DEVELOPMENT OF LOW-COST ALLOY SUPPORTED SOFCS

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INTRODUCTION

The current lack of commercial visibility of SOFC systems is almost entirely due to the high price of the technology at the current stage of development. Accordingly, many developers have focused on cost reduction as the key strategy for successful commercialization of SOFC technology. The U.S. Department of Energy has launched the Solid State Energy Conversion Alliance (managed by the National Energy Technology Laboratory) in order to deliver cost-competitive SOFC generators to the marketplace; the targeted system cost is $400/kW. The complete system consists of fuel cell stack, power electronics (DC-AC inverter), and balance-of-plant. Assuming that each of the sub-systems account for 1/3rd of the total cost, the stack cost should be about $130/kW. Since development of the stack represents the highest technical risk, it is also where costs often spiral out of control. Many developers have utilized high-cost materials and/or processes to solve the technical issues related to performance, seals, and stack longevity. The LBNL group has been developing ferretic steel supported solid oxide fuel cells. The use of ferretic steel as a support for electrode supported solid oxide fuel cells greatly reduces the raw materials cost and improves the strength of the thin-film cells. The basic design include the use of a high-strength FeCr support, a thin interlayer electrode (Ni-YSZ or other), and a thin electrolyte film. The entire structure is fabricated through co-firing of the three layers in a reducing environment.

EXPERIMENTAL

In the fabrication of NiO-YSZ supported thin-film cells, pore formers such as corn starch and graphite are commonly used to maintain porosity of the sintered NiO-YSZ/YSZ structures. During the initial reduction of the NiO-YSZ anode to form Ni-YSZ, additional porosity is introduced into the structure. This is not the case for NiO-YSZ sintered in a reducing environment since the NiO is rapidly converted to Ni during sintering. Also, burnout of binders during sintering in hydrogen is problematic since pyrolysis will lead to the formation of carbon. This is avoided by burnout of the organic binders in both the FeCr support and NiO-YSZ layer in air at a temperature of about 400 ^oC. Sintering profiles of green YSZ disks measured at LBNL in air and in 4% hydrogen showed no measurable effect of the pO_2 on the sintering rate of YSZ; consequently the densification of YSZ thin films is not affected by the conditions needed for co-firing metal supported structures.

RESULTS & DISCUSSION

Proof of principal has been demonstrated using commercial 446 alloys and a catalytic interlayer, typically composed of Ni-YSZ. Half-cell measurements have shown that the overpotential for Ni-YSZ electrodes is increased by exposure to FeCr during high temperature firing in hydrogen. In order to match the performance of Ni-YSZ supported cells, it is likely that a barrier layer to metal interdiffusion, or lower temperature processing will be necessary. Preliminary measurements have indicated the use of a $LaCrO_3$ barrier layer improves the performance of FeCr supported cells.

ACKNOWLEDGMENT

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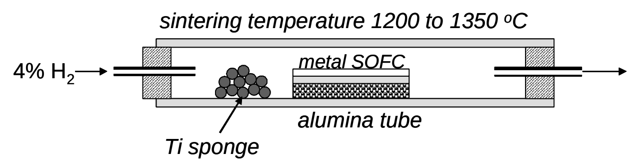

Figure 1. Sintering of metal supported FeCr/Ni-YSZ/YSZ fuel cells in reducing environment.

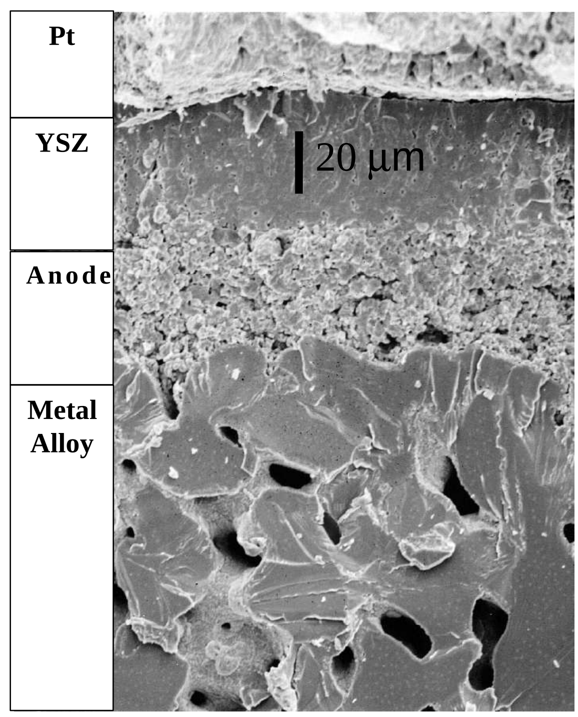

Figure 2. SEM of fracture-section of stainless steel supported SOFC

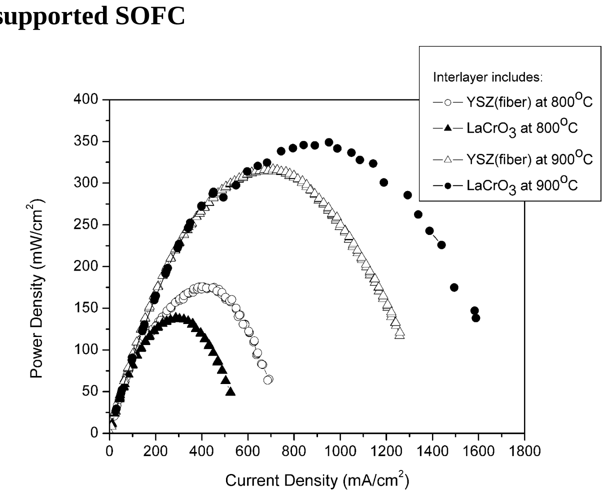

Figure 3. Performance of metal supported SOFCs in H_2-H_2O/air at 800 and 900 ^oC