Abstract #2705, 224th ECS Meeting, © 2013 The Electrochemical Society

Investigation of oxygen reactions in a screen-printed Pt/YSZ-model electrode system

Y. Zheng[a,b], U. Sauter[b], L. Kunz[b], M. Streeb[b], G. Oehler[b], K. Sahner[b], R. Moos[a]

[a] *University of Bayreuth, Functional Materials, 95440 Bayreuth, Germany*
[b] *Robert Bosch GmbH, Applied Research 1, 70839 Gerlingen, Germany*

Oxygen reactions in platinum/yttria stabilized zirconia (Pt/YSZ) systems have been investigated for several decades because of various possible applications like solid oxide fuel cells (SOFC) [1] or oxygen sensors [2]. However, research up to now was mostly either done on sputtered thin film electrodes deposited on single crystal YSZ (e.g. in [3]), which may differ strongly from electrodes in real applications, or on screen-printed porous electrodes (e.g. in [4]), which are difficult to reproduce. Therefore, we have investigated the properties of screen-printed, but dense Pt electrodes (with some ceramics additives to balance mechanical stress) on poly-crystalline YSZ.

The microstructure of the electrodes is analyzed with Focused Ion Beam Scanning Electron Microscopy (FIB-SEM) and then reconstructed three-dimensionally. This method is for example described in [5]. For functional characterization of the electrodes, electrochemical impedance spectroscopy (EIS) is used. The impedance spectra are fitted with equivalent circuits for interpretation and for comparison with our physicochemical model. Other measurement techniques like cyclovoltammetry are used for the determination of the double layer capacitance.

Our physicochemical model is based on a model proposed by Mitterdorfer [6] and uses an impedance computation method by Bessler [7]. The model takes into account the following processes (see Fig. 1): adsorption/desorption, surface diffusion and charge transfer. A grain boundary diffusion path is also considered, as we have observed a dependence of the charge transfer resistance on the Pt/YSZ interface area size, although the electrodes are dense and have no continuous pores (see Fig. 2). Until now grain boundary diffusion in Pt has only been hypothesized for thin film Pt electrodes in literature [8-10]. In order to identify transport parameters though the dense electrode layer, we have conducted experiments with electrodes of different thicknesses and varying Pt grain sizes.

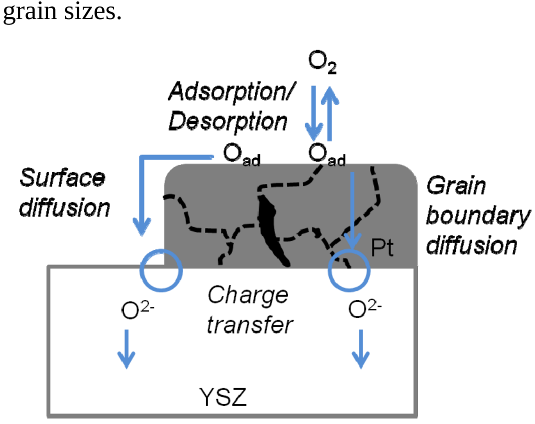

Fig. 1: Assumed Processes at Pt/YSZ-electrode system for electrode model.

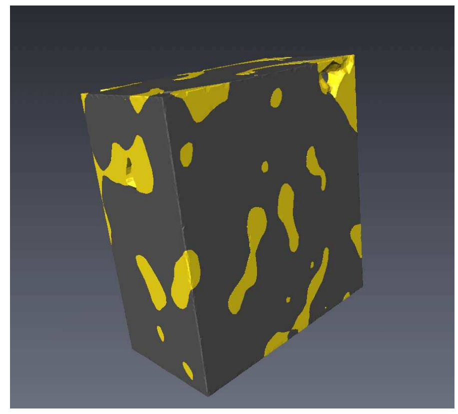

Fig. 2: Reconstructed structure from FIB-SEM of investigated electrode; grey – Pt, yellow – ceramics.

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