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Z. Ranjbar-Nouri, M. Soltanieh, S. Rastegari

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Applying the Protective $CuMn_2O_4$ Spinel Coating on AISI-430 Ferritic Stainless Steel Used as Solid Oxide Fuel Cell Interconnects

Z. Ranjbar-Nouri[1], M. Soltanieh[2], S. Rastegari[3]

[1] MSc Student, Center of Excellence for High Strength Alloys Technology (CEHSAT), School of Metallurgy and Materials Engineering, Iran University of Science and Technology, Tehran, Iran

[2] Professor, Center of Excellence for High Strength Alloys Technology (CEHSAT), School of Metallurgy and Materials Engineering, Iran University of Science and Technology, Tehran, Iran

[3] Associate Professor, Center of Excellence for High Strength Alloys Technology (CEHSAT), School of Metallurgy and Materials Engineering, Iran University of Science and Technology, Tehran, Iran

Abstract

Ferritic stainless steels at high temperature and long operating time of solid oxide fuel cells (SOFC) face with some problems such as overgrowth and spallation of the surface oxide and cathode poisoning due to chromium evaporation. In the present work in order to improve the above-mentioned problems, the protective/conductive $CuMn_2O_4$ spinel coating was created on the AISI-430 ferritic stainless steel by means of pulse electrodeposition and subsequent heat treatment. Therefore, at first, the copper was applied to the substrate from a sulfate bath with an average current density of 48 mA/cm^2 and a deposition time of 4 minutes. Subsequently, manganese was electrodeposited on the copper layer from a sulfate bath with an average current density of 125 mA/cm^2 and a deposition time of 8 minutes. The frequency and duty cycle in the pulse electrodeposition of Cu and Mn Were considered100 Hz and 80%, respectively. Then, to convert the metallic layers to spinel and also to evaluate its prevention of outward diffusion of Cr, oxidation was carried out at 750 ^oC in the air for 24 h and 100 h. Microstructural evaluation of samples cross-section by scanning electron microscope (SEM) equipped with EDS indicated that the $CuMn_2O_4$ spinel layer acted as a barrier to outward diffusion of Cr effectively and the amount of Cr in the coating surface was zero. Also, coating layer had good adhesion to the substrate. By investigation of samples oxidation in the air for 0.5, 10 and 120 minutes at 750 ^oC, the results indicated that Mn was rapidly oxidized to MnO and Mn_3O_4, at the outset of the oxidation of the Cu-Mn metallic coating. Gradually, the MnO and Mn_3O_4 disappeared and Mn_2O_3 was formed and the copper was oxidized to CuO. Finally, spinel phase of CuO and Mn_2O_3 was formed.

Keywords: Solid oxide fuel cell, Interconnect, Coating, Pulse electrodeposition, $CuMn_2O_4$ spinel