LSCF-CDZ Composite Cathodes for Improved SOFC Electrical Performance

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Overview

Solid Oxide Fuel Cells (SOFCs) use cathodes that must have very specific properties. These cathodes need to have high electrical conductivity and excellent catalytic activity for reducing oxygen. In addition, they must be compatible with other cell components in ways that no unwanted reactions occur and no significant mismatch occurs in the thermal expansion coefficients. For intermediate and low temperature SOFCs, lanthanum strontium cobalt ferrite (LSCF) cathodes are used with good performances mainly due to an increased catalytic activity for reducing oxygen. However, a GDC barrier layer needs to be used to prevent unwanted chemical reactions at the electrolyte interface. This poses a concern for long term operation of SOFC systems because this layer introduces additional interfaces where degradation may occur increasing the cell resistance. In addition, such layer adds more fabrication steps and increases cell fabrication cost. Researchers have shown that LSCF-CDZ mixture does not produce the unwanted $SrZrO_3$ compounds after sintering at 850°C. They further indicate that this mixture stabilizes the Sr^{2+} cations in LSCF and suppresses the mobility of strontium, and therefore prevents the reaction between LSCF and YSZ. However, these studies are limited to one composition and the mechanism of preventing Sr segregation in not fully explained. It is therefore the objective of this investigation to study different composition of CDZ in LSCF composite cathodes, and to determine the mechanism that prevents Sr segregation.

Objectives

The goals of this project is to advance SOFC cathodes by fabricating and studying composite LSCF-Ce-doped zirconia (LSCF-CDZ) ability to prevent Sr segregation in order to enhance the performance, reliability, robustness, and endurance of commercial SOFC systems. The proposed work is broken down into the following objectives:

1. Study composite cathodes made of LSCF and CDZ with different composition and determine Sr segregation prevention capabilities.
2. Determine the electrical performance improvements that results from preventing Sr segregation.
3. Determine the mechanism by which Sr segregation is prevented.

Methods

Composite cathodes made of LSCF and CDZ with different compositions will be fabricated, characterized, and electrically tested to determine and quantify cell electrical performance improvements. The new composite cathodes will be screen printed on commercially available anode supported bi-layers, and button cell testing will be performed followed by post-mortem analysis. In addition, a performance baseline will be established using Delphi's anode supported bi-layers and/or complete cells.

Potential impact and expected results

The proposed research is relevant with the stated objectives in the program announcement because it improves the SOFC electrical performance through cathode improvements. The project outcomes are the following:

- Comprehensive study of composite LSCF-CDZ cathodes.
- Determination of Sr segregation prevention capabilities.
- Determination of SOFC electrical performance due to the new composite cathodes.
- Determination of the mechanism of Sr segregation prevention.

The overall impact of this advanced composite cathode technology is that it will expedite the commercialization of SOFC systems because of improved cell reliability.

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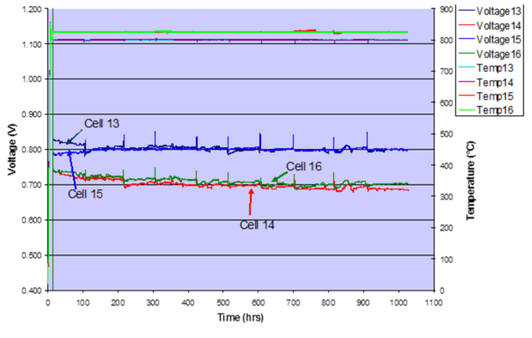
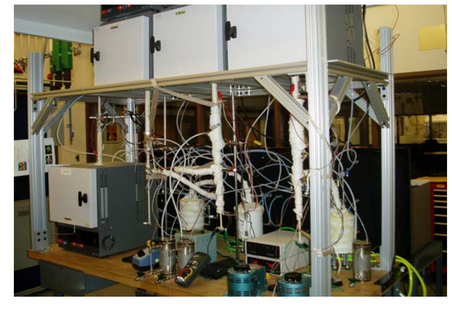
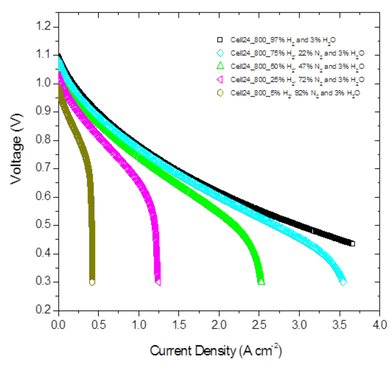
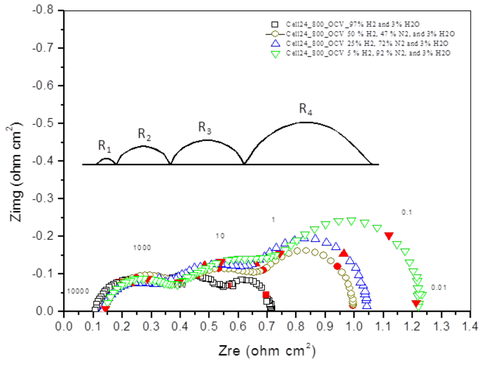
Facilities & Other Resources

- SOFC Research Lab
- Multi-button SOFC cell test station
- Arbin battery testing, PARSTAT 2273
- SEM/EDX, X-Ray Diffractometer
- X-Ray Photoelectron Spectroscopy
- High-resolution Transmission Electron Microscope (MRI pending)









Collaborators

- Rick Kerr (Delphi)
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- Xuan Zhou (Kettering)

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