Degradation of solid oxide cells during co-electrolysis of steam and carbon dioxide at high current densities - DTU Orbit (21/12/2018)

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In this work, the durability of Ni–YSZ based solid oxide cells was investigated during co-electrolysis of steam and carbon dioxide (45% H₂O + 45% CO₂ + 10% H₂) at current density of −1.5 or −2.0 A cm⁻². The cell consists of ∼300 μm Ni–YSZ support, ∼10 μm Ni–YSZ electrode, ∼10 μm YSZ electrolyte and ∼15 μm LSM–YSZ oxygen electrode. The gas conversion was 45% at −1.5 A cm⁻² and 60% at −2.0 A cm⁻², and the operating durations were up to 700 h. The detailed electrochemical analysis revealed significant increase of the ohmic resistance, oxide ion transport resistance in the Ni–YSZ composite electrodes and the electrochemical reaction resistance at the Ni–YSZ triple-phase boundaries. The performance degradation is mainly ascribed to the microstructural change in the Ni–YSZ electrode close to the YSZ electrolyte, including the percolation loss of Ni, the contact loss between Ni and YSZ electrolyte and the decomposition of YSZ close to Ni–YSZ|YSZ interface. The electrochemical performance and the microstructure of the oxygen electrode were found to be relatively stable.

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