

**OHIO COAL DEVELOPMENT OFFICE
ANNUAL PROJECT ABSTRACT
AS OF DECEMBER 2004**

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5. **PROJECT TITLE:** Coal-based Fuel Cell _____
6. **PROJECT TERM FROM:** Sept. 1, 2004 **TO:** Aug. 31, 2005
7. **PROJECT UPDATE** X --OR-- **FINAL REPORT** _____
8. **BUDGET:**
- | <u>CO-SPONSOR'S NAME</u> | <u>COST-SHARE</u> |
|-----------------------------|-------------------|
| OCDO | \$ <u>80,000</u> |
| The University of Akron | \$ <u>26,670</u> |
| TOTAL PROJECT VALUE: | \$ <u>106,670</u> |

ABSTRACT

9. **OVERVIEW OF PROJECT & OBJECTIVES:**

The direct use of coal in the solid oxide fuel cell to generate electricity is an innovative concept for electric power generation. The C-fuel cell (coal-based fuel cell) could offer significant advantages: (i) minimization of NO_x emission due to its operating temperature range of 700 – 1000 °C, (ii) high overall efficiency because of the direct conversion of coal to electricity and CO₂, (iii) the production of a nearly pure CO₂ exhaust stream for the direct CO₂ sequestration, and (iv) low maintenance cost due to the simplicity of the process. Our study has demonstrated that fly ash produced from coal did not adhere to the anode catalyst surface, suggesting that the electrochemical oxidation of coal is technically feasible in the solid oxide fuel cells. The objective of this study is to develop highly active catalysts and novel fabrication processes for C-fuel cell. The performance of this C-fuel cell will be determined by measuring the voltage

output and current density as a function of temperature, time, and anode catalyst composition.

10. WORK TO DATE & CONCLUSIONS:

- The initial study has demonstrated that fly ash produced from coal did not adhere to the anode catalyst surface and sulfur compound in coal did not poison the anode catalyst, suggesting that the electrochemical oxidation of coal to produce electricity and pure CO₂ is technically feasible in the solid oxide fuel cells.
- The current density increased in the order: coke < coke/H₂ < coke/H₂/C₇H₁₆ over a Ni anode catalyst. It is interesting to note that a significant current density was improved as the time-on-stream for C₇H₁₆ increased. One hypothesis for such an increase is that carbon fibers may be formed on the Ni catalyst surface, creating a carbon network linking the Ni catalyst particles, resulting in an increase in current density. This study shows that Ni currently used in the solid oxide fuel cell with H₂ as the fuel requires further modification to serve as an effective anode catalyst for the C-fuel cell.

11. PLANS FOR COMING YEAR:

- Characterization of the anode and cathode catalysts on the used SOFC. The goal is to determine the relationship between the state and suggesting that the electrochemical oxidation of coal is technically feasible in the solid oxide fuel cells micro-structure of the anode/cathode and their performance.
- Determination of Ni and promoted-Ni performance using identical electrolytes and cathodes.
- Test the performance of SDC (Samarium-doped-ceria, Sm_{0.2}Ce_{0.8}O_{1.9}) and GDC (Gadolinia-doped Ceria, GDC) fuel cell. SDC and GDC are low temperature electrolytes which may improve the fuel cell performance.

12. HIGHLIGHTS/ACCOMPLISHMENTS:

- Successful demonstration of power generation for the direct oxidation of coal in the solid oxide fuel cells.
- Successful fabrication of SDC (Samarium-doped-ceria, Sm_{0.2}Ce_{0.8}O_{1.9}) and GDC (Gadolinia-doped Ceria, GDC) electrolyte disks.

13. ARTICLES/PRESENTATIONS:

1. "Catalysis of Solid Oxide Fuel Cell," Steven S. C. Chuang, Catalysis: Volume 17 Series: Specialist Periodical Reports, Ed. J. J. Spivey, Vol. 18, pp 186-198, Royal Society of Chemistry, Cambridge, U.K., 2005.
2. "Coal-based Fuel Cell," Ohio Fuel Cell Coalition, Dec. 8, 2004.
3. "Catalysis of Solid Oxide Fuel Cells," National Central University, Chungli, Taiwan, Dec. 27, 2004.