Mechanical Engineering Thesis Defense

Fabrication of Solid Oxide Fuel Cells and the Effects of Linear Siloxane Deposition on Cell Performance

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Abstract

Biogas's potential as a renewable fuel source has been an area of increased research in recent years. One issue preventing wide-spread use of biogas as a fuel is the trace amounts of impurities that damage fuel-burning equipment by depositing silicon, sulfur, calcium and other elements on their surface. This study aims to analyze the effects of a high concentration of L4 linear siloxane on solid oxide fuel cell performance until failure occurs. L4 siloxane has not been extensively researched previously, and this investigation aims to provide new data to support similar, though slower, degradation compared to D4, D5 and other siloxanes in solid oxide fuel cells. The experiments were conducted inside a furnace heated to 800°C with an Ni-YSZ-supported (Nickel-yttria-stabilized zirconia) fuel cell. A fuel source with a flow rate of 20 mL/min of hydrogen gas, 10 mL/min of nitrogen gas and 0.15 mL/min of L4 siloxane was used. Air was supplied to the cathode. The effects of siloxane deposition on cell voltage and power density degradation and resistance increase were studied by using techniques like the current-voltage method, electrochemical impedance spectroscopy, and gas chromatography. The results of the experiment after reduction show roughly constant degradation of 8.35 mV/hr, followed after approximately 8 hours by an increasing degradation until cell failure of 130.45 mV/hr. The initial degradation and stagnation match previous research in siloxane deposition on SOFCs, but the sharp decline to failure does not. A mechanism for solid oxide fuel cell failure is proposed based on the data.

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