V.L.1 Development of a 5 kW Prototype Coal-Based Fuel Cell*

Steven S.C. Chuang
The University of Akron
200 E. Buchtel Common, Whitby Hall
Akron, OH 44325-3906
Phone: (330) 972-6993; Fax: (330) 972-5856
E-mail: schuang@uakron.edu

DOE Technology Development Manager:
Amy Manheim
Phone: (202) 586-1507; Fax: (202) 586-9811
E-mail: Amy.Manheim@ee.doe.gov

DOE Project Officer: Reg Tyler
Phone: (303) 275-4929; Fax: (303) 275-4753
E-mail: Reginald.Tyler@go.doe.gov

Contract Number: DE-FC36-06GO86055

Project Start Date: June 1, 2006
Project End Date: May 31, 2008

*Congressionally directed project

Objectives

- Improve the anode catalyst structure and the interface between electrode and membrane.
- Refine the techniques for fabrication of the fuel cell assembly.
- Select and test interconnect materials for the coal-based fuel cell.
- Investigate the design factors for the coal injection and fly ash removal systems.
- Design and fabricate a 5 kW prototype coal fuel cell.

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section (3.4.4) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) Durability

(E) System Thermal and Water Management

Technical Targets

Energy density: 160 mA/cm^2 at 0.4 V by May 31, 2008.

Approach

A key innovation of the coal fuel cell technology is the development of a highly active catalyst for the electrochemical oxidation of the solid carbon in coal. The use of the solid carbon as the fuel distinguishes this coal fuel cell technology from conventional solid oxide fuel cells which uses H_2 or syngas as the feed. A novel design of the anode structure composition is required to obtain the optimum performance of the anode for the coal fuel cell.

This project focuses on the refinement of the anode catalyst and the design/fabrication of a coal fuel cell stack. The anode catalyst structure and composition for optimum performance will be fine-tuned through a series of experimental testing: (i) varying compositions, calcination temperature, and reduction temperature, (ii) determining the anode impedance, (iii) evaluating the long term durability, and (iv) characterizing the anode structure. The anode catalysts developed from this project must possess resistance to poisoning by sulfur and impurities from coal.

The fuel cell stack will be designed on the basis of the results of investigation of fly ash/coal particle distribution. The thermal management will be built on the basis of the results of the heat transfer analysis and energy balance of the fuel cell system. The results of this study will be used to evaluate the technical feasibility of scaling up the C-fuel cell.

Accomplishments

- Fly ash produced from coal does not adhere to the anode catalyst surface.
- Current density of more than 80 mA/cm^2 at 0.4 V has been achieved on an oxide anode catalyst at 750°C.
- Technique for the fabrication of the fuel cell with a diameter greater than 1 inch has been developed.

Special Recognitions & Awards/Patents Issued

1. Catalyst Compositions for Use in Fuel Cells," U.S. Provision Patent Application, filed by the University of Akron.

FY 2007 Publications/Presentations

1. "Pulse CH_4/D_2O Reaction on a Ni/YSZ Anode in SOFC," Z. Yu and S. S. C. Chuang, Applied Catal. (in press).

2. "Transient Studies of the Direct Methane Solid Oxide Fuel Cell with a Cu/SDC Anode . Catalysts," The 24th Taiwan Symposium on Catalysis and Reaction Engineering, National Chung Hsing University, TaiChung, Taiwan, June 23, 2006.

3. "Fuel Cell Catalysis," National University of Kaohsiung, Kaohsiung, June 30, 2006 "Direct Coal Fuel Cell," Direct Carbon Fuel Cell Technology Assessment, Electric Power Research Institute, Palo Alto, CA, August 29–30, 2006.

4. "Transient Kinetics of Fuel Cell Reactions," Graduate Seminar, Chemical and Biomolecular Engineering, Clemson University, Clemson, SC, September14, 2006.

5. "Recent Development on Fuel Cell Technology," National Taipei University of Technology, Taiwan, October 27, 2006.

6. "Recent Development on Direct Hydrocarbon Solid Oxide Fuel Cells," Graduate Seminar, Department of Mechanical Engineering, National Central University, Taiwan, October 31, 2006.

7. "Mechanism of the CH4 Electrochemical Oxidation and Reforming on Cu and Ni Anode Catalysts in SOFC," 30th North American Catalysis Society (NACS) Meeting, Houston, June 17-22, 2007.

8. "Studies of Reaction Pathways in Solid Oxide Fuel Cells," 30th North American Catalysis Society (NACS) Meeting, Houston, June 17–22, 2007.