New Routes to Fabricate Reduced-Temperature Solid Oxide Cells

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Abstract

Reduced-temperature Solid Oxide Cells are of interest for fuel production because methane production is promoted during CO_2-H_2O co-electrolysis; this reduces the thermoneutral voltage, useful both to increase efficiency and reduce anode degradation. This paper will describe anode-supported cells with 3-μm-thick Gd-doped Ceria (GDC) – 12-μm-thick Yttria-stabilized Zirconia (YSZ) bi-layer electrolytes prepared by reduced-temperature sintering. The effect of co-firing temperatures from 1250 ^oC - 1400 ^oC on the microstructure of Ni-YSZ / YSZ / GDC structures was studied. Firing at 1250 ^oC, ~ 150^oC lower than typical for anode-supported cells, yielded YSZ/GDC layers sufficiently dense to yield good open-circuit voltage via the use of 1 mol.% Fe_2O_3 sintering aid. After application of LSCF cathodes, the cells had an ASR of 0.2 Ωcm^2 with power density up to 1.5 W/cm^2 at 800 ^oC, and 0.74 W/cm^2 at 700 ^oC, in air and humidified hydrogen. The nearly-dense GDC layer mitigated zirconate formation. Electrolyte resistance was only slightly higher than expected given the YSZ and GDC thicknesses, indicating that the reduced firing temperature minimized the formation of the low-conductivity ceria-zirconia mixed phase by interdiffusion. Results on similar cells, utilizing electrolytes with thinner YSZ and thicker GDC in order to achieve low ohmic resistance at reduced temperature, will also be presented. The effect of Fe_2O_3 amount on the microstructure of YSZ/GDC interface and cell performance will be described.

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