Characterization of Catalysts and Membrane in DMFC Lifetime Testing

Xuan Cheng, Cheng Peng, Ling Chen*, Ying Zhang*

Department of Chemistry, State Key Laboratory for Physical Chemistry of Solid Surfaces
*Department of Materials Science & Engineering
Xiamen University, China

and
Qinbai Fan

Gas Technology Institute, Des Plaines, IL 60018, USA

The main problems associated with the commercialization of direct methanol fuel cells (DMFC) include the low efficiency of anode catalyst and methanol cross over. Much attention has been paid and extensive works have been done in these areas. Another important issue, which is less studied, is the performance and stability of a cell after a long-term operation. This work was extended to investigate the lifetime performance of a DMFC from the previous study in a hydrogen-air proton exchange membrane fuel cell (PEMFC).[1] The lifetime tests of a DMFC single cell were carried out at 60°C with the anode feed of 0.5 M methanol at 1 ml/min and with the cathode feed of air at 0.1 MPa and at 300 ml/min. The cell polarization and performance curves were obtained during the different stages of DMFC single cell operation. As illustrated in Figure 1, significant degradation in cell performance occurred after 200-h operation; while only slight degradation occurred when the cell was operated between 200-h and 700-h. However, an apparent degradation was seen after 1000-h operation. The catalysts and membrane from the lifetime tested membrane electrode assembly (MEA) were carefully examined by XRD, SEM/EDX, TEM and Raman techniques. The increase in mean particle sizes of both anode and cathode catalysts after the DMFC lifetime testing was observed, which is consistent with the results reported previously from a PEMFC.[1]

In addition, the electrocatalytic behavior of catalysts in 0.5 M methanol and sulfuric acid solution at different temperatures was studied by cyclic voltammetry and chronoamperometry. The physical aging of different Nafion® membranes was also probed by measuring their glass transition temperature and ionic conductivity. The effects of microstructure, electrocatalytic activity, surface composition of catalysts and effect of physical aging of Nafion® membrane on the lifetime and performance of cell are discussed based on the experimental results obtained from the DMFC and PEMFC lifetime tests.

References

1. Cheng X., Chen L., Peng C., Chen Z. W., Zhang Y., and Fan Q. B., 2004, "Catalyst Microstructure Examination of PEMFC Membrane Electrode Assemblies vs. Time," *Journal of Electrochemical Society*, **151**(1): A48-52

Acknowledgements

The authors wish to thank the Gas Technology Institute, USA, and the National Natural Science Foundation of China under the Grant Number 20073036 for the financial support of this work.

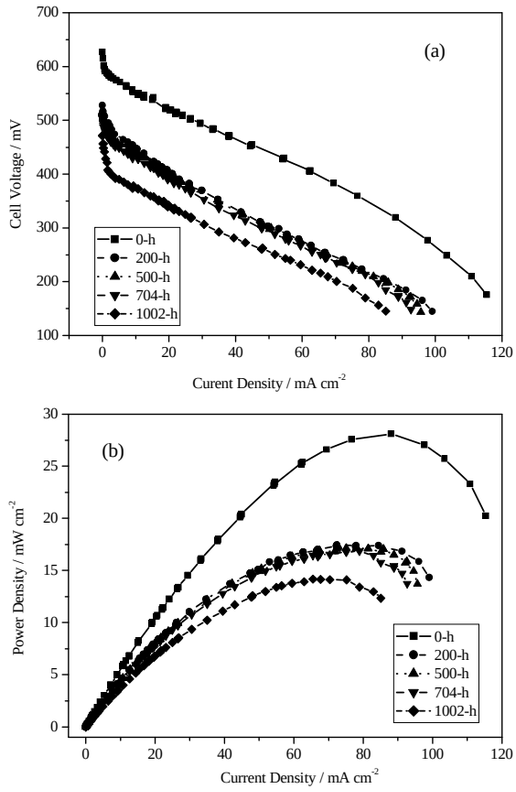

Figure 1. Polarization and performance curves obtained during different stages of a DMFC single cell operation.