Characterization of Anode/Electrolyte Interface For Advanced Anode Structures

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SOFC anodes have to combine various tasks. In anode supported single cells a thick anode substrate is used for current collecting and gas distribution whereas a thin functional layer adjacent to the electrolyte is the electrochemically active part of the anode. This functional anode layer is cofired together with the thin film electrolyte to obtain an enhanced interface with low polarisation losses and good mechanical adherence. This concept of a multilayer structure was transferred to an electrolyte supported single cell. The electrochemical active Ni/8YSZ anode layer was screen printed onto a 8YSZ electrolyte green tape and subsequently cofired at 1350 °. Mechanical stresses and bending during cofiring due to shrinkage mismatch of anode and electrolyte were avoided by changing the geometry of the anode layer from a continuous one to a large number of small sized individual areas. Simulations by finite element modelling (1) indicated that a hexagonal pattern similar to honey-combs is preferable (see fig.1). Thus mechanical stresses in the electrolyte were reduced by 68 % whereas the active anode area was decreased by only 29 %. Besides, mechanical stresses during thermal cycling due to TEC mismatch were also reduced by the use of this patterned anode. A single cell with a hexagonal patterned anode (10 cm^2) and an active area of 71 % is shown in fig.2.

The second layer which adjoins to the fuel gas channels and which is responsible for current collecting and gas distribution was screen printed after cofiring on top and sintered together with the cathode. In fig.3 a SEM image of the fracture surface of this type of anode is shown.

Single cells with this type of two-layer anode and different functional layers were electrochemically characterised by impedance spectroscopy and I/V characteristics under realistic operation conditions. The performance, reduction/oxidation stability and long term stability of this type of anode was investigated.

Although performance of this type of anode was not satisfactory, reduction/oxidation stability of this type of anode was slightly better than that of a single layer anode and long term stability was significantly better as shown in fig.4. It was found that the top anode layer primarily acted as current collector, but also protected the electrochemically active layer during redox cycling and long term operation. In comparison to single layer anodes only little Nickel agglomeration was observable in the electrochemically active layer, whereas significant agglomeration took part in the current collecting layer. However, this did not affect cell performance.

References

1. A.C. Müller, A. Krügel, E. Ivers-Tiffée, Materials and Science Technology, **33**, (2002)

Fig. 1: Honey-comb like pattern used for cofired anode.

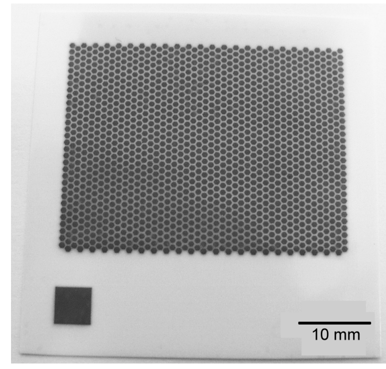

Fig. 2: $10\times10\,cm^2$ cofired single cell with a hexagonal anode pattern.

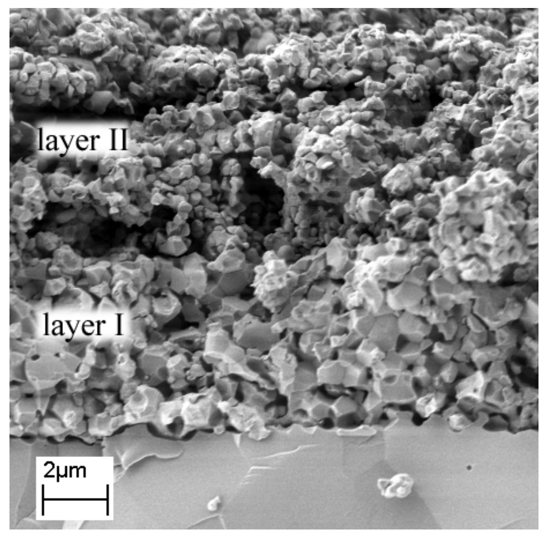

Fig. 3: *SEM image of a 2-layer anode with a patterned and cofired Ni/YSZ anode as layer I and a Ni/YSZ cermet on top.*

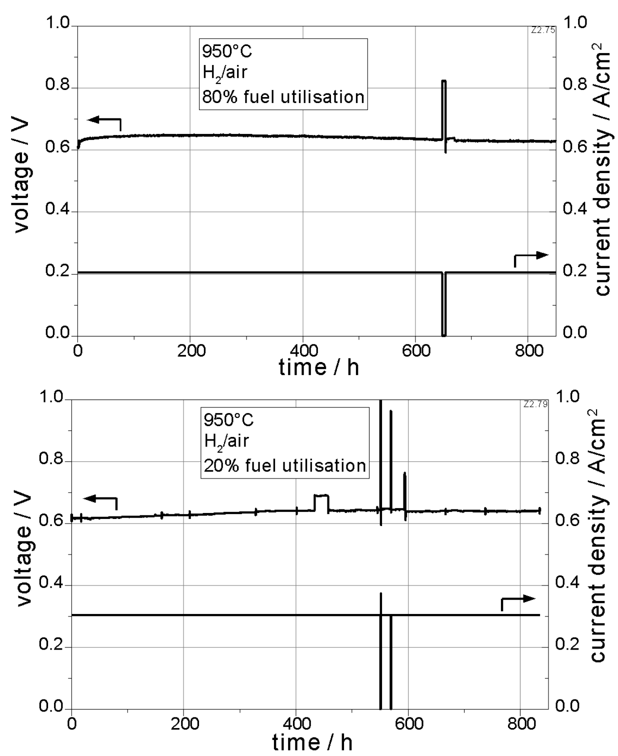

Fig. 4: *Long term behaviour of single cells with 2-layer anode. Stable operation was possible.*