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Performance and durability of solid oxide electrolysis cells for syngas production

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Solid oxide electrolysis cells (SOECs) offer a promising technology for high efficiency energy conversion. With SOECs, electrical energy can be converted into and stored as chemical energy such as H₂ and/or CO (syngas) via electrolysis of H₂O and/or CO₂ [1-2]. From the energy conversion and storage point of view, co-electrolysis of H₂O + CO₂ is more attractive as compared to steam electrolysis, as the produced syngas can be further catalytically converted into various types of synthetic fuels such as ethanol, DME or synthetic diesel. These synthetic fuels possess higher volumetric energy density compared to hydrogen and can be directly transported or consumed based on the current infrastructure [3-6].

Performance and durability are two of the most important factors for commercialization of the SOEC technology. Moreover, it is also important to operate SOECs at high current density in order to make use of excess electricity produced from renewable energy such as wind or solar energy and have high syngas production rate. It has been reported that for an SOEC with Ni/YSZ as cathode, YSZ as electrolyte and LSM/YSZ as anode, almost no degradation has been observed when operated on cleaned inlet gas and at low electrolysis current density (<1 A/cm²) [7]. Up to now, only few studies have been reported on degradation of SOECs at high electrolysis current density [8].

In this work, durability of SOECs (Ni/YSZ-YSZ-LSM/YSZ) at high current density for co-electrolysis of H₂O and CO₂ was studied. The initial cell performance at 800 °C is shown in Fig. 1. The cell shows an ASR of 0.248 and 0.335 Ω·cm² for steam electrolysis and H₂O + CO₂ co-electrolysis respectively. The cell durability was examined under electrolysis current densities of 1A/cm² and 1.5 A/cm² at 800 °C and 850 °C. The degradation mechanism will be discussed based on in-situ electrochemical impedance characterizations and post-mortem studies.

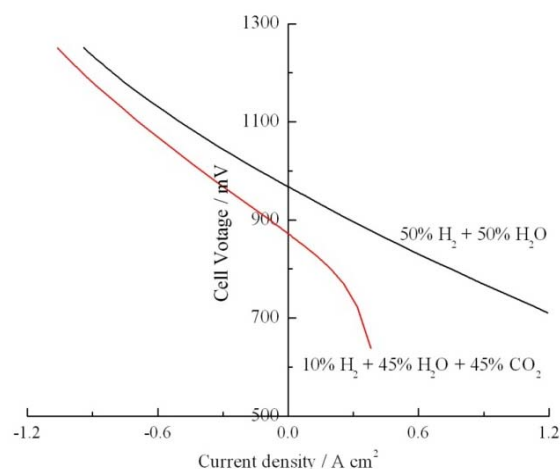


Fig. 1. Initial performance of solid oxide cell (Ni/YSZ-YSZ-LSM/YSZ) for steam electrolysis (50% H₂ + 50% H₂O) and H₂O + CO₂ co-electrolysis (10 % H₂ + 45% H₂O + 45% CO₂) at 800°C.

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