Electrochemical Characterisation of Vacuum Plasma Sprayed SOFCs on Different Porous Metallic Substrates

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Metallic substrate supported thin-film SOFCs have been in development at DLR Stuttgart for nearly ten years. In the DLR SOFC concept, the entire cell is fabricated using an integrated multi-step vacuum plasma spray (VPS) process (1). The stacks are designed in the counter flow principle. The cells are fitted into a recess in the metallic bipolar plates made of ferritic steel (**Fig. 1**). Therefore the cells can be integrated and sealed easily in the metallic plates through brazing and welding processes.

The advantages of the metallic substrate supported cells are their high mechanical strength and the uniform fuel gas supply to the anode. This uniformity is due to the high porosity, approx. 80 Vol.% of the substrates. The low internal resistances of the thin film cells enable the reduction of the operating temperature to 700-800 °C, the increase of the long-term stability and thus the reduction of the material costs. The high material deposition rates of the plasma spray process promise inexpensive and fast cell production, especially in the case when large active cell areas are required.

The material and structure of the porous metallic substrate play an important role for the electrochemical performance of the sprayed cells. Therefore the paper concentrates on the investigation of the influence of the porous substrates on the electrochemical behavoiur of the cells.

The substrates used can be distinguished between felts, porous foams, woven wire structures and knitted wire structures (2). The porous substrates consist of Ni and ferritic steel which contain either Fe, Cr, Al, Y or Fe, Cr, Mn and La ("CroFer22APU"). The corresponding cells with a size of 10 cm x 10 cm were characterised electrochemically by current-voltage measurements (**Fig. 2**), impedance spectroscopy (**Fig. 3**) and by investigating their long term stability. The cells were operated between 800 and 900 °C with different process gases.

In order to analyse possible degradation mechanisms, e.g. diffusion processes, the cells were examined metallographically after operation. The different phases and elements were detected with the energy dispersive X-ray diffraction (EDX) at the scanning electron microscope. This leads to a further improvement of the porous metallic substrates for the SOFC.

References :

(1) M. Lang, R. Henne, S. Schaper, G. Schiller, Development and Characterisation of Vacuum Plasma Sprayed Thin Film SOFCs, J. of Thermal Spray Techn., Vol.10, No 4, Dez. 2001, ASM Thermal Spray Society, USA, C. C. Berndt (ed.), p. 618-625

(2) T. Franco, R. Henne, M. Lang, G. Schiller, P. Szabo, Novel Metallic Substrate Materials for Plasma Sprayed Thin-Film SOFCs, 5th European Solid Oxide Fuel Cell Forum 2002, Lucerne, European Fuel Cell Forum, p. 647-654, Offset- und Dissertationsdruck Jürgen Kinzel, Göttingen, 2002.

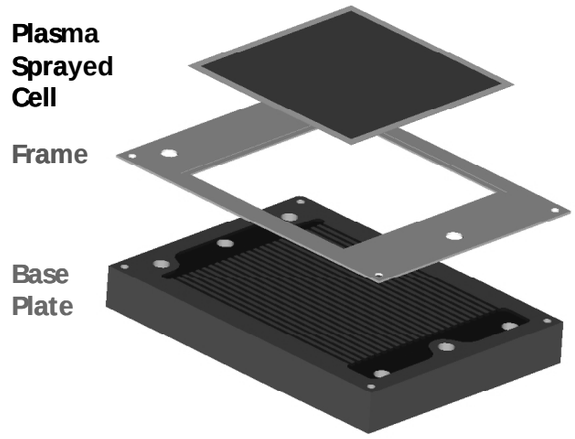

Fig. 1: Design of the DLR plasma spray SOFC concept

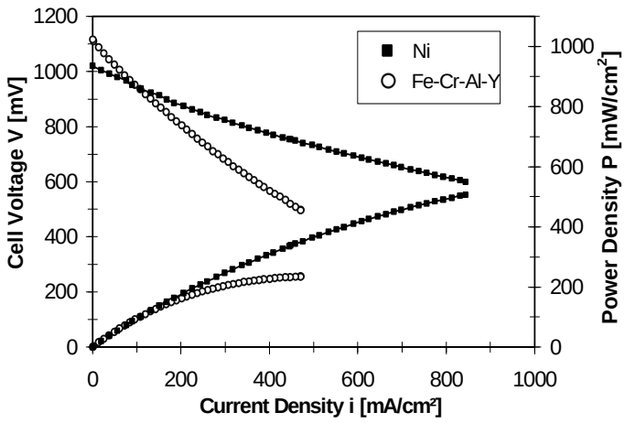

Fig. 2: I-V characteristics of two SOFC cells on different porous substrates (Ni felt, FeCrAlY foam) at 900°C with H_2 and air

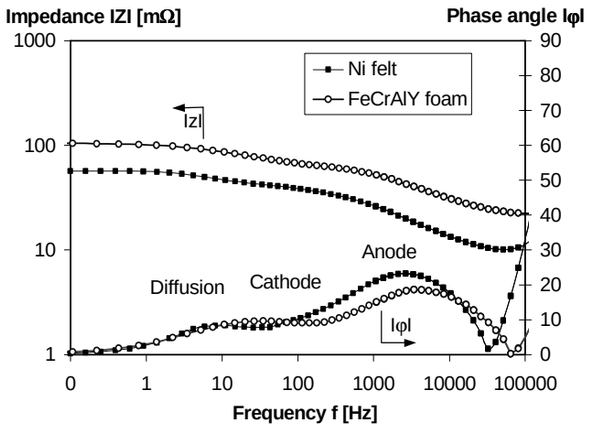

Fig. 3: Impedance spectra two plasma sprayed SOFCs (area 12 cm^2) on different porous metallic substrates (900 °C, H_2, air, OCV)