Fabrication and performance of anode supported Solid Oxide Fuel Cells

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Solid Oxide Fuel Cells operating at elevated temperature of 800-1000°C are becoming more and more attractive because of their ability to utilize a wide range of readily available fuels such as methane, gasoline, and heating oil. Anode supported Solid Oxide Fuel Cells based on a metallic/ceramic composite made from Ni and the electrolyte yttria stabilized zirconia (Ni-YSZ cermet) have been attracted significant interest among SOFC developers world-wide.

In this work the development of alternative techniques for the fabrication of complete anode supported SOFC cells is addressed and involve cold die pressing of the anode substrate and spraying of thin film electrolyte layers. The subsequent steps in the cell fabrication are summarized in Figure 1. Polymer bounded NiO-YSZ granules with 50w% NiO and 50w% YSZ have been prepared with different grades of YSZ and NiO powders.

Two different cells have been prepared: cells consisting of an screen print YSZ electrolyte layer and an LSCF cathode for single cell tests and cells having an additional anode functional layer and CYO buffer layer for short stack tests as shown in Figure 2.

The single cells have been tested in a non sealed cell configuration at 750°C in hydrogen. The results of both current –voltage curves and impedance spectra at various hydrogen flow rates point to mass transport being a limiting factor for the cell performance at low hydrogen flow rates (e.g. high fuel utilization).

Stacks consisting of three cells as shown in Figure 2 have been assembled according to the Sulzer HEXIS stack design. Performance, durability and RedOx stability was tested at 800°C in steam reformed natural gas with a steam to carbon ratio of 2. An example of the stack and individual cell performance shows Figure 3. With reformed natural gas the cell performance reached 0.43 W/cm^2. Electrical efficiencies (>60%) at high fuel utilization (90%) have been achieved representing an excellent performance for the non sealed HEXIS stack design. Differences in the performance and the RedOx stability are attributed to residual differences in the microstructure of the anode support even for nominally identically prepared supports. Therefore, the need for further optimization of the anode substrate fabrication with respect to reproducibility and RedOx stability of the cells is clearly indicated. Further automation of the pressing procedure has promising perspectives with respect to reproducibility and low cost mass production of anode supported cells.

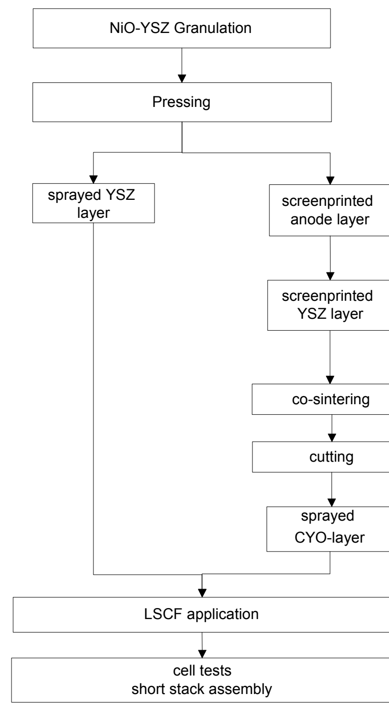

Figure 1 Flowsheet describing the individual steps in the fabrication of anode supported SOFC cells

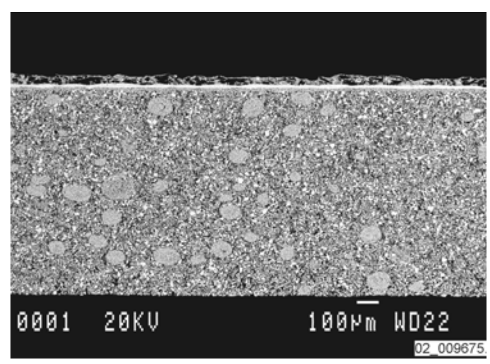

Figure 2 Crosssection image of an anode supported cell with screenprinted YSZ and sprayed CYO electrolyte layer.

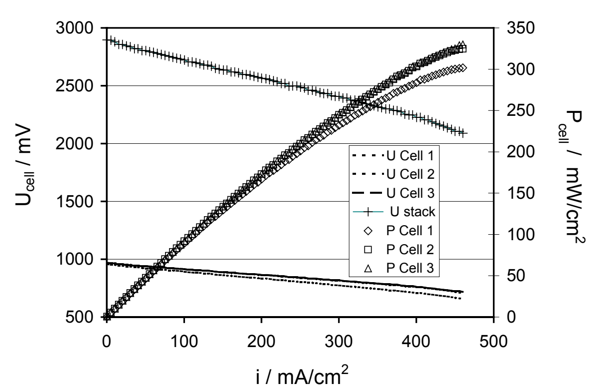

Figure 3 I/V-characteristics of the short stack in steam reformed natural gas at 800°C

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