the ENERGY lab

PROJECT FACTS

Fuel Cells

Manufacturing Analysis of SOFC Interconnect Coating Processes—NexTech Materials

Background

The adoption of high-temperature metal alloys as alternatives to traditional ceramic interconnect materials provides a cost effective path for the production of solid oxide fuel cells (SOFCs). Low-cost and effective protective coatings must be developed for the metallic system and stack components for SOFCs to be economical. Since current coating technologies have a high cost per unit, there is a clear need for a manufacturing assessment and optimization of interconnect coating processes.

In this work NexTech Materials Ltd. (NexTech) will evaluate methods for coating interconnects from technical and economic perspectives. NexTech will develop a coating method that is deemed suitable for low-cost, high-volume manufacturing and validate their cost analyses.

This fuel cell project was competitively selected under the Small Business Innovative Research (SBIR) Program. It is managed by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL). With the Solid State Energy Conversion Alliance (SECA), NETL is leading the research, development, and demonstration of SOFCs for coal-fueled central generation power systems that will enable low cost, high efficiency, near-zero emissions and water usage, and capture carbon dioxide (CO_2). This project augments SECA's Core Technology Program for the Cross-Cutting Materials, Testing, and Manufacturing focus areas of research.

Project Description

The viability of five competing coating technologies was assessed in Phase I. The analysis identified aerosol spray deposition (ASD) as a commercially viable (less than $2/part when stack production volume totals 400 megawatts), high value method to apply protective coatings to metallic interconnects. Phase II involves demonstrating the effectiveness of ASD coatings through long-term electrical testing in both single- and dual-atmosphere configurations and parallel oxidation weight gain experiments. Accelerated testing protocols are allowing expeditious experimental validation of oxidation kinetics and prediction of coating lifetime. The emphasis is on driving the technology toward commercialization.

The manufacturing cost model analyses developed in Phase I will continue to be refined to address the range of production volumes—from prototyping, through pilot-scale production, to full volume production—anticipated as the SOFC market evolves. An example of one such cost model curve developed in coordination with a commercial

CONTACTS

Briggs White
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-5437
briggs.white@netl.doe.gov

Matthew Seabaugh
Principal Investigator
NexTech Materials Ltd.
404 Enterprise Drive
Lewis Center, OH 43035
614-842-6606
m.seabaugh@nextechmaterials.com

Daniel Driscoll
Technology Manager, Fuel Cells
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-4717
daniel.driscoll@netl.doe.gov

PARTNERS

None

PROJECT DURATION

Start Date	End Date
09/23/2009	08/14/2012

COST

Total Project Value
$1,100,000

DOE/Non-DOE Share
$1,100,000/$0

AWARD NUMBER

SC0001208

customer is shown in Figure 1. The three regimes of production correspond to Stage I: prototyping (1–1,000 parts/month), Stage II: outsourced coating runs (1,000–100,000 parts/month), and Stage III: continuous component coating (greater than 100,000 parts/month). Manufacturing strategies within each of these regimes have been identified to reduce volume manufacturing costs.

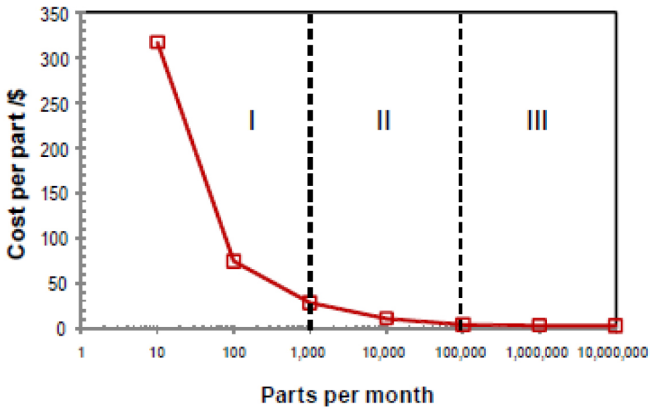

Figure 1. Anticipated cost curve for ASD coating of metallic interconnects of active areas <400 cm^2.

Goals and Objectives

The overall goal for this project is to demonstrate ASD interconnect coatings and develop and validate associated cost models. Current objectives of this project are as follows:

- Develop and production-validate cost models for ASD coatings to address the range of metallic interconnect production volumes (1,000–100,000 parts/month) anticipated as the SOFC market evolves.
- Develop customer-specific cost curves (5-year forecasts).
- Identify manufacturing strategies to reduce volume manufacturing costs.
- Demonstrate ASD-coated interconnect performance to reinforce the value proposition for SECA.
- Identify key coated interconnect failure mechanisms and develop lifetime predictive models.
- Create and validate accelerated testing protocols to simulate 40,000-hour service.
- Develop a refined firing condition to maintain a high quality protective coating while preventing resistive scale formation on any area of the interconnect left uncoated.

Accomplishments

Accomplishments for fiscal year 2011:

- Refined cost and manufacturing models to encompass volumes from prototyping through pilot-scale production and full volume production.
- Created metallic interconnect SOFC market forecast and demand curves at various stages of commercialization.
- Defined key process limits and lifetime stability tests in progress (greater than 1,500 hours operation at 800 degrees Celsius [°C] in both single and dual-atmosphere configurations).
- Tailored firing processes to prevent the formation of a deleterious resistive scale on any uncoated areas of the interconnect.
- Identified key failure mechanisms and acceleration factors for metallic interconnects. Predictive lifetime models were successfully applied to long-term stability tests.
- Integrated coating technology into three- to five-cell short stacks, rated at up to one kilowatt, used on concurrent Department of Defense and commercial demonstration efforts. There were more than 40 stacks built using the coating technology.

Figure 2. Coated and uncoated AL SS441 stainless steel substrates after accelerated oxidation at 900 °C for 200 hours in air.

Benefits

This SBIR project assists the SECA program in meeting its cost and performance targets by developing and validating low-cost and effective protective coatings for SOFC metallic stack components. SECA will ultimately enable fuel cell-based near-zero emission coal plants with greatly reduced water requirements and the capability of capturing 99 percent of carbon at costs not exceeding the typical cost of electricity available today. Achieving this goal will significantly impact the nation given the size of the market, expected growth in energy demand, and the age of the existing power plant fleet. Federal funding support of this research is appropriate given the game changing nature of the technology accompanied by risks higher than the private sector initially can accept.