Durable solid oxide electrolysis cells for hydrogen production - DTU Orbit (17/12/2018)

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Solid oxide cell (SOC) for electrolysis application has attracted great interest in recent years due to its high power-to-gas efficiency and capability of co-electrolysis of H2O and CO2 for syngas (H2 + CO) production. The demonstration of durable solid oxide electrolysis cell operation for fuel production is required for promoting commercialization of the SOEC technology. In this work, we report a recent 4400 hours test of a state-of-the-art Ni-YSZ electrode supported SOEC cell. The cell consists of a Ni-YSZ (YSZ: yttria stabilized zirconia) support and active fuel electrode, an YSZ electrolyte layer, a CGO (Gd doped ceria) inter-diffusion barrier layer and a LSCF-CGO (LSCF: lanthanum ferrite doped with strontium and cobalt) oxygen electrode layer. The electrolysis test was carried out at 800 °C under 1 A/cm2 with 90 % H2O + 10 % H2 supplied to Ni-YSZ electrode compartment. The results show that except for the first 250 hours fast initial degradation, for the rest of the testing period, the cell showed rather stable performance with a moderate degradation rate of around 25 mV/1000 h. The electrochemical impedance spectra show that both serial resistance and polarization resistance of the cell increased during the durability test. Further analyses of the cell impedance show that both the LSCFCGO electrode and Ni-YSZ electrode degraded and the degradation was dominated by that of the Ni-YSZ electrode. Post-mortem analysis on the Ni-YSZ electrode revealed loss of percolation between Ni-Ni grains and changing of porosity inside the active layer. The degree of these microstructural changes becomes less and less severe along the hydrogen-steam flow path. The present test results show that this type of cell can be used for early demonstration electrolysis at 1A/cm2. Future work should be focus on reducing the high initial degradation rate and improving the long term durability.

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