TITLE:	MATERIALS SYSTEM FOR INTERMEDIATE EMPERATURE SOLID OXIDE FUEL CELL
AUTHORS:	Uday B. Pal and Srikanth Gopalan
STUDENTS:	Wenquan Gong
INSTITUITION:	Department of Manufacturing Engineering 15 St. Mary's Street Boston University, MA 02446
PHONE NO.:	(617) 353 7708
FAX NO.:	(617) 353 5548
E-MAIL.:	upal@bu.edu
GRANT NO.:	DE-FG26-02NG41539
PERIOD OF PERFORMANCE.:	September, 2002 – March, 2004
DATE.:	March 30, 2004

1. ABSTRACT

Objectives

The objective of the proposed research is to investigate a materials system for intermediate temperature solid oxide fuel cell that is capable of operating between 500-700^{0}C with a power density greater than 0.6W/cm^2 at 0.7V. The electrolyte, anode, and cathode materials in the SOFC system being investigated are based on lanthanum gallate ($La_{1-x}Sr_xGa_{1-y}Mg_yO_{3-\delta}$ or LSGM), nickel-ceria ($Ce_{0.9}Y_{0.1}O_{2-x}$) cermet, and LSGM-lanthanum cobaltite ($La_{0.8}Sr_{0.2}CoO_3$, or LSC) composite, respectively. These material choices are based on their property information available in the literature.

Accomplishments to Date

Interfacial polarizations of the candidate electrodes for the $La_{0.9}Sr_{0.1}Ga_{0.8}Mg_{0.2}O_3$ (LSGM) electrolyte have been investigated by Impedance spectroscopy technique. Among the cathode materials (LSM ($La_{0.85}Sr_{0.15}MnO_3$), LSM-LSGM and $La_{1-x}Sr_xCo_yFe_{1-y}O_3$ (LSCF)), the pure LSM electrode had the worst polarization performance. The addition of LSGM electrolyte material to the LSM electrode increases the mixed-conducting boundary with the gas phase and lowers the overall polarization. Although LSM-LSGM composite electrodes are better than just pure LSM, the performance of the best LSM-LSGM (40:60) electrode was similar to that of platinum.

Single-phase mixed-conducting LSCF electrode had three orders lower polarization resistance than the LSM-LSGM composite electrodes. Addition of LSGM to LSCF did not significantly alter (lower) the polarization resistance of the LSCF electrodes. However, a composite LSCF-LSGM (40:60 by volume) electrode is preferred over plain LSCF electrode in order to match the coefficient of thermal expansion with the LSGM electrolyte and reduce the residual stresses. It is also observed that the interfacial polarization resistance of the LSCF electrode decreased asymptotically as the electrode thickness is increased. However, it is anticipated that above a certain electrode thickness mass-transfer polarization will start to dominate and increase the overall polarization. Therefore if the cathode is not used as a supporting electrode then it requires a certain minimum thickness (30-40 micrometers) with finer electrode porosity to lower the interfacial polarization.

The anode material investigated was Ni-Gadolinium doped Ceria (Ni-GDC). It was observed that the LSGM electrolyte reacts with the Ni during processing and also at the operating temperature and increases the polarization resistance. A dense buffer layer of GDC between the LSGM electrolyte and the Ni-GDC composite anode prevents this interaction and a much lower electrode polarization is observed. It is important to keep the temperature below 1200 degree C during electrode sintering or firing otherwise there appears to be an interaction between the LSGM and the GDC buffer layer.

Future Work

Different methods of anode manufacture will be investigated. Effects of Ni-GDC anode composition, structure and thickness on interfacial polarization will also be investigated once the optimum anode manufacturing process is standardized. After determining the optimum electrode composition, structure and thickness of the cathode and the anode, complete anode-supported planer cells will be fabricated and evaluated in terms of its I-V characteristics and stability.

List of Paper Published

1. Wenquan Gong, Srikanth Gopalan, and Uday B. Pal, “Cathodic Polarization Study on Doped Lanthanum Gallate Electrolyte Using Impedance Spectroscopy”, to be Published in the Journal of Electro Ceramics.
2. Wenquan Gong, Srikanth Gopalan, and Uday B. Pal, “Polarization Study on Doped Lanthanum Gallate Electrolyte Using Impedance Spectroscopy”, to be Published in the Journal of Materials Engineering and Performance.

Conference Presentation

November 2003, "Polarization Studies on Intermediate Temperature Solid Oxide Fuel Cells Based on Lanthanum Gallate Electrolytes", ASM Fall Meeting, Pittsburgh, Pa.

Student Supported Under this Grant

Mr. Wenquan Gong