High-performance(Mn,Co)3O4 Spinel Coating Prepared by Electrophoretic Deposition for Solid Oxide Fuel Cell Interconnects

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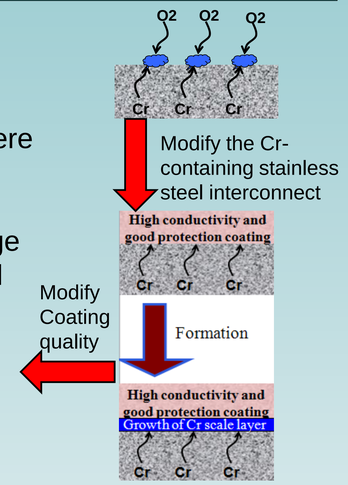
Objectives

❖Fabricate the (Mn,Co)3O4 spinel coatings on metal interconnects through electrophoretic deposition (EPD) followed by reduced-atmosphere sintering;

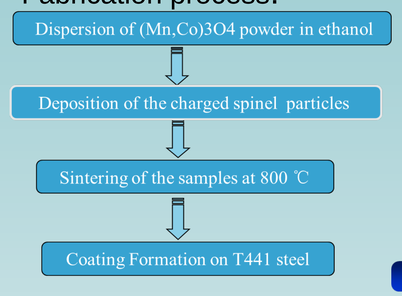
❖Investigate the effect of EPD voltage on surface composition and electrical conductivity of SOFC interconnects;

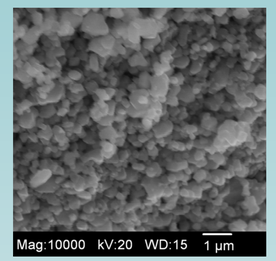
❖Examine the influence of reduced atmosphere on the growth of sub-coating oxide scale and long-term stability of SOFC interconnects.



Methods

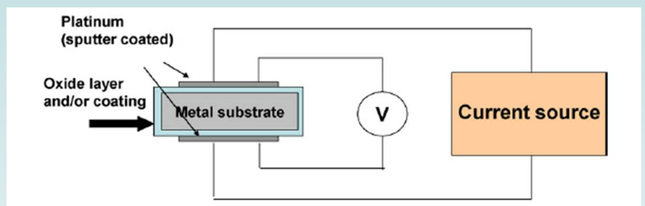
Fabrication process:



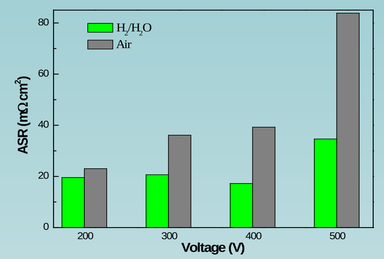


$(Mn,Co)3O_4$ spinel powder used for EPD

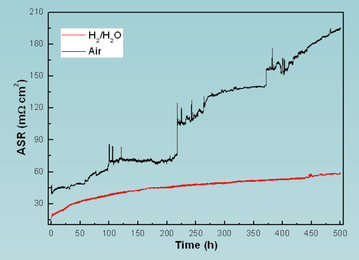
ASR test apparatus:



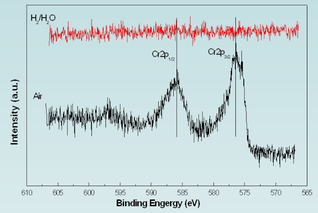
Conduction & long-term stability



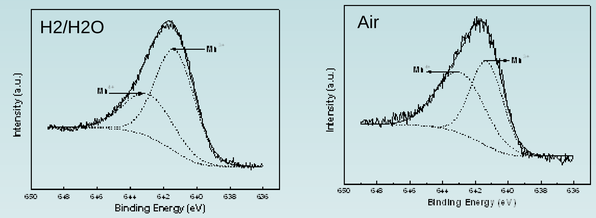
The effect of applied voltage on the ASR value of the (Mn,Co)3O4 layers sintered in H2/H2O or air atmospheres. The measurements were performed in air at 800°C.



ASR results of the H2/H2O-treated and the air-treated coatings measured in air at 800 ℃.



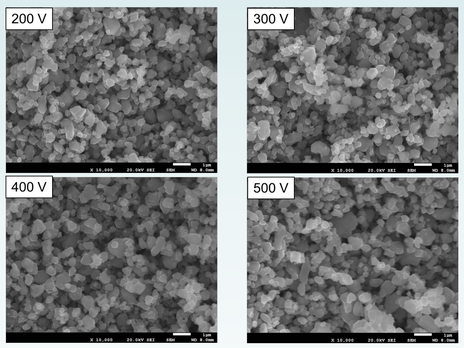
Comparison of XPS patterns in Cr 2p region acquired on the H2/H2O-treated and air-treated coatings after oxidation of 500 h in air at 800 ℃.



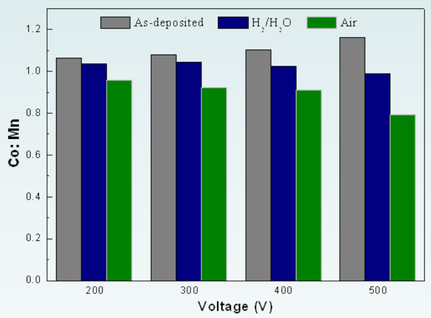
XPS patterns in Mn 2p region for the H2/H2O-treated and air-treated coatings after oxidation of 500 h in air at 800 ℃.

Inspections of fitted Mn2p3/2 peaks show Mn3+/Mn4+ ratios for the H2/H2O-treated and air-treated coatings are around 2:1 and 1:1, respectively.

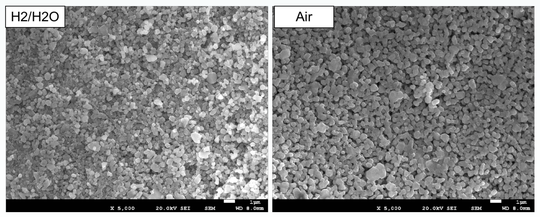
Microstructures



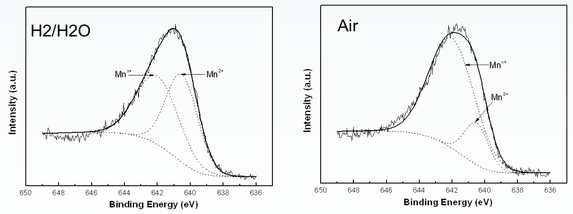
SEM images of original (Mn,Co)3O4 spinel coatings without heat treatment formed under electrical field of (a) 200V, (b) 300V, (c) 400V, or (d) 500V.



The Co/Mn atomic ratios of (Mn,Co)3O4 spinel coatings before and after sintering with the change of EPD voltages and sintering atmospheres.

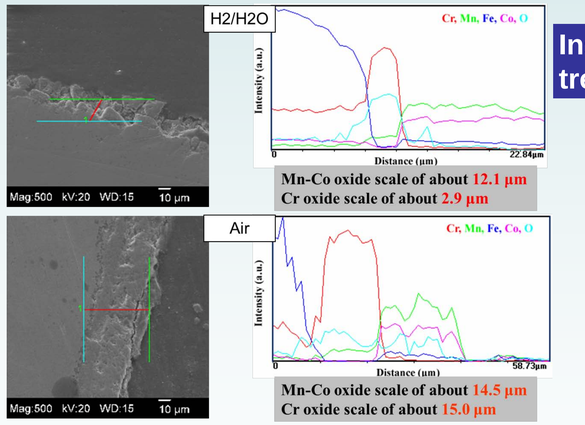


SEM photographs of the (Mn,Co)3O4 coatings sintered in (a) H2/H2O and (b) air atmospheres.



Comparison of XPS spectra in Mn 2p region obtained on the coatings sintered in different atmospheres.

The Mn2+ species on the coatings sintered in H2/H2O and air atmospheres account for about 50% and 16%, respectively.



Cross-sectional SEM images, respectively, for the coatings sintered in H2/H2O and air atmospheres.

Conclusion

- The uniform distribution and high conductivity of the (Mn,Co)3O4 spinel coatings can be achieved by using the deposited voltage of 400 V.
- The interfacial layer of Cr based oxide in H2/H2O-treated sample is obviously thinner than that in air-treated sample due to the low oxygen partial pressure.
- The slow increase of ASR from the initial value of 17.2 mΩ·cm2 to about 59 mΩ·cm2 after oxidation of 500 h is observed for the spinel coating sintered in H2/H2O atmosphere.
- No Cr penetration is observed on the H2/H2O-treated coating after long-term oxidation, explaining the improved long-term stability for SOFC operation.

Acknowledgments

The authors would like to thank Dr. Z. Gary Yang from PNNL for providing (Mn,Co)3O4 spinel powders, Dr. Chris Johnson for continuous encouragement and insightful technical discussion over the years .