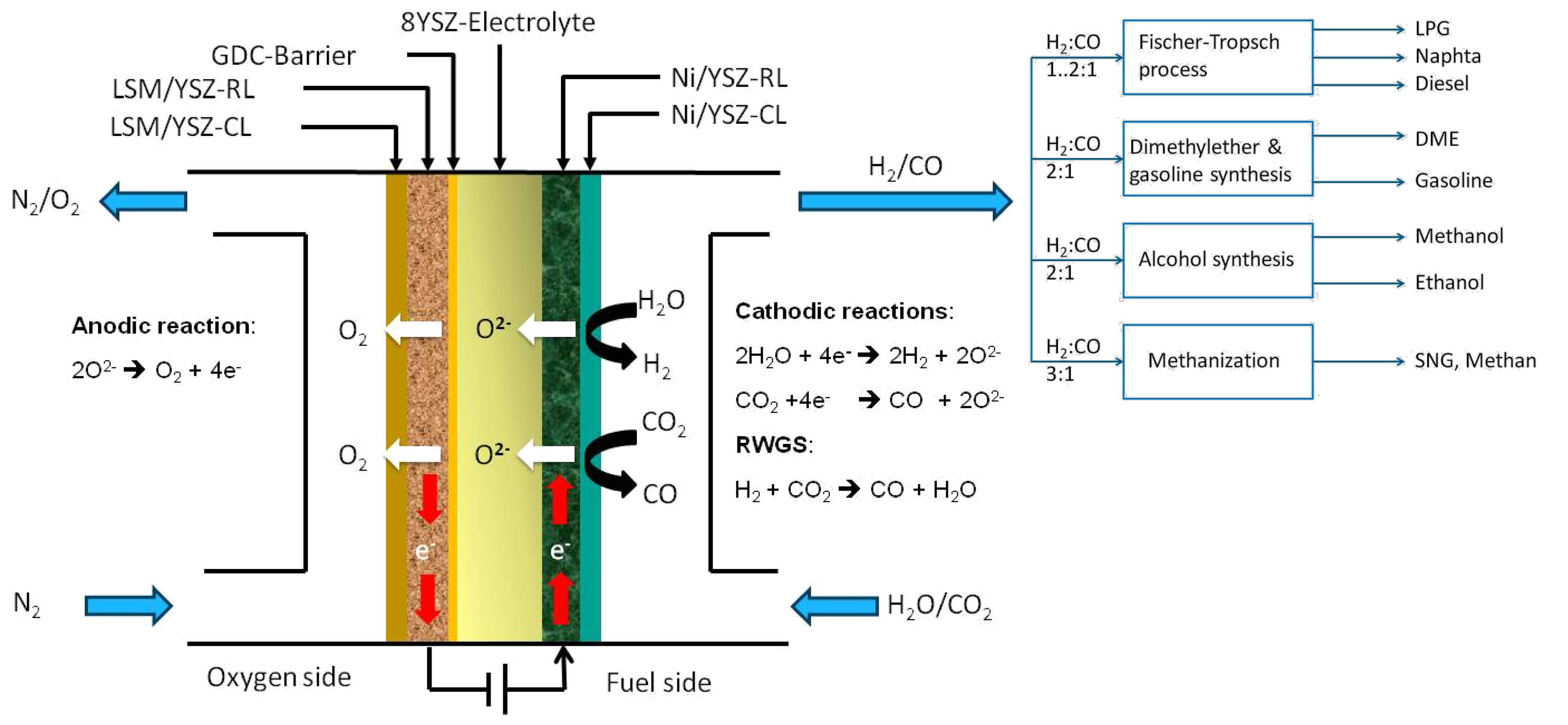

- CO can be produced either via reverse water-gas shift or electrochemically

Experimental

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NiSn catalyst preparation

- NiSn catalyst material was prepared by melting Tin and Nickel in a centrifugal casting oven under argon atmosphere
- The crushed ingot was ball-milled to powder

Reactor experiments

- 5g NiSn and Ni powder were tested regarding activity for reverse water-gas shift reaction (RWGS) in a quartz tube reactor at 750 and 850 °C under different H_2/CO_2 atmospheres

Analysis

- Outlet gas composition was analyzed by gas-chromatography and with humidity sensor
- Materials were characterized by XRD, SEM/EDX and Raman spectroscopy

Results

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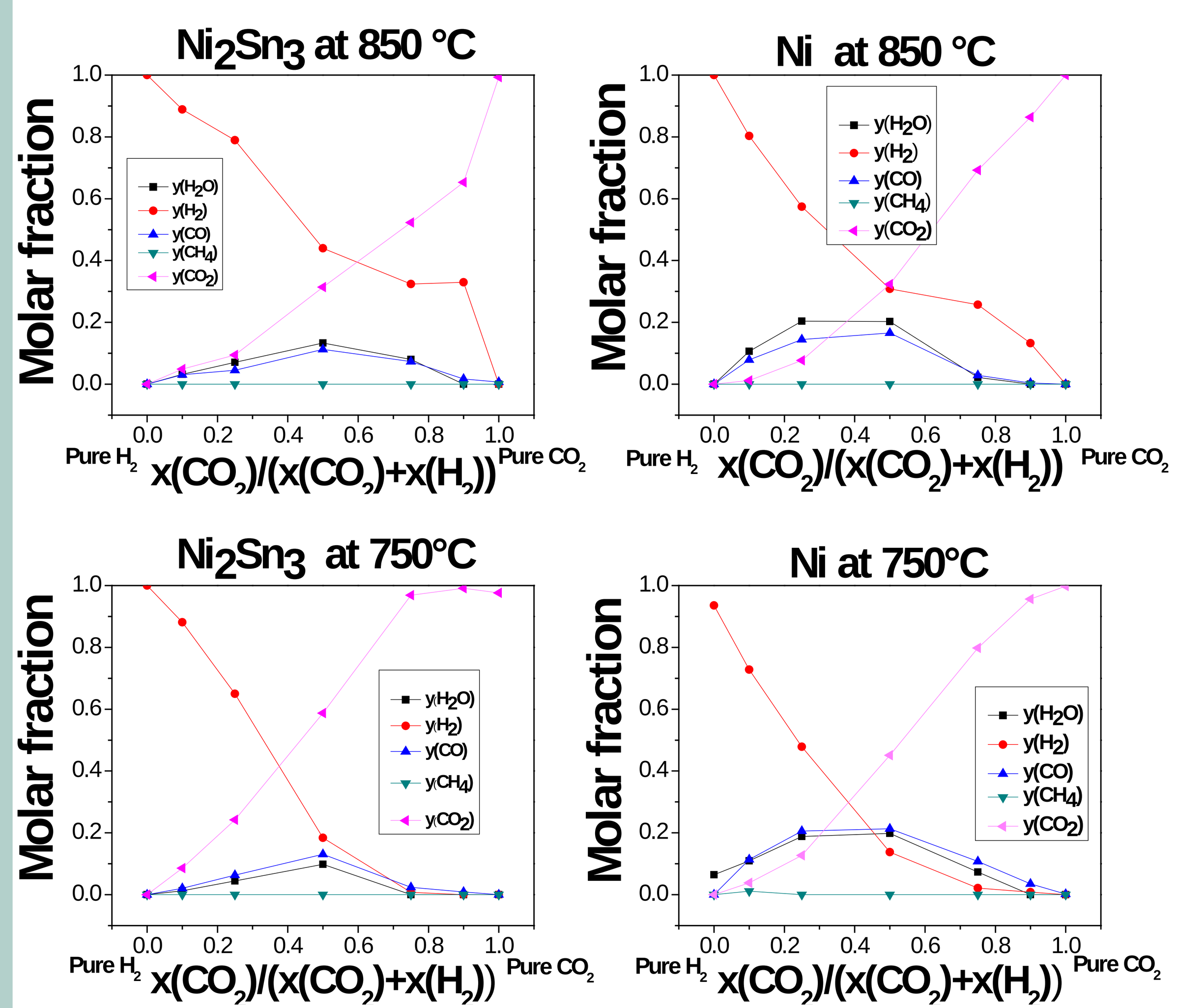
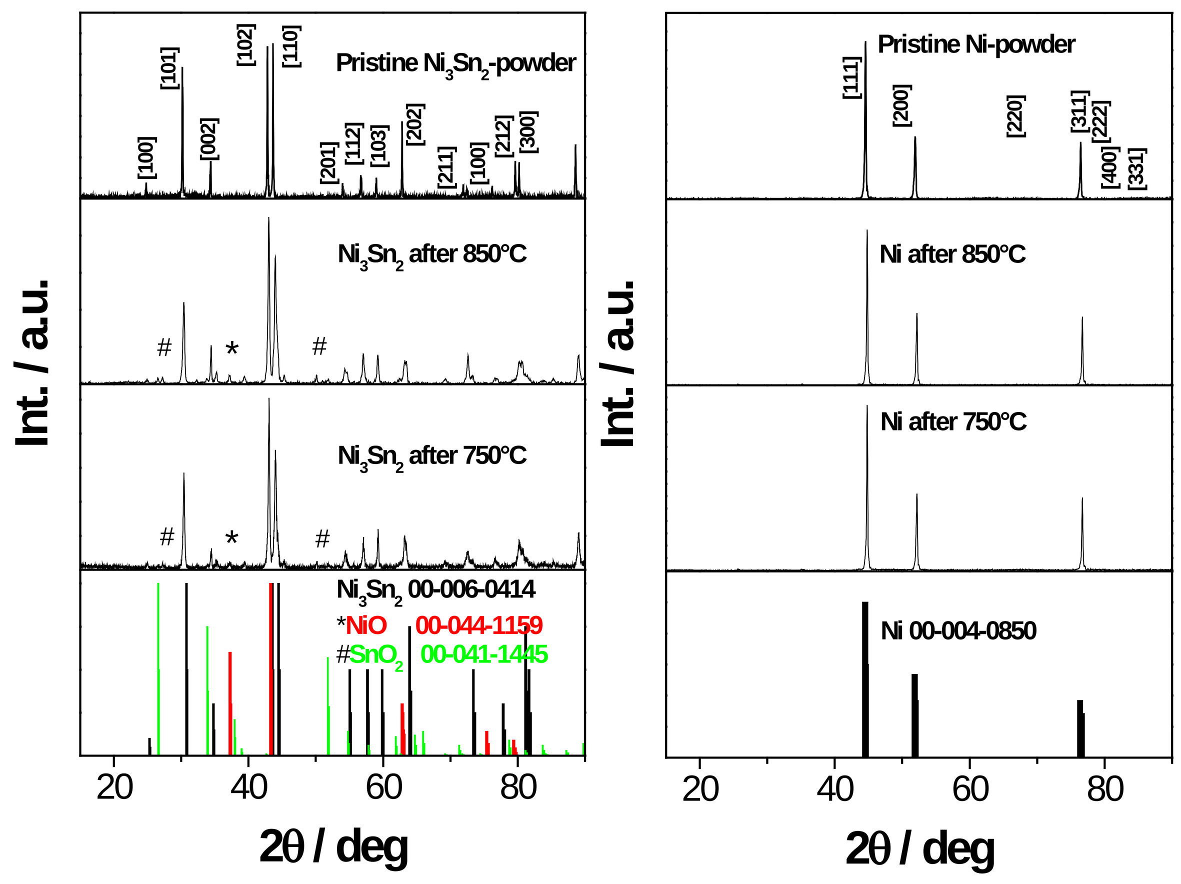
Reactor outlet gas composition



CO and water production by RWGS @ NiSn and Ni

- NiSn is active for reverse water-gas shift reaction
- Absolute activity of NiSn for CO production is lower than that of Ni, but Ni mass-normalized activities are similar
- Highest CO yield at H_2: CO_2 = 1: 1 (mol%)

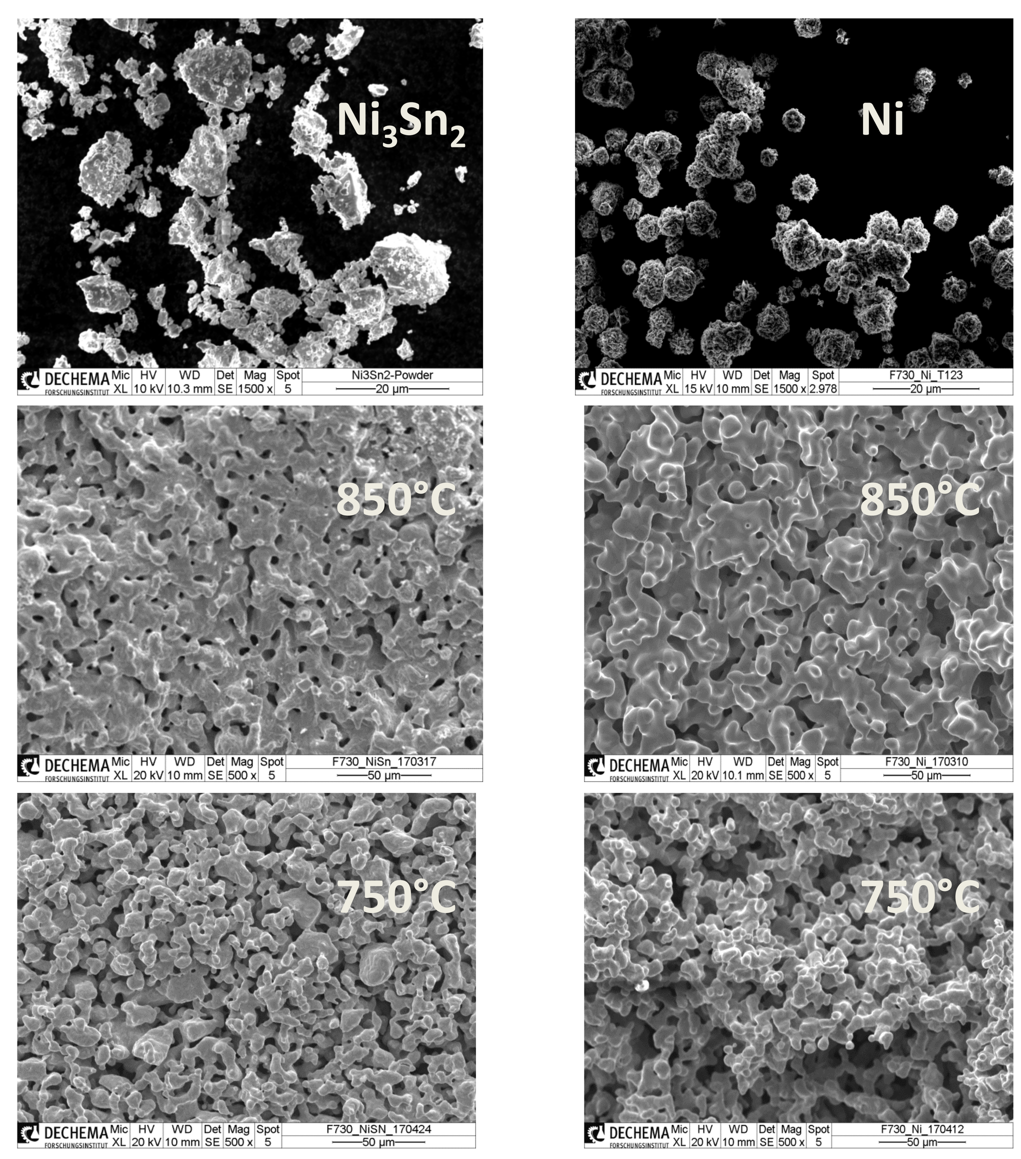
XRD and Raman analysis



XRD of NiSn and Ni before and after experiment

- Although samples had been cooled down under reducing atmosphere (10% H_2 in Ar), slight formation of SnO_2 and NiO phase in NiSn XRD
- In Raman spectra (not shown here), no peak related to amorphous or graphitic carbon was visible on Ni and NiSn after 100 h of testing

SEM analysis



SEM images of NiSn and Ni

- Particle sintering after one week of experiment
- Sinter activity increases with temperature

Conclusions & Outlook

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- NiSn is active for RWGS but prone to slight phase segregation into NiO and SnO_2
- No carbon formation observed at Ni and NiSn
- Further alternative materials e.g. perovskites will be investigated
- Tests at higher pressure and for longer exposure time are planed

Acknowledgements:

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The German Federal Ministry of Education and Research (BMBF) is gratefully acknowledged for financial support and project partners for fruitful cooperation.