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Ferritic Stainless Steels Coated a Dense $La_{0.7}Sr_{0.3}CrO_3$ Layer as Interconnects for SOFCs†

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The $La_{0.7}Sr_{0.3}CrO_3$ (LSC) powders were prepared using liquid-solid reaction method. The LSC ceramic layer was coated by plasma spraying on ferritic stainless steels to form a dense LSC film to resist high temperature oxidation corrosion. The results show the crystal phase of the coated layer is perovskite structure and the LSC coated layer is dense and the mass loss of the interconnects is 0.3 mg/cm^2 after heating at 850 ºC for 60 h.

Key Words: Solid oxide fuel cells, Ferritic stainless steel, Interconnect.

INTRODUCTION

The solid oxide fuel cell is an electrochemical reactor for generating electricity and has some unique advantages over the traditional power generation technologies, including inherently high efficiency, low gas pollution emissions and fuel flexibility[1]. Anode-supported, planar solid oxide fuel cells have achieved sufficient voltages for practical applications, necessitating the use of interconnects to electronically connect anodes and cathodes to one another. In addition to being electronically conducting, interconnects must be easily fabricated, be stable at operating temperatures, have similar thermal expansion coefficients to other fuel cell components, have low ionic conductivity and be impermeable to fuel and oxidizing gases[2]. Coated ferritic stainless steel interconnects have electronically conductive doped $LaCrO_3$ coating and high temperature oxidation resistance, which have widely been applied as interconnector for solid oxide fuel cells[3,4]. Here, the preparation of $La_{0.7}Sr_{0.3}CrO_3$ (LSC) powder and coating characteristics were studied.

EXPERIMENTAL

$La(NO_3)_3$ and $Sr(NO_3)_2$ nitrates (Analytical reagent grade) were dissolved in distilled water to form a nitrate solution. Stoichiometric amounts of the nitrate solution and Cr_2O_3 were mixed and then were ball-milled for 8-12 h and then dried to form a precursor of LSC. Subsequently, the precursor was calcined at 900-1250 ºC for 2 h to form LSC powder. Ferritic stainless steel (16-18 wt. % Cr) sheets, approximately 5 mm thick, were sectioned into sample of 2.5 cm × 2.5 cm. The LSC powder granules with 50-100 μm were produced by pressing. The dense coating with a thickness of 50-100 μm was yielded by plasma spraying method on ferritic stainless steels. The structure was characterized by an X-ray diffractometer and the morphology of the sample was analyzed by scanning electron microscope.

RESULTS AND DISCUSSION

The X-ray diffraction of the coated layer was showed in Fig. 1. From Fig. 1, the microstructure of the coated layer is pure perovskite structure, indicating the LSC material crystal structure did not changed after plasma spraying. The existence of impurity phases in the LSC coating directly affects its electrical conductivity. The electrical conductivity was largely decreased as the insulated phases, such as Cr_2O_3, form in LSC coating. Correspondingly, the internal resistance of planar solid oxide fuel cells will increase.

The SEM morphology of a LSC coating using plasma spraying method is shown in Fig. 2. From Fig. 2, the LSC particles were completely melted in the process of spraying and form a dense sintering body. After cooling and heating, no spelling and cracks were observed, which is attributed to a good thermal match between the film and the substrate. Some pores of about 10-30 μm were observed. These pores may be yielded when the melting LSC particles sintered together.

Mass loss of interconnects coated a dense LSC layer with 50-100 μm is shown in Fig. 3 after heating at 850 ºC for different

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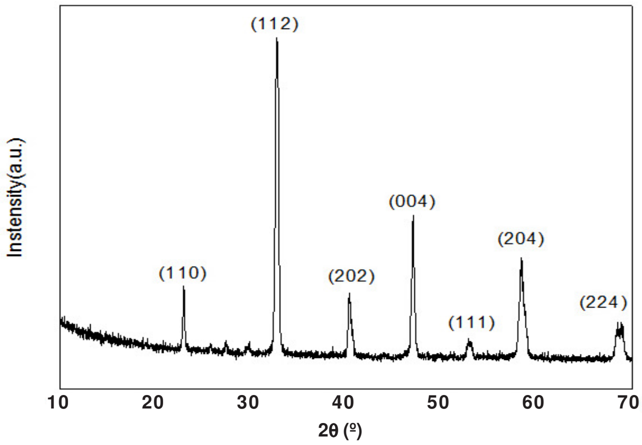

Fig. 1. XRD pattern of the $La_{0.7}Sr_{0.3}CrO_3$ layer coated on ferritic stainless steels by plasma spraying method

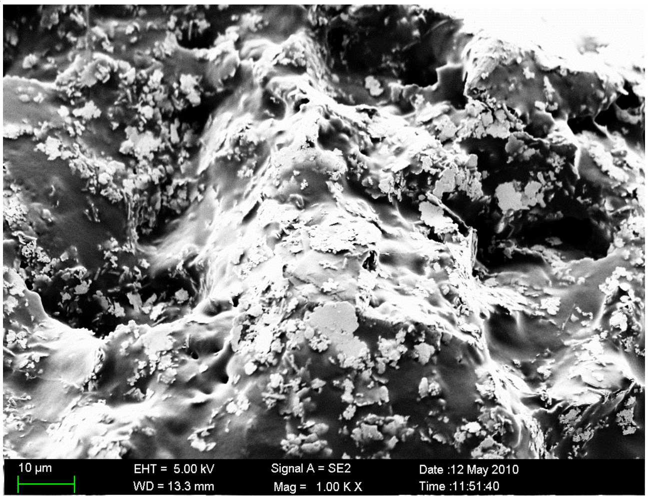

Fig. 2. SEM morphology of the LSC layer coated by plasma spraying method

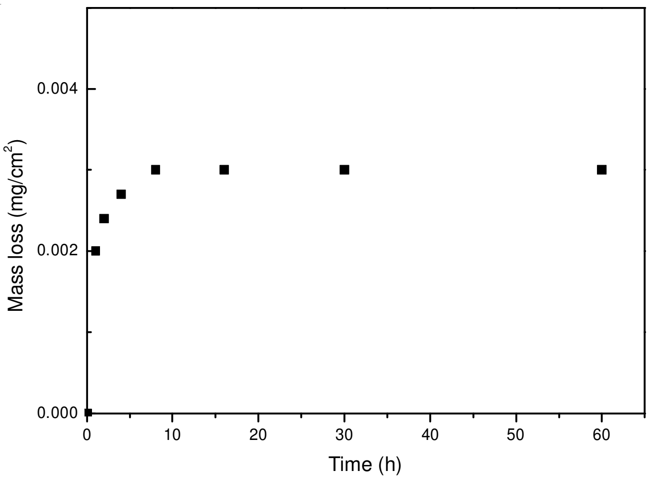

Fig. 3. Mass loss of the interconnects at 850 ºC

times. At 850 ºC for 60 h, the mass loss of the interconnects is 0.3 mg/cm^2, indicating that the LSC coated layer prepared by plasma spraying method has formed a dense ceramic protective film to resist high temperature oxidation corrosion.

Conclusion

A dense LSC coating on ferritic stainless steels was implemented by plasma spraying method. The LSC powders were prepared using liquid-solid reaction method. The XRD pattern showed the crystal structure of the coating is pure perovskite structure and no impurity phases were observed. The mass loss of the interconnects is 0.3 mg/cm^2 after heating at 850 ºC for 60 h because a dense film was acquired to resist high temperature oxidation corrosion.

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