Electrodeposition of Cobalt-Manganese Alloy Coatings onto Metallic SOFC Interconnects

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Research efforts for the past several years have focused on cobalt-manganese oxide systems as a candidate material for coating chrome containing metallic solid oxide fuel cell (SOFC) interconnects (1,2,3,4). The cobalt-manganese oxide coatings have a satisfactory thermal expansion coefficient match with the metallic interconnect, suppress the growth of the chromia scale to maintain adhesion with the substrate, minimize chrome vaporization that has been shown to poison the cathode causing a reduction in cell performance and maintain an adequately low resistance to sustain electrical connection between cells connected in series to boost the overall SOFC system voltage. Electrodeposition is one coating technology under consideration for deposition of cobalt-manganese alloy coatings that may subsequently be converted to cobalt - manganese oxide systems through thermal treatment at elevated temperatures in an oxidizing environment. Electrodeposition is widely considered an inexpensive, scalable, industrial manufacturing process capable of coating components with complex surface features such as the gas flow field features located on the surface of SOFC interconnects.

In this work, a pulse electrodeposition process is being developed and validated for coating ferritic stainless steel SOFC interconnects with a cobalt-manganese alloy. The electrodeposition process produces the alloy coatings from a single acidic sulfate based electrolyte containing cobalt and manganese ions, sodium gluconate, ammonium sulfate and boric acid. Experiments demonstrate that the pulse waveform parameters influence the chemical composition of the alloy coating. Chromia scale thickness as a function of coating thickness as well as the influence of the atmosphere during the post-deposition thermal treatment has been investigated and will be reported. Survival of long term exposure at elevated temperatures has shown that the coatings function as a barrier to chrome diffusion toward the surface with minimal increase in the area specific resistance (ASR). The pulse electrodeposition process has been scaled from 25 cm^2 to 100 cm^2 planar ferritic stainless steel SOFC interconnects and was demonstrated on 25 cm^2 interconnects containing gas flow field features. Figure 1 provides SEM images for gas flow field channels coated with the cobalt-manganese alloy after thermal exposure at 800 °C for two hours. Future work will demonstrate coating thickness and compositional uniformity on industrial scale SOFC interconnects containing gas flow fields and coating performance and compatibility with SOFC components in a typical SOFC environment

References:

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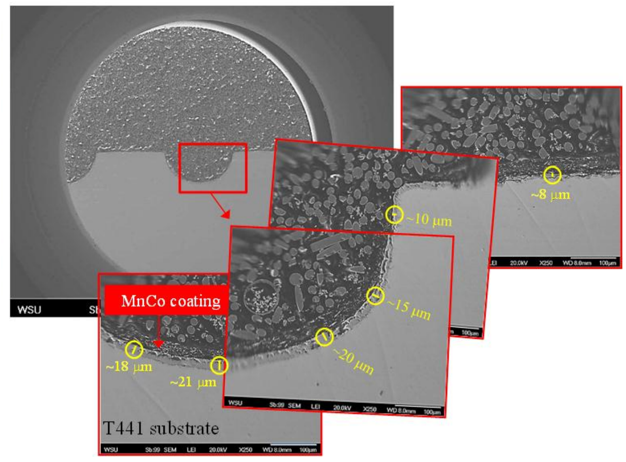

Figure 1: SEM images of a 430 stainless steel interconnect that contains a three channel serpentine pattern with channel and rib widths of 0.9 and 0.8 mm respectively and a feature aspect ratio 0.5. The surface of the interconnect contains a cobalt-manganese oxide coating deposited by electrodeposition and subjected to a post-deposition thermal treatment. Complete coverage of the surface, the channel walls and the channel bottom by the coating was achieved. The coating thickness ranges from ~20 μm at the bottom of the channel to 8 μm at the surface of the channel.