Fabrication of Anode Supported Ceria Electrolyte by the Colloidal Deposition Method for IT-SOFC

Abhishek Jaiswal and Eric D. Wachsman
Department of Materials Science and Engineering,
University of Florida,
Gainesville, FL32611, USA

Two approaches have been actively pursued to reduce the operating temperatures of SOFC's. The first approach involves finding better electrolyte materials, or a combination of known electrolyte materials such that the combination overcomes individual shortcomings. One such combination consists of a bilayer of doped Bismuth oxide and doped Ceria [1]. The second approach involves reducing the thickness of the electrolyte in cells with electrode supported electrolytes [2].

Investigation into the effect of relative thickness of the bilayers is further facilitated by electrode supported electrolytes, as fabrication of the bilayer requires some ingenuity due to the large difference in the sintering temperatures of Bismuth oxide and Ceria. As a first step, we report the fabrication and performance of Ni-Gadolinium doped Ceria (GDC) anode supported GDC thick film electrolyte, using a colloidal deposition method. Colloidal deposition has advantages over other techniques for thick film processing in its simplicity, cost-effectiveness, upscalibility and flexibility (thickness ranging from 10-100μm can be deposited)[3]. Further, under the reducing conditions at the anode doped Ceria is a mixed ionic electronic conductor and hence, the reaction zone will not be restricted to the interface of the anode and the electrolyte leading to enhanced performance of the anode.

NiO-GDC anodes were fabricated using the conventional solid-state route with Ni content of 50vol%. Reduction of NiO to Ni was accomplished in situ in the cell, which would generate ~26% porosity in the structure. The green bodies were pre-sintered at temperatures between 800°C to 1100°C, to coarsen the microstructure and to provide strength for further processing steps. Colloidal suspension of GDC powder was made in Iso-propanol. Anode substrates were dip coated in the suspension to form the electrolyte layer and then, finally sintered at temperatures of 1600°C and 1650°C.

The pre-sintering and final sintering temperatures were varied to find the optimum combination at which the densification rate of the GDC film matches with the shrinkage rate of the NiO-GDC anode substrate. Fig 1 shows the percentage porosity in the GDC film under different sintering profiles, measured by stereological counting methods using point probes. Pre-sintering at 850°C leads to a minima in the porosity. Hence, it was decided to work with samples pre-sintered at 850°C and finally sintered at 1600°C for further electrochemical measurements. Fig. 2 shows the cross-sectional SEM of the sample with the reduced porous anode and the dense Ceria layer, after being tested for over 200 hours. Electrochemical performance results of Ni-GDC supported GDC in a fuel cell configuration will be presented.

References
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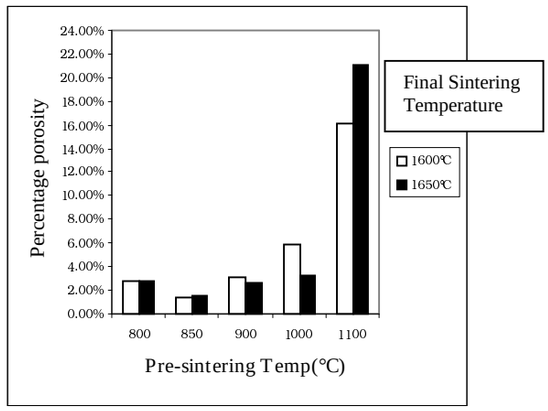

Fig. 1 Porosity in the Ceria film as a function of the pre-sintering and final sintering temperature of the anode.

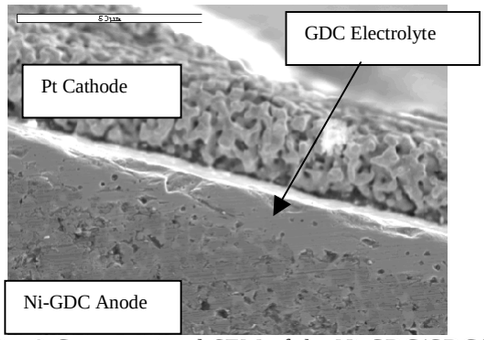

Fig. 2 Cross-sectional SEM of the Ni-GDC/GDC/Pt, pre-sintered at 850°C for 4 hours and finally sintered at 1600°C for 6 hours, after being tested for over 200 hours.