European Fuel Cell Car Workshop | March, 1st - 3rd 2017, Orléans, France

Distribution of Relaxation Times as a Diagnosis Tool for Polymer Electrolyte Fuel Cells

M. Heinzmann, A. Weber, E. Ivers-Tiffée
Institute for Applied Materials (IAM-WET), Karlsruhe Institute of Technology (KIT)
Adenauerring 20b, D-76131 Karlsruhe/Germany

marcel.heinzmann@kit.edu

Keywords: PEFC, EIS, impedance spectroscopy, DRT, electrochemical characterization, polarization processes, diagnosis

Electrochemical impedance spectroscopy (EIS) has proven its applicability for the characterization of electrochemical systems such as fuel cells. In general, physico-chemical processes with different time constants can be distinguished in the EIS spectra. However, the deconvolution of different processes overlapping in the frequency domain and the identification of the underlying physicochemical mechanisms remains challenging. Systematic and comprehensive parameter variations combined with high resolution deconvolution techniques are required to resolve the polarization processes and set up physicochemical meaningful models. The distribution of relaxation times (DRT) [1] has been established as a valuable diagnosis tool giving direct access to the quantities of interest in the measurement data by providing a higher resolution in the frequency domain. The benefits of this approach have been successfully demonstrated for high temperature fuel cells and lithium-ion batteries [2, 3].
For the first time, we will present this approach for PEFCs. Impedance measurements in a wide frequency range (10 mHz to 1 MHz) have been conducted on 1 cm² commercial MEAs (Greenerity H500EL2). The impedance data quality was ensured by an improved Kramers-Kronig validity test [4]. The combination of small active electrode areas (1 cm²) and high gas flow rates (250 ml/min) eliminates lateral gradients in temperature, gas composition and current density. Hence, we trigger a homogenous operational state over the entire cell area during one measurement, sharpening the peaks in the DRT and increasing the resolvability of individual processes in the impedance spectrum.

REFERENCES

1. H. Schichlein, A.C. Müller, M. Voigts, A. Krügel, E. Ivers-Tiffée, *Journal of Applied Electrochemistry* **32** (8), 875 (2002)
2. A. Leonide, V. Sonn, A. Weber, E. Ivers-Tiffée, *J. Electrochem. Soc.* **155** (1), B36-B41 (2008)
3. J. Illig, M. Ender, T. Chrobak, J.P. Schmidt, D. Klotz, E. Ivers-Tiffée, *J. Electrochem. Soc.* **159** (7), A952-A960 (2012)
4. M. Schönleber, D. Klotz, and E. Ivers-Tiffée, *Electrochim Acta* **131** (10), 20-27 (2014)