the ENERGY lab

PROJECT FACTS

Fuel Cells

Cathode Contact Materials for Anode-Supported Cell Development—Lawrence Berkeley National Laboratory

Background

The mission of the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is to advance energy options to fuel our economy, strengthen our security, and improve our environment. With the Solid State Energy Conversion Alliance (SECA), NETL is leading the research, development, and demonstration of solid oxide fuel cells (SOFCs) for coal-fueled central generation power systems that enable low cost, high efficiency, near-zero emissions and water usage and capture carbon dioxide (CO_2).

Lawrence Berkley National Laboratory (LBNL) is one of various SECA Core Technology Program participants working to provide vital research, development, and testing support that addresses applied technological issues common to multiple SECA Industry Teams.

Novel and inexpensive techniques are desired to improve the performance of the SOFC air electrode (cathode)—contact zone—interconnect system over the temperature range of 650 to 800 degrees Celsius (°C). One area for improvement is Cathode Contact Materials (CCMs). CCMs provide the electrical connection between the cathode and interconnect. CCM improvement includes bond strength, bond temperature, electrical conductivity (especially at low temperatures), and coefficient of thermal expansion (CTE) adjustment. Improved CCMs would allow for less severe processing conditions, reduced interconnect oxidation, improved electrical efficiency, and resistance to thermal-cycle damage.

Project Description

In this project, SOFC component performance will be improved through selection of appropriate materials and the development of novel, inexpensive alternative materials, architectures, and concepts. The primary challenge is electrical connection and bonding between the interconnect and cathode layers (Figure 1). Historically, a cathode materials such as lanthanum strontium manganite (LSM) was used as a CCM paste to bond the cell to the interconnect. High temperature is typically required to achieve good bonding, but this leads to rapid oxidation of the stainless steel interconnect. Poor bonding and eventual delamination of the contact material may occur if the temperature employed during the bonding step is low enough (less than 1,000 °C) to avoid oxidation of the steel.

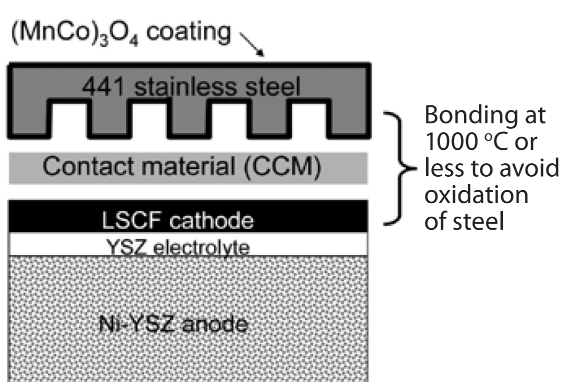

Figure 1. Schematic of CCM placement in cell stack.

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PARTNERS

None

PROJECT DURATION

Start Date	**End Date**
05/01/2001	09/30/2012

COST

Total Project Value
$3,150,000

DOE/Non-DOE Share
$3,150,000/$0

AWARD NUMBER

MSD-NETL-01

U.S. DEPARTMENT OF ENERGY

In the 2011 and 2012 fiscal years, LBNL's main effort is to identify cathode materials that offer promise as candidate cathode-interconnect contact materials. Candidate materials will be synthesized and characterized. This will include determination of sintering behavior, conductivity, bonding, CTE, and reaction with adjacent materials. The most promising candidates will be down-selected and the long-term stability of their area-specific resistance (ASR) will be determined in relevant test geometries using model cathode and interconnect layers. The most promising materials will be demonstrated in lab-scale cells operating under realistic conditions. Novel materials and architectures will be pursued in which the bonding and electronic connection functions of the CCM material are separated, and also in composite materials that are used to provide both bonding and electrical connection.

Goals and Objectives

The goal of this project is to identify and develop novel materials, architectures, and approaches for cathode contact materials that address electrical connection and bonding between the interconnect and cathode layers.

Current project objectives are:

- Identify and develop candidate materials, architectures, and concepts to solve issues related to delamination and degradation of cathode contact material.
- Initiate in situ testing using commercially available lab-scale fuel cells.
- Target high-risk/high-benefit strategies and novel technical approaches.

Accomplishments

Accomplishments for the fiscal year (FY) 2011:

- Screened an extensive list of candidate cathode materials for suitability as cathode contact pastes. Determined conductivity, sintering behavior, CTE, reactivity with lanthanum strontium cobaltite ferrite and manganese cobalt spinel (MCO) neighbor materials, and bonding strengths.
- Quantified the ASR of the most promising candidates at 800 °C for 200 hours.
- Conducted post-mortem analysis of ASR specimens to determine extent of reaction between layers.
- Identified novel cathode contact schemes and materials. Determined feasibility of novel approaches, and selected the most promising candidates for further development.
- Initiated in situ testing of CCM candidates using anode-supported lab-scale cells and MCO-coated 441 stainless steel interconnect coupons.

Benefits

Findings and inventions under the SECA Core Technology Program are made available to all SECA Industry Teams under unique intellectual property provisions (an exception to the Bayh-Dole Act) that serve to accelerate development. 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. This project pro-vides the basis for developing more robust cathode-interconnect contact materials thus improving the reliability, robustness, and endurance of SOFCs.

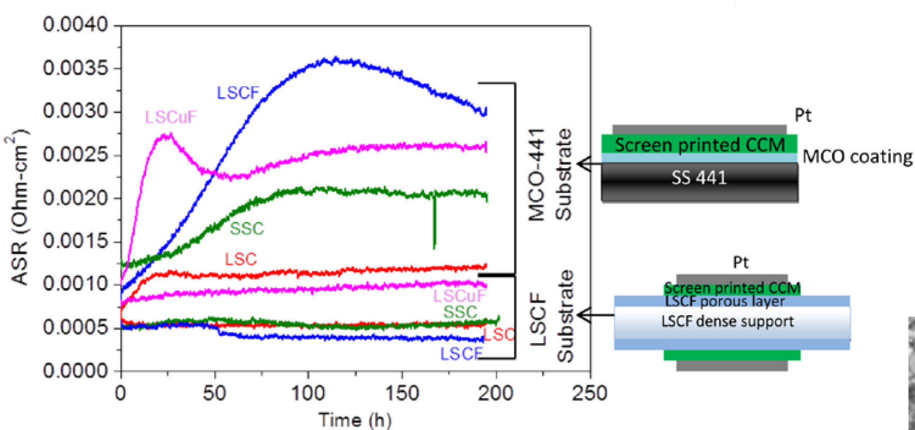

Figure 2. ASR for various CCM compositions at 800 °C.

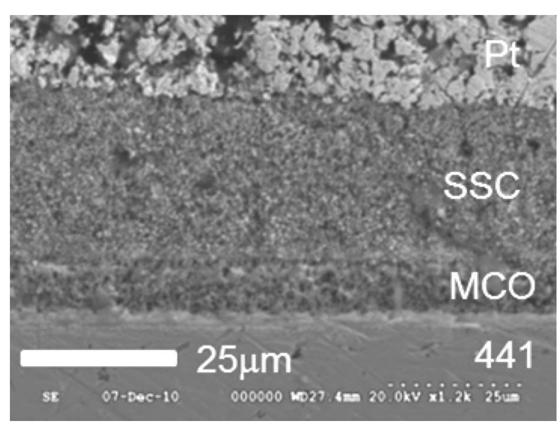

Figure 3. Post-mortem cross section SEM image of SSC on MCO-441 substrate.