the ENERGY lab

PROJECT FACTS

Fuel Cells

Phase III Xlerator Program: Electro-deposited Mn-Co Alloy Coating for Solid Oxide Fuel Cell Interconnects—Faraday Technology

Background

Based on preliminary cost analysis estimates, Faraday Technology has shown that its FARADAYIC™ electrodeposition process for coating interconnects is cost competitive. Funding from the American Recovery and Reinvestment Act (ARRA) under the Small Business Innovation Research (SBIR) Phase III Xlerator Program will be directed toward developing, optimizing, and validating the FARADAYIC process as an effective and economical manufacturing method for coating interconnect materials with a manganese-cobalt (Mn-Co) alloy for use in solid oxide fuel cell (SOFC) stacks.

This project is managed by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) whose mission is to advance energy options to fuel our economy, strengthen our security, and improve our environment. With the SOFCs program and systems coordination from the Solid State Energy Conversion Alliance (SECA), DOE/NETL is leading the research, development, and demonstration of SOFCs for both domestic coal and natural gas fueled central generation power systems that enable low cost, high efficiency, near-zero emissions and water usage, and carbon dioxide (CO_2) capture.

Project Description

Electrodeposition is widely considered an inexpensive, scalable, non-line-of-sight industrial manufacturing process, and the addition of FARADAYIC's pulse/pulse-reverse processing further enhances the electrodeposition process through the control of grain size, morphology, stress, and composition of the deposits. In addition to reducing SOFC component manufacturing costs, this technology will mitigate SOFC performance losses by minimizing SOFC performance degradation mechanisms due to chromium diffusion from the interconnect, increase the lifetimes of SOFC systems, and enable more flexibility in the flow field designs, bringing SOFCs one step closer to being a commercially viable alternative energy source. Therefore, the anticipated outcome of this Phase III Xlerator program is the development of an inexpensive manufacturing process for coating interconnect materials used in SOFC stacks with a Mn-Co alloy that is subsequently converted to a conductive spinel coating. The intent of the process development is to prepare as-plated Mn-Co interconnects that can be directly inserted into the SOFC stack without post deposition annealing steps to produce the $(Mn,Co)_3O_4$ spinel coating, thus minimizing the number of production steps and the total manufacturing cost. On-cell tests with button cells will be performed by subcontractor West Virginia University (WVU) to determine the coating electrical properties and their effect on cell performance.

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PARTNERS

West Virginia University

PERFORMANCE PERIOD

Start Date	End Date
10/01/2010	09/30/2013

COST

ARRA Funded

Total ARRA Project Value

$992,392

DOE/Non-DOE Share

$992,392 / $0

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

AWARD NUMBER

FE0006165

U.S. DEPARTMENT OF ENERGY

Goals and Objectives

The specific objectives of the Phase III Xlerator program are as follows:

- Continued development, optimization, and validation of the FARADAYIC electrodeposition process for 4"x4" single and dual sided grooved interconnect materials;
- Development of a layered coating structure of Co and MnO_x that could reduce T441 stainless steel surface exposure to oxygen and prevent chromium (Cr) from diffusing to the coating surface where it could potentially poison the SOFC;
- Mitigation of Cr diffusion by determining the controlling mechanism through in situ high-temperature, X-ray diffraction (XRD) measurements and X-ray photoelectron spectroscopy (XPS) depth profiling;
- Development of a more comprehensive economic assessment of the electrodeposition coating process as it relates to interconnect manufacturing; and
- Enhancement of the program's commercialization plan through close collaboration with SECA SOFC developers.

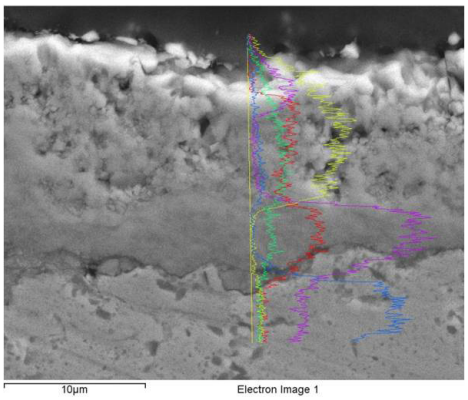
Photograph of pilot-scale electrodeposition cell for coating industrial scale SOFC interconnects.

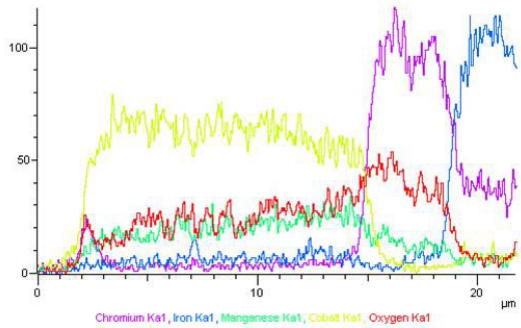
Accomplishments

- Completed fabrication of a small FARADAYIC electrodeposition cell similar to the one used for the SBIR Phase I program work (a prior agreement with the DOE) for Mn-Co alloy deposition onto 2"x2" and 1"x1" planar T441 stainless steel interconnect substrates for West Virginia University.
- Commissioned the tube furnace located on-site in Faraday's pilot-scale facility for use in long term, high temperature thermal evaluation
- Completed program milestone 1, installation of a pilot-scale electrodeposition cell for coating industrial scale interconnects.
- Completed program milestone 2, long-term, high-temperature thermal evaluation of coatings, in which Mn-Co spinel coated samples exhibited minimal chromia scale growth, good scale adhesion and low area specific resistance values.
- Completed program milestone 3, process development of 100 cm^2 planar interconnects in which coated samples exhibited thickness and chemical compositional uniformity.
- Initiated program milestone 4, process development for 100 cm^2 interconnects containing gas flow field features by performing coating activities and evaluating coated samples by scanning electron microscope / energy dispersive spectroscopy.
- Initiated program milestone 5, long-term on-cell performance evaluation by coating 16 cm^2 button cells for insertion into test equipment.

Benefits

The SBIR program is positioned to leverage the agility and innovative competencies of small businesses. It is through this program that a small company, Faraday Technology, in Clayton, Ohio has developed a breakthrough technology for the electrodeposition process of coating interconnects. ARRA investment in this small business will likely result in more U.S. jobs, and a successful coating process that would help reduce SOFC stack manufacturing costs would help enable an economically viable alternative energy option for the commercial energy sector. The technical success of this project is dependent upon scaling the process up to full-size interconnects for testing under ideal SOFC operating conditions by potential commercial partners.





SEM image (left) and EDS line scan data (right) for Mn-Co coated T441 stainless steel sample exposed to an air atmosphere at 800 °C for 2000 hours. Image shows the good adhesion etween the 4 µm chromia scale and T441 stainless steel.