the ENERGY lab

PROJECT FACTS

Fuel Cells

Solid Oxide Fuel Cell Cathode Enhancement Through a Vacuum-assisted Infiltration—Materials & Systems Research

Background

Solid oxide fuel cell (SOFC) technology promises to provide an efficient method to generate electricity from coal-derived synthesis gas (syngas), biofuels, and natural gas. The typical SOFC composite cathode (current source) possesses excellent performance characteristics but is subject to chemical stability issues at elevated temperatures both during manufacturing and power generation. Costs attributed to the cathode and its long-term stability issues are a current limitation of SOFC technologies. These must be addressed before commercial SOFC power generation can be realized.

Materials & Systems Research Inc. (MSRI), teaming with Argonne National Lab (ANL), will develop a vacuum-assisted infiltration technique to improve SOFC cathode performance and longevity through the impregnation of an inexpensive electro-catalyst precursor into a preformed cathode backbone.

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 cathode focus area of research.

Project Description

Currently, composite cathodes are formed by directly mixing the active cathode material with electrolyte at different ratios, followed by deposition and sintering into graded functional layers. Since the effectiveness of the composite cathode (the cathode is the electrode at which oxygen ions are removed from the air supply) greatly depends on the composite microstructure and intrinsic material properties, SOFC cell fabrication processes must be engineered to ensure the electrode micro-structural characteristics have continuous phases, open and continuous pores, well-linked (sintered) cathode particles, and a long triple phase boundary.

This project will develop a cost-effective vacuum-pressure infiltration thermal treatment (VPIT) technique to improve SOFC cathode performance and longevity through the impregnation of an inexpensive electro-catalyst precursor into a cathode backbone. Upon calcination (a thermal treatment process) at reduced temperatures, a thin but continuous network of nano-sized catalysts is formed, covering the cathode backbone with enlarged

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PARTNERS

Argonne National Laboratory

PROJECT DURATION

Start Date	End Date
07/08/2011	03/16/2012

COST

Total Project Value
$150,000

DOE/Non-DOE Share
$150,000/$0

AWARD NUMBER

SC0006374

U.S. DEPARTMENT OF ENERGY

catalytic surface area and heterogeneous microstructure. This enhances both the oxygen exchange rate and oxygen ion transport rate on the cathode surface. The reduced temperature calcination will greatly improve the stability of the cathode.

In Phase I, the vacuum-assisted infiltration apparatus and the infiltration protocol will be developed and validated using two sizes of cell test apparatus: button cells and short stacks with 100 square centimeters per-cell active areas. Catalyst distribution and morphology will be investigated via advanced x ray diffraction and radiographic techniques. Phase II will support manufacturing scale-up to meet SECA cost goals, and will include kilowatt-scale stack validation.

Goals and Objectives

The goal of this project is to develop a vacuum infiltration process for adding catalysts to SOFC cathodes.

Current project objectives are:

- Fabrication of anode-supported SOFCs for testing.
- Development of a nano-catalyst infiltration technique.
- Experimental characterization of performance enhancement due to infiltration treatment.

Accomplishments

This project was recently awarded. Each of the experimental and computational project phases/tasks will have deliverables in the form of the development of a nano-catalyst infiltration technique, validation of the results, and experimental measurements that will enhance SOFC performance and be useful to other researchers in the fuel cell industry.

Benefits

This SBIR project assists the SECA program in meeting its cost and performance targets by increasing SOFC life through increased cathode performance and longevity. 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 in 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.

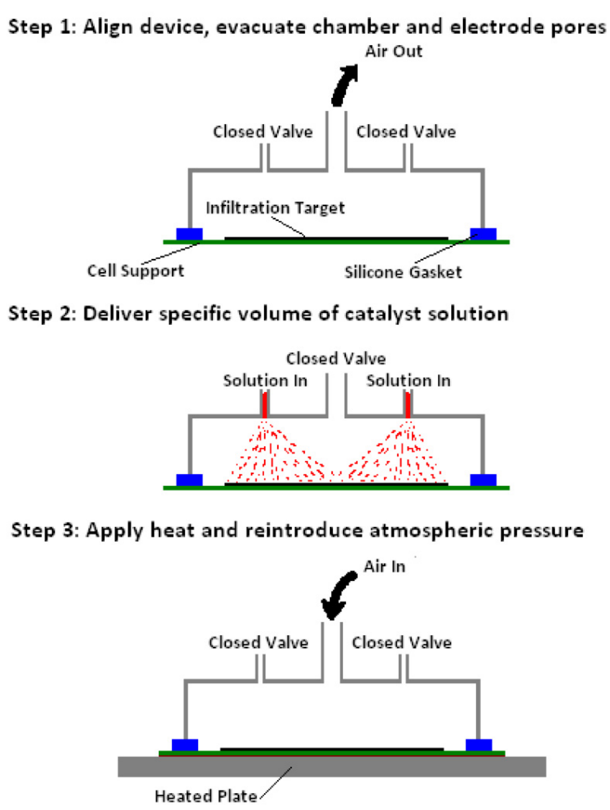

Diagram of the VPIT technique, involving the precipitation of a nitrate solution into the porous cathode backbones (with engineered electrode morphology), followed by gelation at a proper rate, and decomposition.