Preparation and Evaluation of Multi-Layer Anodes of Solid Oxide Fuel Cell

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ABSTRACT

The development of an energy device with abundant energy generation, ultra-high specific power density, high stability and long life is critical for enabling longer missions and for reducing mission costs. Of all different types of fuel cells, the solid oxide fuel cells (SOFC) is a promising high temperature device that can generate electricity as a byproduct of a chemical reaction in a clean way and produce high quality heat that can be used for other purposes. For aerospace applications, a power-to-weight of 21.0 kW/kg is required. NASA has a patented fuel cell technology under development, capable of achieving the 1.0 kW/kg figure of merit. The first step toward achieving these goals is increasing anode durability. This catalyst plays an important role in the fuel cells for power generation, stability, efficiency and long life. Not only the anode composition, but its preparation and reduction key to achieving better cell performance. In this research, multi-layer anodes were prepared varying the chemistry of each layer to optimize the performance of the cells. Microstructure analyses were done to the new anodes before and after fuel cell operation. The cells’ durability and performance were evaluated in 200 hrs life tests in hydrogen at 850 ºC. The chemistry of the standard nickel anode was modified successfully reducing the anode degradation from 40% to 8.4% in 1000 hrs and returning its microstructure.

SOFC: MULTIPLE APPLICATIONS WITH SINGLE TECHNOLOGY

Solid oxide fuel cell is a high temperature (700 – 1000 ºC) ceramic fuel cell that generates energy from an electrochemical reaction.

SOFC Advantages:
- High efficiency
- High energy density
- Flexible fuel capability
- Low temperature operation
- Hydrogen and hydrocarbon fuels

SOFC Disadvantages:
- High temperature operation
- Lower power density than PEM
- Cost effective only at larger scales

Fuel Cell Mode
- Electrolysis Mode
- Power Generation

Space Applications
- Power Generation Using Methane-Generated by In-Situ Resource Utilization
- Power Generation for Space Vehicles and Lunar Habitats with Methane/Oxygen Propulsion System

Bi-Electrode-Supported Cells
- Advantages of BSC:
  - The cell is structurally symmetric with both electrodes supporting the two electrolytes.  
  - Electrodes containing microchannels for gas diffusion.
  - Both low volume and low weight, ideal for small, lightweight applications.
  - Ceramic design ensures at least 100 times the thermal conductance to ceramic seals.
  - BSC design has the potential to improve the power density. Si, three times state of the art.

Ceramic Interconnects
- Removal of Metal Interconnect
- NASA BSC-SOFC enables rapid prototyping of electrode chemistries and microstructures for O2, pump or other novel applications.