The Effect of Fabrication Technique on Direct Methanol Fuel Cells Designed to Operate at Low Airflow.

T. I. Valdez and S.R. Narayan

Jet Propulsion Laboratory,
California Institute of Technology,
4800 Oak Grove Drive, Pasadena, CA 91109

Introduction

Direct Methanol Fuel Cell (DMFC) technology has matured to a level that has allowed complete fuel cell systems to be fabricated [1]. The airflow at which DMFCs operate for a given power level has been shown to control the fuel cell system water balance [2,3]. It has been shown that the phenomenon of crossover is a process that increases the airflow a DMFC requires to operate [4]. Thus, a solution to minimizing the airflow required for a DMFC to operate is in curbing the effects of crossover. This paper will present the effects of anode and cathode ink constituents on curbing the effects of crossover. Particular attention was focused on increasing the overall cell efficiency.

Experimental

Several membrane electrode assemblies (MEAs) have been fabricated by variants of the Jet Propulsion Laboratory Direct Deposit Technique [5]. Each of these MEA consists of a Pt-Ru-Black (50:50) anode and Pt-Black cathode. Catalyst used for these MEAs was purchased from Johnson Matthey. Nafion was used as the MEA electrolyte. VI polarization, anode polarization, and crossover experiments where used to determine the impact of airflow and crossover on MEAs with varying catalyst constituents.

Results and Discussion

The effect of airflow on cathode performance for a DMFC operating at 60 °C, 0.5M MeOH is shown as figure 1. Minimal variation in the IRC cathode potential for airflow greater than 0.15 LPM at an applied current density of 100 mA/cm^2 is observed.

The effect of DMFC fabrication technique on cell efficiency can be seen in figure 2. A DMFC peak efficiency of 28.9% and power density of 55.7 mW/cm^2 can be obtained at 60 °C, 0.1 LPM airflow. This is an 8% increase in peak efficiency and a 13% increase in power density over previous low airflow cell designs.

As shown in figure 3., the incorporation of hydrous RuO_2 in the anode shows promise in obtaining similar anode performance at reduced catalyst loadings. Preliminary results show that RuO_2 is effective at lowering the total cell resistance and in increasing the over all cell efficiency.

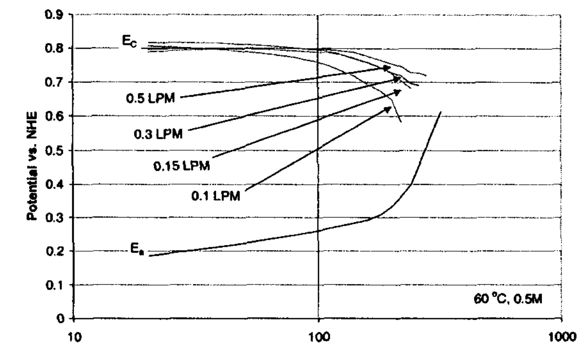

Figure 1. Cathode performance as a function of airflow and applied current density for a DMFC.

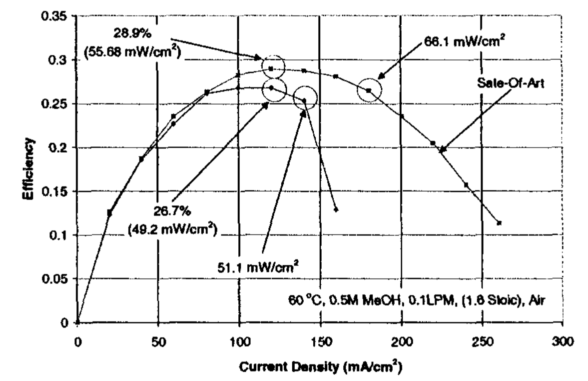

Figure 2. Cell efficiency as a function of applied current density for typical and state-of-art DMFC.

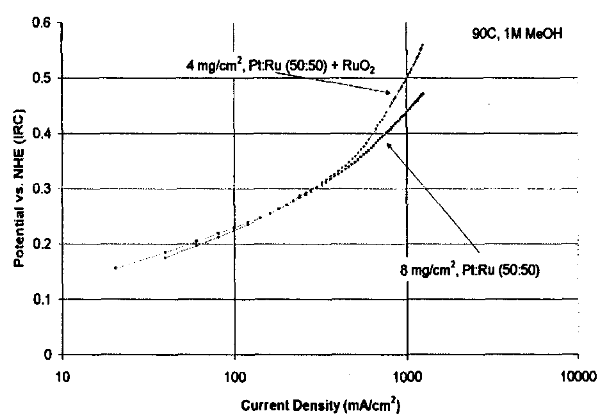

Figure 3. IRC Anode potential as a function of applied current density for a DMFC with and without Hydrous RuO_2.

References

1-Kindler, A., T.I. Valdez, Proceedings of Direct Methanol Fuel Cells, ECS Proceeding Series, Pennington, NJ. 1998 pg. 380 –387
2-Narayanan, S.R., Proceedings of Proton Conducting Membrane Fuel Cells II, ECS Proceeding Series, Pennington, NJ. 1998 pg. 316 –326
3-Valdez, T.I., Proceedings of the 11th annual Battery Conference on Applications and Advances, Long Beach, CA., Jan 9-12, 1997. IEEE pg. 239 - 244
4-Valdez, T.I., Proceedings of Proton Conducting Membrane Fuel Cells II, ECS Proceeding Series, Pennington, NJ. 1998 pg. 380 –387
5- Narayanan *etal*, US Patent Number #