Electrodeposited Mn-Co Alloy Coating For SOFC Interconnects

H.A. McCrabb1, Savidia Lucatero1, T.D. Hall1, H. Zhang2, X. Liu2, S. Snyder1, and E.J. Taylor1

1Faraday Technology Inc., 315 Huls Dr., Clayton, OH 45315, USA
2West Virginia University, Dept. of Mechanical and Aerospace Eng. ESB, Morgantown, WV, 26506, USA

Introduction

Reducing SOFC operating temperatures below 1000 °C has permitted less resistive and expensive ferritic stainless steel interconnects to replace ceramic materials. However, even specially developed ferritic alloys operated at elevated temperatures for lengthy periods of time form a chromia scale that increases the interconnect resistance and results in chrome diffusion from the interconnect to the cathode that causes a reduction in cathode performance. One attractive method to resolve the chromia scale growth and diffusion issues is to electrodeposits a Mn-Co alloy coating onto the interconnect surface and subsequently convert it to a (Mn,Co)3O4 spinel.

Under funding from the Department of Energy, Faraday Technology and WVU are developing, optimizing and validating an electrodeposition process to apply Mn-Co alloy coatings to SOFC interconnects. The FARADAYCSTM Electrodeposition Process is used to deposit a Mn-Co alloy that is subsequently oxidized to a spinel by thermal exposure at high temperatures in an oxidizing environment. Coatings exposed to extended thermal soaks exhibited relatively dense, crystalline microstructures that prevented chrome diffusion through the coating and maintained low area specific resistance. Faraday has scaled its process capabilities to industrial size SOFC interconnects with gas flow features.

Approach

The FARADAYICSM Electrodeposition Process

The appropriate waveform can alter the thickness of the pulsating diffusion layer and effectively focus or defocus the current distribution to create non-uniform or uniform deposition respectively.

The FARADAYICSTM Electrodeposition process…

• Enables alloy composition control
• Enables control of coating uniformity for flow field patterns
• Maintains fast processing times to enable high throughput manufacturing
• Is an inexpensive manufacturing process for SOFC interconnect coatings

Processing Equipment

Electrochemical Cell

Based upon Faraday’s electrochemical cell design that facilitates uniform flow across the surface of a flat substrate (US patent 8,553,401)

Results

2000 Hour Thermal Soak

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>1200 Hour thermal soak</th>
<th>1200 C Coating</th>
<th>Chromate scale thickness</th>
<th>ASR [mg cm²]</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
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</table>

Process Scale-up from 25 cm² to 100 cm²

• Addition of Na2Cr2O7 to electrolyte
• Observed benefits
• Basic and electrochemical compatibility
• Improved cathode capacity
• Counting metal ions prevents hydroxide formation
• Anodic behavior is enhanced
• Improved coating adhesion to substrate
• Coating deposition rate appears linear
• Coating thickness change is consistent upon spinel conversion
• Associated challenges
• Coating thickness limits can be achieved
• Cycles intercorrosion issues to addressed
• Coating deposition rate acceptable
• Is the process reproducibility impeded?

Accomplishments/Future Work

FY 2013 Accomplishments

• Completed 2000 hour thermal soak evaluation
• Infrared and long term cell performance evaluation using 3.8 cm (441) stainless steel interconnects
• Began coating industrial scale interconnects

Future Work

• Complete long term cell performance evaluation of current buttons
• Qualification of electrochemical coating in single cell test rig under ideal SOFC operating conditions by potential commercial partners

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Principal Investigator: Heather McCrabb, Company Name: Faraday Technology, Inc., Address: 315 Huls Drive, Clayton, OH 45315, Phone: 937-836-7749, E-mail: heathermccrabb@faradaytechnology.com, Company website: faradaytechnology.com