A1515

Electrochemical impedance spectroscopy of SOFC and SOEC stacks

Michael Lang (1), Corinna Bohn (1), Michelle Sophie Lemcke (1), Matthias Pysik (1), Qingxi Fu (2), Xiufu Sun (3)
(1) German Aerospace Center (DLR), Institute for Engineering Thermodynamics
Pfaffenwaldring 38-40, D-70569 Stuttgart / Germany
(2) European Institute for Energy Research (EIFER)
Emmy-Noether-Str. 11, D-76131 Karlsruhe / Germany
(3) Technical University of Denmark (DTU)
Frederiksborgvej 399, DK-4000 Roskilde / Denmark
Tel.: +49-711-6862-605
Fax: +49-711-6862-747
michael.lang@dlr.de

Abstract

The successful development of the solid oxide fuel/electrolysis cell (SOC) technology requires high quality, reliable and reproducible test results which enable 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. Therefore, the paper focuses on the improvement of the understanding of the electrochemical behavior of SOC stack repeat units with focus on electrochemical impedance spectroscopy. Both, the fuel cell (SOFC) and the electrolysis (SOEC) operation are addressed. The corresponding results have been obtained within the German funded project “Smart 2” and the European funded project “SOCTESQA” (Solid oxide cell and stack testing and quality assurance).

For measuring of high quality EIS spectra on SOFC/SOEC stacks aspects like different equipment, high frequency artefacts and voltage instabilities have to be taken into account. These issues have been addressed by the pre-normative test procedure “Test Module 04: EIS” of the SOCTESQA project. By the consequent application of this procedure reliable and reproducible spectra among different test laboratories can be measured. Moreover, the results of the EIS are consistent with the results of other techniques. The reproducibility of the low and high frequency impedances of the EIS with the ASR of the j-V curves and the HCI measurements has been proven. The EIS enables to determine the resistances and voltage losses in the SOFC/SOEC stacks, to investigate the influence of different operating conditions and to analyze degradation mechanisms. With EIS a significant progress in the understanding of the electrochemical stack behavior is achieved.