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. Off 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. The 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 are 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 catalysts in order to achieve 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 catalysts in order to achieve better cell performance.

SOFC: MULTIPLE APPLICATIONS WITH SINGLE TECHNOLOGY

Solid oxide fuel cell is a high temperature (700 – 1000 °C) ceramic fuel cell that generates energy from an electrochemical reaction. The high temperature reduces the cost of electrical energy generation due to the improved fuel efficiency. In addition, the generated energy can be used for other purposes as well. These characteristics make SOFC a promising technology for various applications such as power generation, transport and aerospace. SOFC Advantages: High efficiency, high energy density, flexible fuel reaction (energy/enthalpy), and high and hydrothermal stability.

FUEL CELL DURABILITY TESTS

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Fuel Cell Durability Tests

The SOFC consists of a solid oxide electrolyte (SOE) sandwiched between two electrodes: the anode and the cathode. The performance and stability of the SOFC are highly dependent on the durability of the anode in the SOFC. The ASR (Anode Surface Reactivity) from the starting sample was degraded for all fuel cells. The test was unexpectedly interrupted at day 7. After the removal of the cell, it was observed that the ASR from the starting sample had a 40.7 % degradation for day 9. The durability test was done for 200 hrs and the percent of degradation at day 9 was 8.4 %.

CONCLUSIONS

The performance and stability tests and the SEM analysis confirms the importance of not only the electrode material but also the electrode preparation process on the performance and especially the long term stability of the fuel cells. The fuel cells Ni/SDC Red have better stability than the fuel cells of Ni Standard. According to the data, the performance and stability tests can be used to compare the performance and stability of the fuel cells. The data also indicates that the fuel cells Ni/SDC Red show a good performance and stability. The results of the tests show that the fuel cells Ni/SDC Red have a better performance and stability than the fuel cells Ni Standard.

CURRENT AND FUTURE WORK

• Ni anodes reduced at higher temperatures, currently being tested, demonstrate better performance and stability.
• New anodes will be created alternating the layers of nickel, magnesium and SDC and in the hopes that this will reduce the degradation and increase the lifetime of the fuel cells.
• Different compositions of nickel and magnesium will be studied for the optimization. The reduction temperature will also be increased for the cells.
• The study of other compositions also is expected.

SEM ANALYSIS

The SEM analysis of the fuel cells Ni/SDC Red shows a good coating of the layer electrode materials on the reduced catalysts. The SEM study confirms that the fuel cells Ni/SDC Red show a good coating of the layer electrode materials on the reduced catalysts. The SEM study confirms that the fuel cells Ni/SDC Red show a good coating of the layer electrode materials on the reduced catalysts.