Study of SOFC Operational Behavior by in situ Laser Raman Spectroscopy

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The application of advanced diagnostic methods for monitoring cell characteristics of solid oxide fuel cells (SOFC) under real operating conditions can provide detailed information about the spatial distribution of cell properties in order to increase the fundamental understanding and to optimize the operational behavior. At high fuel utilization which is required for achieving high efficiency, strong concentration gradients of the fuel gas can occur which might detrimentally affect both performance and durability. To study inhomogeneous distributions of electrochemical and thermal cell properties during operation, DLR has developed spatially resolved diagnostic techniques such as segmented cell technology that allows for the determination of local current density and voltage, local impedance data, temperature distribution and local gas concentrations (1, 2). To complement the existing diagnostic techniques, gas-phase laser Raman spectroscopy has recently been adopted to determine the concentrations of relevant gaseous species within the anode flow channel with high spatial and temporal resolution during operation at technically relevant operating conditions. A test rig has been built up which gives an optical access to the flow field of a SOFC cell setup through transparent windows in the furnace (Fig. 1) and using a transparent anode flow field entirely consisting of quartz glass (Fig. 2). The Raman experiments were performed by means of a laser system using three double-pulse Nd:YAG lasers.

The paper describes the experimental setup of gas-phase Raman spectroscopy measurements with an operating electrolyte-supported SOFC cell of a size of 50x50 mm^2. At varying operating conditions with different fuel gas compositions, electrical loads and operating temperatures, Raman spectra were recorded and concentration profiles of gas species along the flow path in the anode were determined. The results obtained from Raman spectroscopy measurements are correlated with results from electrochemical characterization methods such as i-V characteristics and electrochemical impedance spectroscopy.

Figure 1: Experimental setup for in situ laser Raman spectroscopy with a SOFC cell

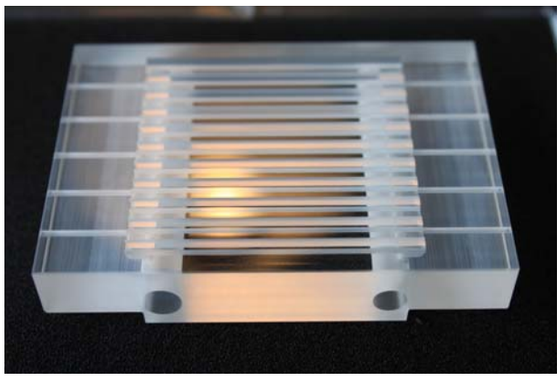

Figure 2: Transparent flow field consisting of quartz glass

References

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