DOE Hydrogen Program

Development of a 5 kW Prototype Coal-based Fuel Cell

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Project ID #
FCP9

Overview

Timeline

- Project start date: 6/01/2006
- Project end date: 5/31/2008
- Percent complete: 46%

Budget

- Total project funding
  - DOE share: $495,000
  - Contractor share: $178,654
- Funding received in FY06

  $323,538
- Funding for FY07

  $171,462

Barriers

- Barriers addressed
  - Long term catalyst durability
  - System thermal management

Partners

- Bob Brown, The Ohio Coal Development Office

Objectives

- **Overall: Design a 5 kW prototype coal-based fuel cell and fabricate a small scale coal fuel cell system including coal injection and fly ash removal ports.**
- **2006:**
  - **Improvement of the anode catalyst structure and the interface between electrodes**
  - **Development of fuel cell fabrication techniques**
- **2007: Fabricate and test a small scale coal fuel cell system.**

Approach

- Improvement of the anode catalyst structure and the interface between electrode and membrane.
- Refinement of the techniques for fabrication of the fuel cell assembly
- Selection and testing of interconnect materials for the coal-based fuel cell.
- Investigation of the design factors for the coal injection and fly ash removal systems.
- Design and fabrication of a small scale coal fuel cell system.

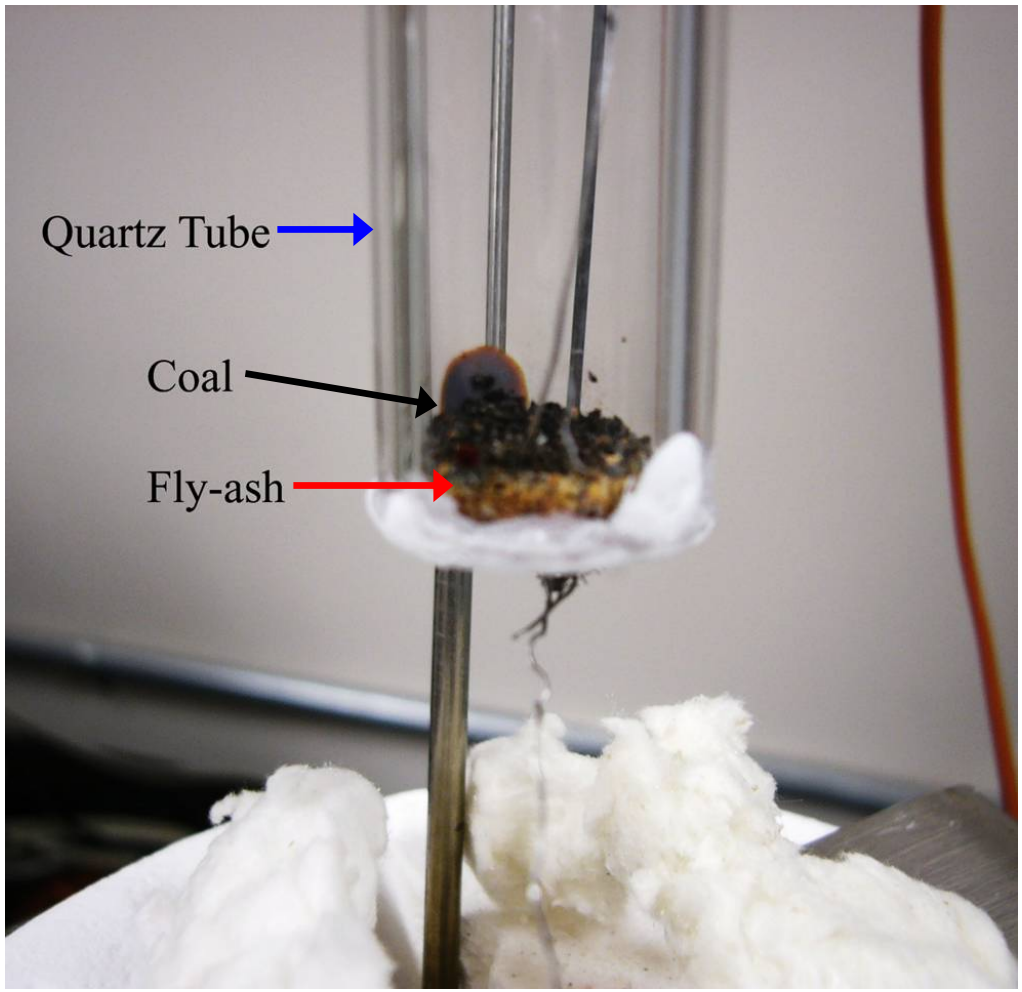
Technical Accomplishments/ Progress/Results

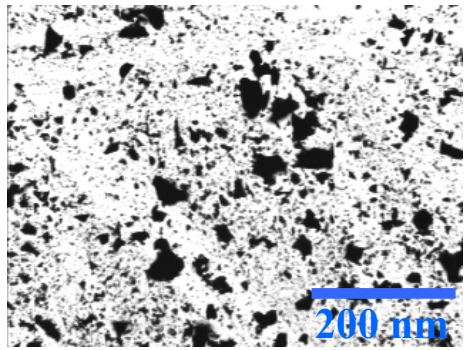
- Successful fabrication of the fuel cell assembly with a diameter greater than 1”.
- Identification of the active anode catalyst components for the electrochemical oxidation of coal and coke at temperature below 800 ^{o}C.
- Design and fabrication of coal fuel cell testing systems.
- Preliminary development of sulfur tolerant anode catalysts

Ohio Coal # 5

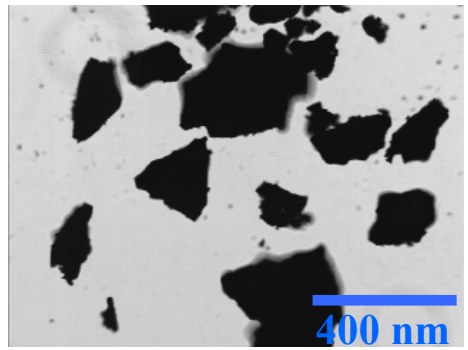
PROXIMATE ANALYSIS		ULTIMATE ANALYSIS	
% Moisture as received	4.15	% Carbon	83.99
Dry % ash	4.80	% Hydrogen	5.50
Dry % volatile matter	37.98	% Nitrogen	1.88
Dry % fixed carbon	57.22	% Oxygen	8.63
SULFUR FORMS		CALORIC VALUE (BTU/lb) 14258	
% Pyritic 0.70	% Organic 1.21	EQULIBIRUM MOISTURE (%) 7.98	
% Sulfate 0.01	% Total 1.92		

Coke and fly ash after the SOFC reaction in the reactor

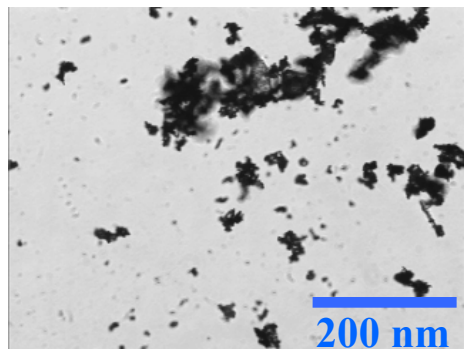




Coke before reaction

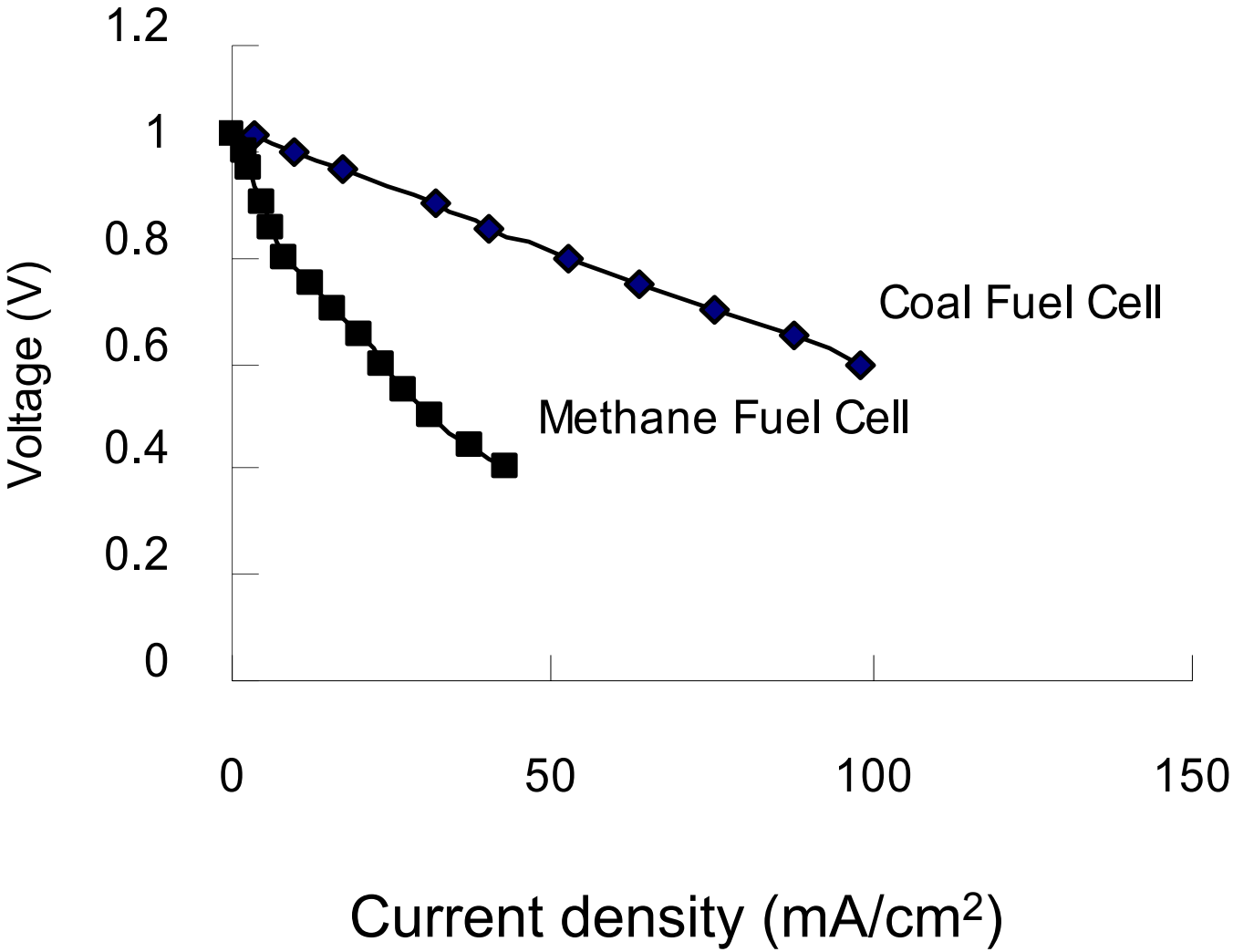


Coke after reaction



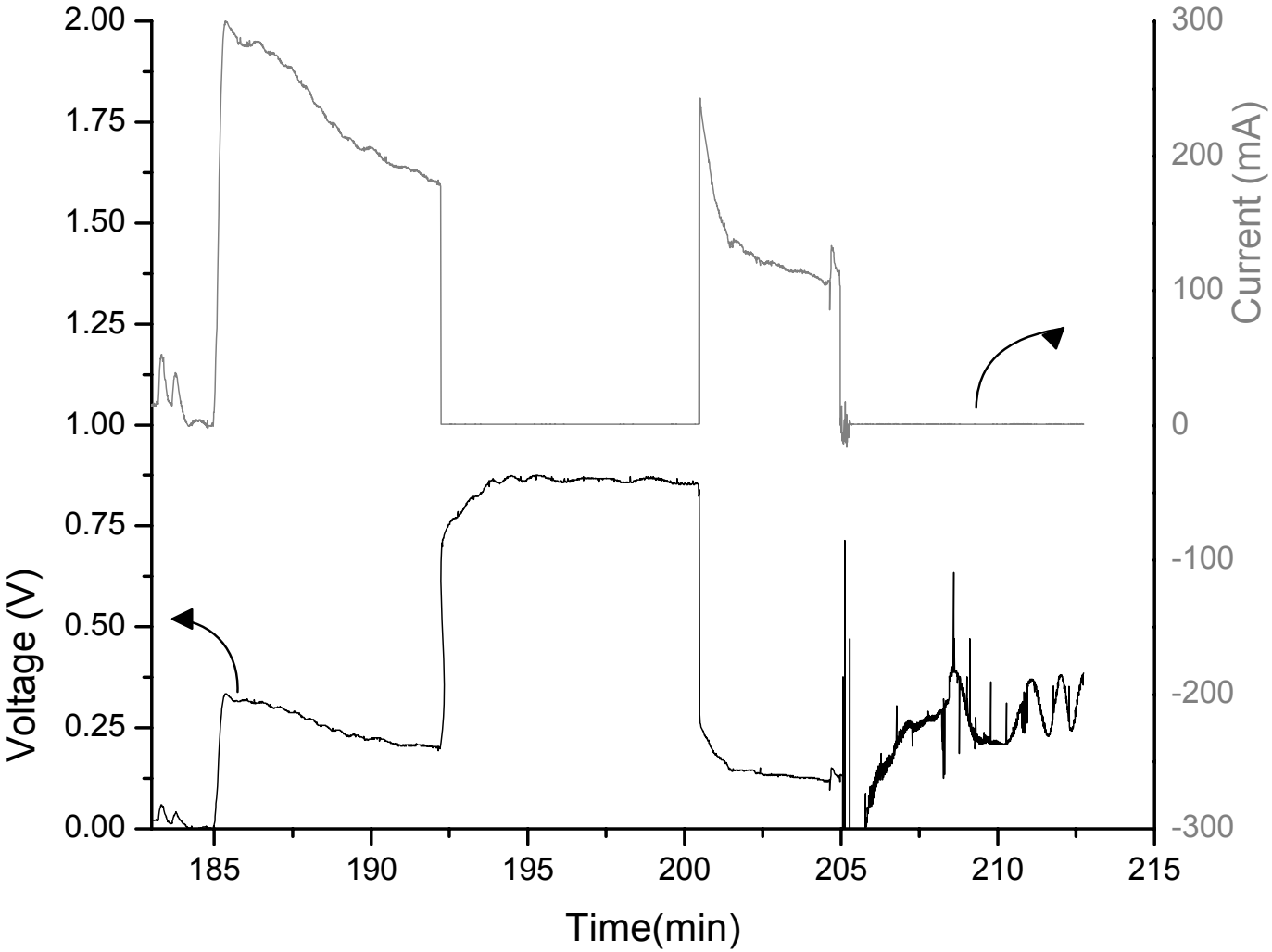
Fly ash after reaction

Comparison of IV curves for Cu Anode SOFC at 900 °C



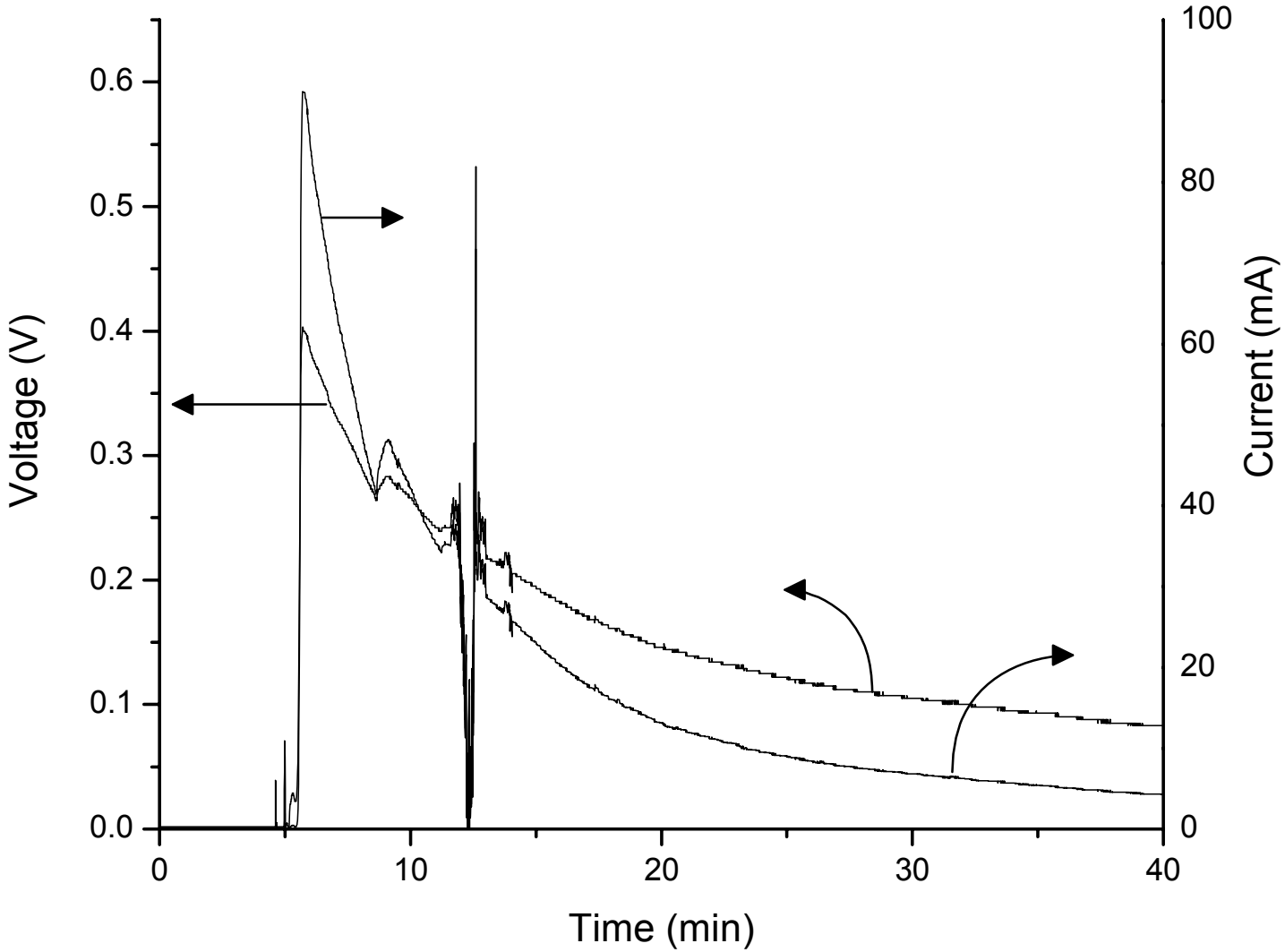
"Coal-based Fuel Cell," S. S. C. Chuang, PCT Int. Appl. (2006) (i.e., European Patent Application), 35 pp. CODEN: PIXXD2 WO 2006028502 A2 20060316; U.S. Patent Application; India Patent Application.

Fuel cell performance at 800 ^{o}C
Anode: oxide; Fuel: 3 g of Ohio No. 5 coal

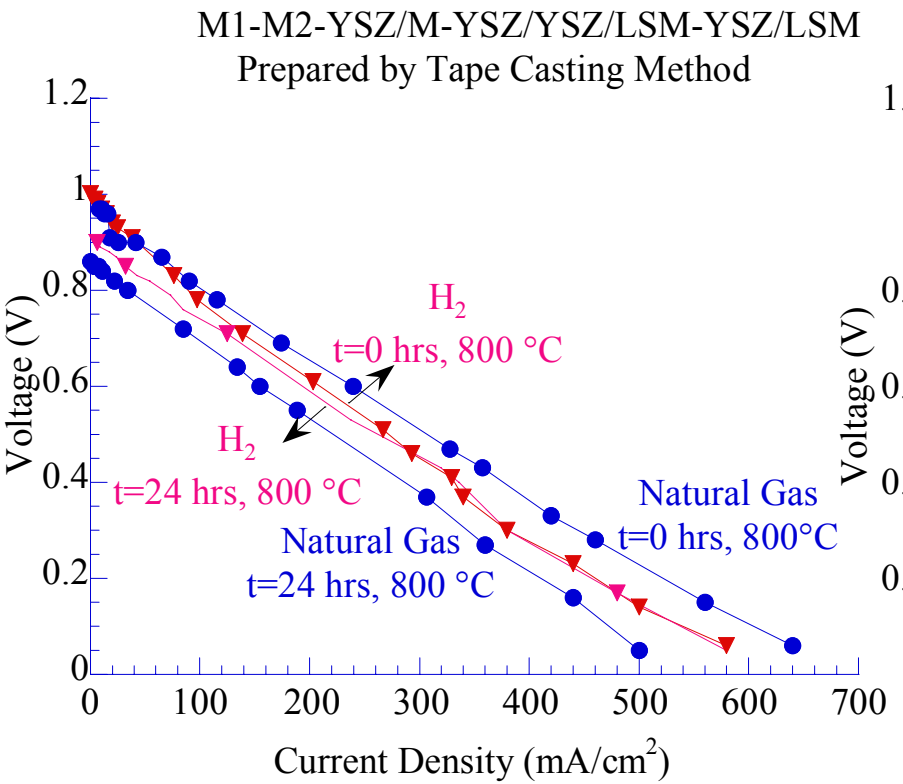


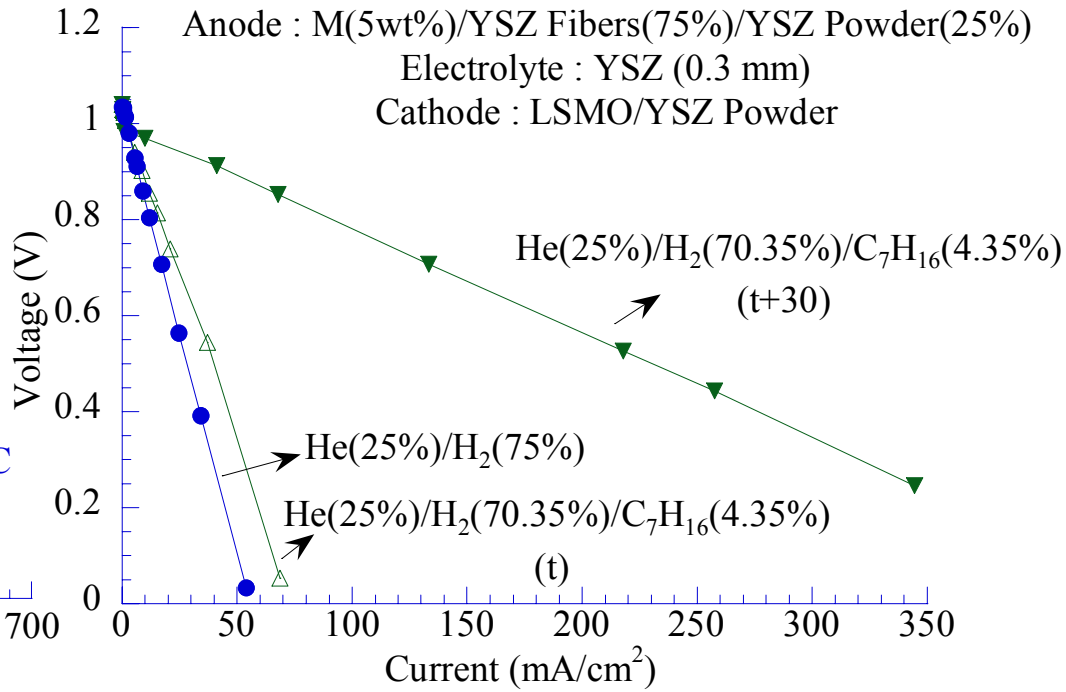
Fuel cell performance at 750 ^{o}C

Anode: oxide, Fuel: 0.5 g of Ohio No. 5 Coal



SOFC Performance





- Stable, Sulfur tolerant and Carbon resistant catalyst
- Novel method to deposit the metal on anode

- Formation of carbon fiber network by metal catalyzed reforming of heptane improved the current collection ability.

Future Work

- Selection and testing of low cost interconnect materials for the coal-based fuel cell.
- Investigation of the design factors for the coal injection and fly ash removal systems.
- Design, fabrication, and test of a small scale coal fuel cell system
- key milestones:
  - Identification and successful development of an interconnects which cost less 50% of the present interconnects.
  - Development of a fundamental understanding of the migration of the fly ash particles on the anode catalyst surface.
  - Design and fabrication of a lab-scale of the coal fuel cell system.

Summary 1

- Relevance: Development of an effective anode catalyst to catalyze the electrochemical oxidation of coal/coke at 750 ^{o}C will allow the use of low cost materials for the construction of the fuel cell system.
- Approach: Identification and test of the low cost anode catalysts, interconnect, fuel cell housing materials for the design and fabrication of the coal fuel cell system.

Summary:2

- Technical Achievements:
  - 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 ^{o}C.
  - Technique for the fabrication of the fuel cell with a diameter greater than 1 inch has been developed.
- Technology Transfer/Collaboration:
  - Patent applications in progress
  - Collaboration with the Ohio Coal Development Office
- Proposed Future Research:
  - Development of low cost interconnects.
  - Determination of the key factors controlling the removal of fly ash.
  - Design, fabrication, and test of a small scale coal fuel cell system