Lehrstuhl für Energiesysteme
TUM School of Engineering and Design
Technische Universität München

ZAE BAYERN

Master's Thesis

(Theoretical)

Solid Oxide Cells for Hydrogen Energy Systems
Development of Reinforced Mechanical Support Components

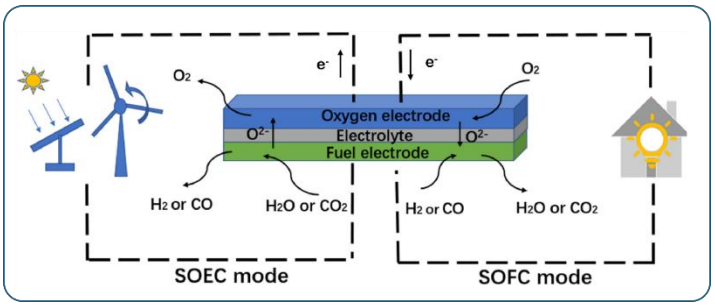
Description:

Solid Oxide Cell (SOC) technology is considered one of the most efficient energy conversion technologies in both fuel cell and electrolyzer modes. However, the mechanical instability of SOCs is standing as one of the major issues. For mechanical stability SOCs rely on their Hydrogen-Electrode (HE) support-layers, which are fabricated from NiO and YSZ powders, but NiO is later *in situ* reduced to Ni. Namely, HE support-layers are chemically not stable, and if they contact an oxidizing atmosphere due to, e.g., interruption of the hydrogen supply or poor gas tightness, etc. Ni within their microstructures can reform NiO. This consecutive change in the chemistry of a HE support-layer can occur multiple times, and hence it is called RedOx cycle. RedOx cycles cause consecutive contraction and expansion in the HE support-layer due to the volume difference of NiO and Ni, which trigger cracks in the HE support-layer as well as in the adjacent SOC components. In summary, SOCs relying on HE support-layers made of NiO-YSZ are mechanically not stable, and thus they demand reinforcement.

In this study, we aim to strengthen the HE support-layers via introducing mechanically robust reinforcement structures of chemically stable materials. The primary objective of the study is to develop reinforcement structures of potential designs and materials. Mechanical resistance of the reinforced HE support-layers will be assessed in terms of the Transverse Rupture Strength (TRS). For assessing the TRS of the HE support-layers, the Ball-on-Ring and Ring-on-Ring methods will be implemented numerically. For the TRS analysis of the HE support-layers, the FEM (Finite Element Method) modelling will be employed, for which COMSOL Multiphysics or ANSYS Fluent software will be used.

Work Packages:

- Developing robust reinforcement structures for the HE support-layers
- Assessing mechanical resistance of reinforced HE support-layers by numerical modeling
- Optimizing reinforcement structures in terms of mechanical resistance



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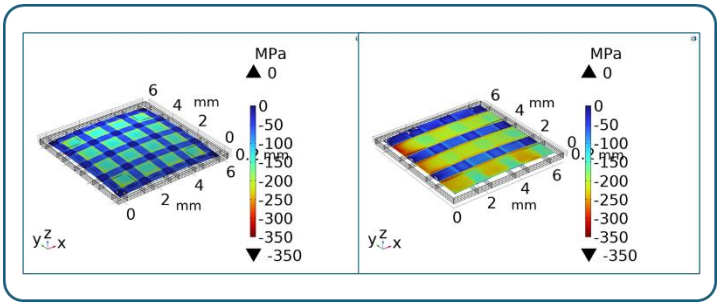

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