☒ **Oral presentation** ☐ **Poster**

Electrochemical impedance spectroscopy for solid oxide fuel cell (SOFC) and electrolysis (SOEC) stacks

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Abstract

High temperature solid oxide fuel cells (SOFC) and solid oxide electrolysis cells (SOEC) have a high potential as future power generation systems with high efficiency, low noise and low emissions. This covers the wide field of, e.g. stationary SOFC µ-CHP (combined heat and power), mobile SOFC APU (auxiliary power unit), SOEC power-to-gas and combined SOFC/SOEC power-to-gas-to-power systems. However, the successful development of the solid oxide cell (SOC) stacks requires high quality reliable and reproducible test results, which enables the proper understanding of the corresponding electrochemical processes. Especially the different resistances, the overvoltages under electrical current and the degradation mechanisms in the stacks are not well understood. In this context, temperature and fuel gas composition gradients along the cell area and along the height of the stack play an important role under operation. Electrochemical impedance spectroscopy (EIS) is a very useful tool in order to close this knowledge gap [1, 2].

The presentation focuses on the improvement of the understanding and of the electrochemical behavior of SOC stack repeat units both in fuel cell (SOFC) and electrolysis (SOEC) mode. The stacks have been investigated in different projects by electrochemical impedance spectra, current voltage curves (jV-curves) and gas analysis. In the first part the quality of the results is presented in terms of reproducibility and repeatability among different testing partners and among different test methods. The corresponding results have been obtained within the European funded project “SOCTESQA” (Solid oxide cell and stack testing and quality assurance) [3]. Moreover, the most relevant parameters influencing the reliability of the EIS spectra and jV-curves are outlined.

In the next part the electrochemical results of the SOC stacks operated at different characteristic conditions are presented and discussed. This includes stacks operated at high current density and at high fuel utilization and stacks with high contact resistance [4]. In order to understand the electrochemical behavior of these three cases the different resistances of the repeat units have been determined with an equivalent circuit. Both experimental and modeling results are presented and discussed. The results were obtained in the German funded project “ZeuS 3”.

In the last part of the presentation degradation issues of the SOC stacks are addressed. Aspects for determining reliable and reproducible degradation rates are discussed. Moreover, results of stacks with and without Cr-evaporation protection layer from the German funded project “Smart” are presented. The stacks have been operated in SOFC mode galvanostatically at 300 mA/cm^2 for 10.000 h. The increases of the different resistances in the stack repeat units which have been determined by EIS spectra during operation are outlined. Additionally, the most relevant degradation mechanisms are discussed.

References

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