MODEL TYPE La$_{0.6}$Sr$_{0.4}$FeO$_{3.5}$ ELECTRODES FOR HIGH TEMPERATURE WATER ELECTROLYSIS

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Introduction

The utilization of renewable energy sources such as wind and solar power is inevitable for a sustainable energy supply. Hydrogen is considered to be a promising future energy carrier, since it can be produced from excess renewable energy via electrolysis of water and easily be retransformed into electricity by means of fuel cells.

Current research on solid oxide electrolysis cells (SOEC) is often done by simply operating solid oxide fuel cells (SOFC) in "reverse" mode. However, these cells do not necessarily perform as well as in the fuel cell mode. For example, the Ni/ytria stabilized zirconia (YSZ) cermet electrode was shown to have higher activity for hydrogen oxidation than for steam electrolysis and in electrolysis mode additional degradation phenomena can come into play [1]. Redox stable perovskite-type electrodes are discussed as promising alternatives for the classical Ni/YSZ cermet electrodes [2,3]. In the present study the mixed conductor La$_{0.6}$Sr$_{0.4}$FeO$_{3.5}$ (LSF64) was investigated as SOEC cathode material.

Experiments

Thin film electrodes of LSF64 were deposited onto YSZ electrolyte substrates by means of pulsed laser deposition (PLD). To compensate for the relatively low electronic conductivity of LSF64 under reducing conditions [4] an additional – photolithographically patterned – Pt thin film grid was sputter deposited on top of the LSF64 thin film. A porous paste counter electrode consisting of La$_{0.6}$Sr$_{0.4}$Co$_{0.2}$Fe$_{0.8}$O$_{3.5}$ (LSCF) was applied onto the bottom of the samples.

Electrochemical impedance measurements as well as water electrolysis experiments were performed in a "NorTEC Program" sample holder at a temperature of 650°C. The initial gas composition at the anode was 2.5% H$_2$O in Ar. The hydrogen produced during electrolysis (as well as background oxygen impurity) was measured by a mass spectrometer.

Results and Discussion

Since the polarization resistance of the porous paste counter electrode can almost be neglected, it is possible to relate the measured gas fluxes to the effective voltage at the model-type LSF64 electrode. Thus the experimental setup allows relating the amount of produced hydrogen directly to the electrochemical driving force. In Fig. 1a the volume fractions of H$_2$ and O$_2$ (from a minor leakage) are shown as a function of the potential at the LSF64 thin film electrode. In Fig. 1b the corresponding faradayic current is shown to correspond satisfactorily with the measured total dc current.

![Figure 1](image)

**Fig. 1.** (a) Volume fraction of H$_2$ and residual O$_2$ as a function of the potential at the LSF electrode ($E_{LSF}$). (b) Faradayic currents corresponding to gas fluxes as well as electrically measured dc current plotted vs. $E_{LSF}$.

Conclusions

By means of model type SOEC experiments it was possible to demonstrate the usability of LSF64 as an SOEC cathode material. Moreover, the amount of produced hydrogen could be related to the potential drop at the LSF64 thin film electrode.

References


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