Introduction

Solid oxide cells (SOC) exhibit the unique feature to be able to run in reversible operation and the capability to run with hydrocarbons. Due to the high temperature of the process, solid oxide cells exhibit very high efficiency in steam electrolysis and co-electrolysis mode (H₂O+CO₂). This makes it very attractive for Power-to-X. At the German Aerospace Center, SOCs are investigated from cell to stack level in order to characterize and understand the degradation behaviour (Fig.1 and Fig.2), identify an appropriate operation strategy and propose alternative materials to mitigate degradation issues.

At the system level the coupling of the high temperature electrolysis process with heat from a concentrated solar power plant is investigated in order to achieve very high efficiency (Fig.3 and Fig.4). In the frame of the DLR project „Future Fuels“ the combination of a steam receiver powered by heat from a solar simulator with a solid oxide electrolyzer stack has been realized for the first time.

Within a recently started project with AUDI AG, Germany, DLR works on the investigation of SOC stacks under near-system operating conditions in Germany, DLR works on the investigation of SOC during long-term tests to be compared with identical electrolysis as well as reversible operating mode. The electrochemical performance will be monitored during long-term tests to be compared with identical stacks implemented in an industrial reversible SOC system. The concept of the power-to-gas plant with 300 kW power is presented (Fig.5 and Fig.6); experimental results will be published later.

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References


Solar heat integrated steam electrolysis

Fig. 3: Photograph of system with SOEC stack from SolidPower (left) and solar receiver (right)

Fig. 4: jV-curve of a 12-cell SOEC stack at 765 °C with steam generated by a high flux solar simulator