Investigation of SOFC interconnect coating material for protecting cathode from Cr deposition

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Solid oxide fuel cell (SOFC) is one of energy conversion device that is able to directly convert fuel into electricity. SOFC has been focused to overcome the energy crisis due to high efficient. For these reasons, many research groups in the world have studied SOFC for many years. In order to generate high power density and voltage, SOFC should have stacking process. Interconnects are crucial parts of stack for efficient transport of output power and current. Typically interconnects have been used $LaCrO_3$-based ceramic. However traditional ceramic-based interconnect had many problems such as fabrication, robustness and price. Then, with the operating temperature being reduced to intermediate temperature (600-800°C), it is possible to replace metallic materials with ceramic-based interconnect.[1] Ferritic Stainless steels are considered to be the most promising candidates of interconnects due to appropriate thermal expansion behavior, low price and good stability of oxidation. Commonly used ferratic interconnect such as Crofer22APU, AISI430 and E-brite etc. However, two major problems still exist. First, alloys can still be oxidized at SOFCs operating temperature 600°C-800°C. Considering SOFCs long life time about 40000h, such oxidation which would cause significant increase of inner resistance must be avoided. Second, porous Cr_2O_3 react with O_2, H_2O and form gas species such as CrO_3(g), $CrO_3(OH)$(g). Cathode active areas can be poisoned by Cr volatilization. It leads to polarization increasing and performance degradation. In order to prevent the Cr deposition which critical affects cell performance, coating alloys with a conductive ceramic layer is an effective way. [2, 3]

Therefore, in this research AISI444 was selected as a substrate, and suitable coating materials for AISI444 were investigated. In order to develop coating material, Ag was selected as dopant of $Mn_{1.5}Co_{1.5}O_4$, and amount of dopant was selected above 10wt%. Powder was synthesized via GNP; furthermore, XRD and XPS were conducted for validating synthesized powder. Then, electrical conductivity and thermal expansion coefficient of developed coating materials were measured. After these experiments, the coating materials were coated on AISI444 coupons via dip-coating method. Then, ASR of coated samples was measured at 800°C via 4-prove method for validating stability. Finally, in order to certify performance of coating material, SOFC single cell test with coated sample as a current collector was conducted at 800°C.

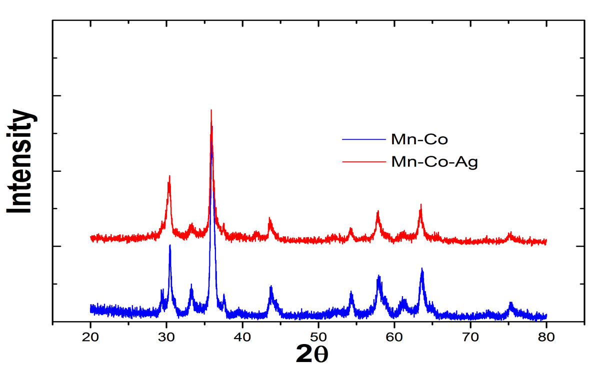

Fig. 1 XRD of Mn-Co-Ag, Mn-Co

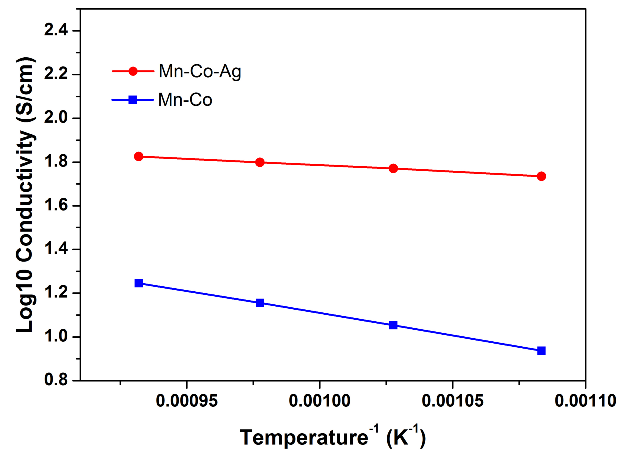

Fig. 2 Electrical conductivity of Mn-Co-Ag, Mn-Co

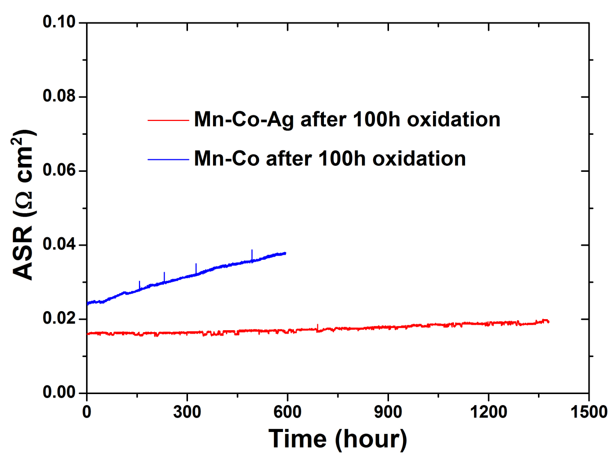

Fig. 3 Long-term test of coated samples

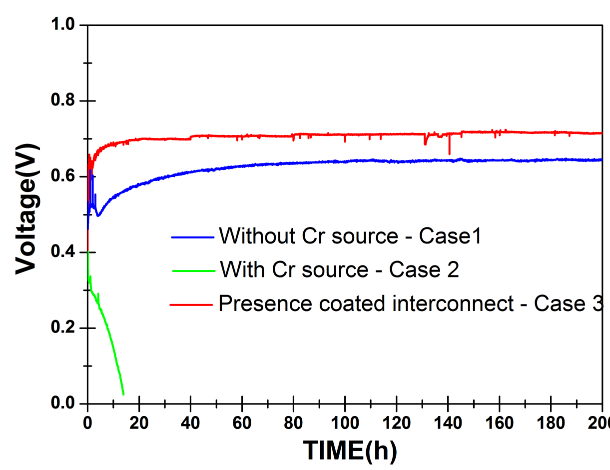

Fig. 4 SOFC single cell test with coated sample

Reference

[1] Yanjie Xu, et.al. , *Cu doped Mn-Co Spinel protective coating on ferritic stainless steels for SOFC interconnect applications*, Solid State Ionics, *192*, 2011, pp. 561–564.

[2] Zhenguo Yang, et.al. , *$(Mn,Co)_3O_4$ Spinel coatings on ferritic statinless steels for SOFC interconnect applications*, Int. J. Hydrogen 32 (2007) 3648–3654.

[3] Z.Yang, et.al. , *Thermal growth and performance of manganese cobaltite spinel protection layers on ferritic stainless steel SOFC interconnects*. Journal of the Electrochemical Society,(2005),152,A1896-A1901