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Thin films of $La_{0.7}Sr_{0.3}MnO_{3-\delta}$ dip-coated on Fe–Cr alloys for SOFC metallic interconnect

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ABSTRACT

$La_{0.7}Sr_{0.3}MnO_{3-\delta}$ (LSM) porous films were deposited on different ferritic stainless steels (SS) (430: Cr-16.0%; 439: Cr-16.6%; 444: Cr-17.4%) by sol–gel/dip-coating process. The structure, morphology and composition profiles of investigated assemblies were examined using X-ray diffraction, scanning electron microscopy and energy dispersive X-ray analysis. The area specific resistance (ASR) was measured during long term oxidation in air at 800 °C for 200 h by DC measurements. ASR values lower than 10 mΩ cm^2 were recorded after 200 h for LSM-coated SS439 and SS444. This is likely to be due to the high Cr content and to Nb, Ti and Mo elements used to stabilize the stainless steel against oxidation. This paper shows that LSM coatings provide an enhanced stability of the alloy at high temperature and the formation of an interfacial Cr–Mn spinel layer hinders the oxide scale growth.

1. Introduction

The reduction of the operating temperature of solid oxide fuel cells (SOFC) from 1000 °C to below 800 °C allows the use of metallic interconnects in planar-type SOFCs [1]. Metallic interconnects have many advantages over ceramic-based ones including higher thermal and electronic conductivities, good mechanical strength and lower cost [2–5]. Considering the material requirements for interconnect applications, the metallic materials of interest potentially include Ni, Fe, and Cr-based oxidation resistant alloys. Most attention has been given to the transition metal-based alloys which form a semiconductive chromia scale, including Cr-based alloys and ferritic stainless steels (FSSs) that have a body-centered cubic crystal structure [5]. In recent years, FSSs have become the most widely studied group of metallic alloys for interconnect applications because they not only demonstrate good oxidation resistance and the ability to match the thermal expansion coefficient of cell components, but also are among the most cost-effective alloys.

In chromium containing alloys, the preferential oxidation of Cr to Cr_2O_3 in air as well as in fuel atmospheres prevents the breakaway oxidation [6,7]. However, the scale-forming chromia presents high chromium volatility and its subsequent vaporization (into CrO_3 and $CrO_2(OH)_2$) degrades the cell performance [8–11]. Numerous studies have been dedicated to protection coatings and surface modifications of Fe–Cr alloys as interconnects for intermediate temperature SOFCs [12–14].

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