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Towards long-term stable solid state electrolyzers with infiltrated catalysts

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Renewable energy sources like wind and solar are widely considered as the key technologies to cover our growing demands. However, the fluctuating nature of these sources requires a flexible energy system and storage technologies to ensure that energy supply can be covered in a stable and affordable manner. One of the promising solutions is the production of synthetic fuel by solid oxide electrolyzers. Electricity can be converted to gas and further to liquid products during times of electricity production excess. In times of need, these fuels can be converted back to electricity by either conventional power plants or fuel cells.

Key challenges for a successful commercialization of solid oxide electrolyzers are up scale it, reduce cost and improve durability. Therefore, large efforts are allocated to improve cell performance. As a relatively novel method to introduce electro-catalysts into the porous structure of the electrodes, infiltration has shown very efficient. Solid oxide cells with infiltrated electrodes have been reported to show improved performance compared to conventional cells [1].

In this study, the development of infiltration procedures to improve the stability and catalytic performance of the fuel electrode of solid state electrolyzers (SOEC) will be presented. The infiltration process was optimized through choice of surfactants and concentrations of precursor solutions, to ensure easy penetration of the precursor solution into a Ni-YSZ (yttrium stabilized zirconia) composite backbone. The influence of surfactants on the coverage of specific grains with the infiltrated $\text{Ce}_{0.8}\text{Gd}_{0.2}\text{O}_{2-d}$ (CGO) nano-sized catalyst in the composite backbone was also studied. The optimized infiltration process was applied to 5 x 5 cm solid oxide cells.

The cells composed of a thin YSZ electrolyte, a Ni-YSZ fuel electrode and an LSCF-CGO oxygen electrode were tested in steam electrolysis operation under a current load of up to 1.25 A/cm². Under high steam content and high current density, a fast cell degradation (~700 mV/kh) was observed for un-infiltrated cells. The infiltration of a CGO nano-sized catalyst into the Ni-YSZ backbone was observed to reduce the degradation rate to around 117 mV/kh.

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Reference

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