Electrodeposited Mn-Co Alloy Coating For SOFC Interconnects

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Overall Objective
Develop, optimize & validate an inexpensive manufacturing process for coating metallic SOFC interconnects with Co and Mn.

Introduction
Reducing SOFC operating temperatures below 1000ºC 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 electrodeposite a Mn-Co alloy coating onto the interconnect surface and subsequently oxidize it to (Mn,Co),O₃.

Under funding from the Department of Energy, Faraday Technology and WVU demonstrated that the electrodeposition process can produce Mn-Co alloy coatings with adequate adhesion after 2000 hrs at 800ºC for specific compositional ranges and that a 3 µm coating is sufficient to minimize chrome diffusion to the surface after 500 hrs at 800ºC in air. Furthermore, a preliminary economic assessment, based on a batch manufacturing process, suggests that the pulse/pulse reverse electrodeposition technology can meet the Department of Energy’s high volume target of 1,600,000 plates per annum at a cost of ~$1.23 per 25 cm x 25 cm coated interconnect.

Approach
The FARADAYIC 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

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Evaluation of Process Parameters

- The appropriate waveform can alter the thickness of the plating diffusion layer and effectively focus or deliques the current distribution to create non-uniform or uniform deposit respectively.
- Microstructure: Diffusion layer tends to follow the surface contour. Mass transport control results in a uniform current distribution or a conformal deposit during deposition.

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Results

Test Matrix for Samples Undergoing a 500 hour Soak at 800 ºC

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Deposit Thickness (µm)</th>
<th>Co Composition</th>
<th>Cr Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>66%</td>
<td>0%</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>66%</td>
<td>0%</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>66%</td>
<td>0%</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>66%</td>
<td>0%</td>
</tr>
<tr>
<td>0</td>
<td>5</td>
<td>66%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Coat pattern interconnects

- Based on batch manufacturing, the DOE’s high volume target of 1,600,000 plates per annum at a cost of ~$1.23 per 25 cm x 25 cm coated interconnect.

Approach

- The FARADAYIC Electrodeposition process allows for non-linear selectivity of the electroplating bath.
- Ferrite ASR and crystallography analysis showed that the as-deposited thickness composition had little effect on performance after a 3000 hour cycle.
- The SOFC performance of the 3 µm Mn-Co alloy coating after 5000 hour testing.
- Based on batch manufacturing, the DOE’s high volume target of 1,600,000 plates per annum at a cost of ~$1.23 per 25 cm x 25 cm coated interconnect.

Conclusions

- Ferrite ASR and crystallography analysis showed that the as-deposited thickness composition had little effect on performance after a 3000 hour cycle.
- The SOFC performance of the 3 µm Mn-Co alloy coating after 5000 hour testing.
- Based on batch manufacturing, the DOE’s high volume target of 1,600,000 plates per annum at a cost of ~$1.23 per 25 cm x 25 cm coated interconnect.

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