DIRECT METHANE OXIDATION IN MICRO-TUBULAR SOFCs USING DOPED $LaGaO_3$ ELECTROLYTE

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Micro-tubular Solid Oxide Fuel Cells (SOFC) based on yttria-stabilized zirconia (YSZ) have several advantages over other SOFC designs (1,2) and in this study the same concept has been applied to doped-lanthanum gallate (LSGM) electrolytes. Hydrogen has been traditionally used as a SOFC fuel and currently most of the fuel cell applications make use of an external reformer. Its been shown that direct oxidation of hydrocarbon fuels (e.g., methane) would eliminate the need for use of such external reformers but, results have shown that carbon deposition occurs when conventional Ni-YSZ is used as the anode material. However, the use of doped-ceria in the SOFC anode can potentially overcome this problem.

This paper follows the work of Du and Sammes (3) on the fabrication and performance of a $LaGaO_3$-based micro-tubular SOFC. In this study, commercially available $La_{0.8}Sr_{0.2}Ga_{0.8}Mg_{0.2}O_{2.8}$ was used as an electrolyte material while the anode and cathode materials were doped-ceria based and $La_{0.6}Sr_{0.4}CoO_3$, respectively. The electrical performance of the fuel cells was tested using a furnace test station setup as shown in Fig. 1. Dry methane, methane/oxygen (fuel/oxygen ratio of 3:1) and hydrogen were the different fuels that were used for comparison.

Typical V-I and P-I characteristic of a single cell running on different fuels measured in this study at 900^{o}C are shown in Figs. 2 and 3, respectively. Dry methane gave a maximum power density of 282.5 mW/cm^2 at a current density of 565 mA/cm^2, while that of hydrogen was observed to be 308 mW/cm^2 corresponding to a current density of 616 mA/cm^2. The methane/oxygen (ratio 3:1) gave comparable performance to that of hydrogen. This work is in agreement with the earlier work performed by Kendall et al. (4) in a zirconia based micro-tubular SOFC, who has shown that for such a fuel cell configuration there is no surface carbon formation, which was observed in a post reaction TPO.

These initial results are encouraging and show a way of utilizing readily available hydrocarbon fuels for intermediate temperature (650-800^{o}C) operation of SOFCs. The next step of this study would be to carry out similar experiments on different compositions of the LSGM electrolyte and to look for compatible anode materials.

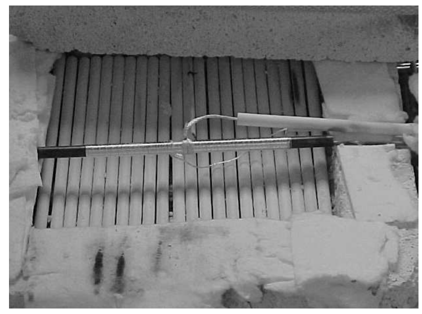

Figure.1. Furnace Test Station Setup.

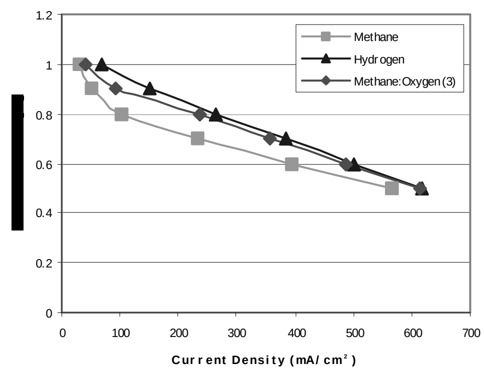

Figure. 2. V-I curves for a LSGM-based micro-tubular SOFC with a NiO/SDC/YSZ anode running on different fuels at 900^{o}C.

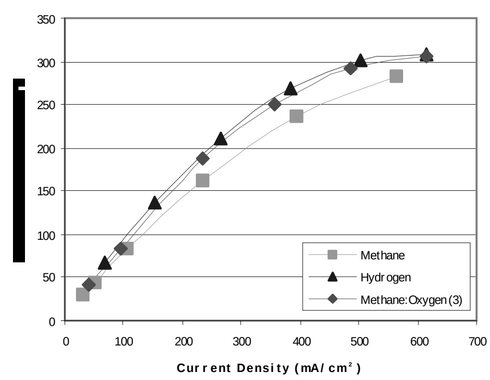

Figure. 3. P-I curves for a LSGM-based micro-tubular SOFC with a NiO/SDC/YSZ anode running on different fuels at 900^{o}C.

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