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 1000 °C has permitted less reactive 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 electrodeposit a Mn-Co alloy coating onto the interconnect surface and subsequently convert it to a (Mn,Co)₂O₃ 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 FARADAYIC® 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 soak exhibited a relatively dense, crystalline microstructure 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 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

Previous Accomplishments

- Varying Cobalt Concentration
  - 4 Co, 1 Mn: 100% Fe, 100% Mn
  - 6 Co, 4 Mn: 100% Fe, 100% Mn

- Processing Equipment
  - Electrochemical Cell
    - Based upon Faraday's electrochemical cell design that facilitates uniform flow across the surface of a flat substrate
    - US patent #7,553,401, 7,947,186, 8,226,804

- Technical Results
  - Long-term on-cell performance evaluation
    - Button Cell Dimensions
    - Cell Test Feature
    - Air inlet, voltage
    - SOFC IC coated
    - 441 stainless steel button cell

- Economic Analysis
  - Current cost analysis of coating process based upon batch manufacturing of 1,600,000 plates per annum at a cost of ~$0.98 per 625 cm² coated interconnect.

- Accomplishments/Future Work
  - FY 2013 Accomplishments
    - Complet elong-term on-cell performance evaluation of button cells
    - Updated economic cost evaluation
    - Delivered coated interconnects to commercial partners for performance evaluation via SOFC stack testing

- Future Work
  - Qualification/demonstration of interconnect coating in single cell test rig under ideal SOFC operating conditions by potential commercial partners

Acknowledgements
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Milestones

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10 μm thick cathode coating