Systematic Studies of the Cathode-Electrolyte Interface in SOFC Cathodes Prepared by Infiltration

University of Pennsylvania
Philadelphia, Pennsylvania 19104, USA

Rainer Küngas, John M. Vohs, and Raymond J. Gorte

vohs@seas.upenn.edu, 215-898-6318

Abstract

In this study we systematically investigated how the structure, morphology, and ionic conductivity of the porous YSZ backbone affects the performance of infiltrated $La_{0.8}Sr_{0.2}FeO_3$ (LSF)-YSZ composite SOFC cathodes. The morphology and surface area of the YSZ backbone was varied using different pore formers and by treating with concentrated hydrofluoric acid (HF). This latter treatment caused dissolution and precipitation of the YSZ resulting in increased surface area and the formation of 100 nm wide sheets and pillars of YSZ (see Fig. 1). The performance of the electrodes was found to scale with the surface area of the YSZ backbone with the HF-treated electrodes exhibiting the lowest impedance, 0.07 Ω cm^2, at 973 K. The high-surface area HF-treated electrodes were also found to exhibit the highest thermal stability and exhibited much lower increases in impedance upon calcination at 1173 K compared to infiltrated LSF electrodes with conventional YSZ backbones.

The effect of the ionic conductivity of the zirconia backbone on the electrode performance was studied using cells constructed with scandia-stabilized zirconia (ScSZ), YSZ, and yttria-alumina co-stabilized zirconia (Y,Al)SZ scaffolds of identical microstructure. In agreement with the hypothesis that electrode resistances decrease with increasing ionic conductivity of the electrolyte in the composite, the polarization resistances increased in the order ScSZ < YSZ < (Y,Al)SZ for all temperatures studied (873 K – 1073 K). At 973 K, the polarization resistance values of 0.06, 0.33, and 1.16 Ω cm^2 were observed for fuel cells with LSF composite cathodes with ScSZ, YSZ, and (Y,Al)SZ,. A similar trend was observed for maximum power densities. An inverse square root dependence between polarization resistance and electrolyte ionic conductivity, proposed in prior theoretical studies was confirmed for cathodes calcined to 1373 K; however, a linear dependence on ionic conductivity was observed for cathodes calcined to only 1123 K.

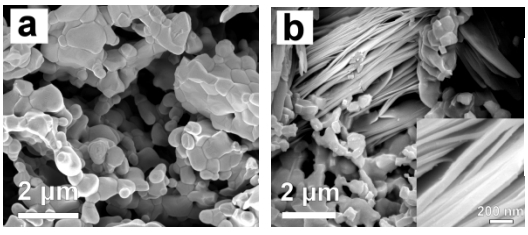

Fig. 1. SEM images of porous YSZ scaffolds: (a) initial porous YSZ, (b) porous YSZ after HF treatment.