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$La_{0.7}Sr_{0.3}MnO_3$-coated SS444 alloy by dip-coating process for metallic interconnect supported Solid Oxide Fuel Cells

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HIGHLIGHTS

- Single and double LSM layers were deposited by dip-coating on SS444 substrates.
- Chemical reactivity was detected at the interface of the substrate and LSM film.
- The oxidation resistance of the alloy is enhanced by one single LSM layer.
- ASR values as low as 0.6 mΩ cm^2 were recorded after 200 h at 800 °C.

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ABSTRACT

Sol–gel and dip-coating technologies have been used to deposit $La_{0.7}Sr_{0.3}MnO_3$ (LSM) porous thin films on stainless steel SS444-Cr-17% interconnect plates. Single and double LSM layers were fired in air at 800 °C for 2 h to achieve a sufficient adhesion on the substrate. The microstructure and composition of oxide scales were investigated using X-ray diffraction, scanning electron microscopy and energy dispersive X-ray analysis. The area specific resistance (ASR) for coated and uncoated plates was evaluated during long term oxidation in air at 800 °C for 200 h, and between 600 and 900 °C, by DC two point measurements. The formation of an interfacial oxide scale based on $(Cr,Mn)_3O_4$ spinel and Cr_2O_3 has been evidenced for uncoated and LSM-coated SS444. The results indicate that the oxidation resistance of the alloy is enhanced by a protective coating consisting of one single LSM layer. ASR values as low as 0.6 mΩ cm^2 were recorded after 200 h at 800 °C. The effectiveness of the LSM layer as a protective coating depends on the stability of the film and its adherence on the alloy substrate.

1. Introduction

Solid Oxide Fuel Cells (SOFC) have attracted a great attention as a new electric power generation system because of high energy conversion efficiency and an excellent long term stability during operation [1]. Ceramic materials are the basic components in SOFC. The high operating temperature of SOFC increases the electrode reaction rates but also enhances degradation of components and thus decreases the cell durability. The performance can be improved by a better control of the morphology of the different components and the reduction of the working temperature from 1000 °C to below 800 °C is likely to preserve the stability besides allowing the use of metallic interconnects instead of ceramic-based ones.

Many alloys based on iron, chromium and nickel have been investigated as interconnects for SOFCs [2–5]. Among these alloys, ferritic stainless steels are the alloy of choice for metal-supported SOFCs because they are quite inexpensive, have similar thermal expansion coefficients with other cell components, produce a thin, continuous and conductive chromia scale, and can have very long lifetimes at the SOFC operating temperature [6,7]. One of the major degradation problems when using these alloys is cathode poisoning by chromium from vaporization of the metallic interconnect. Several degradation mechanisms have been proposed in the literature [8–12]. In most of the proposed models, the oxidation of chromium oxide in the interconnect releases volatile Cr^{6+} species, such as CrO_3 and $CrO_2(OH)_2$, which are reduced at the triple phase boundary in the cathode leading to a rapid deterioration of the cell performance.

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