Influence of Ionomer Content in the Cathode Catalyst Layer on the Performance ef PEM Fuel Cells

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In order to reduce the loading level of precious metal catalysts and improve the performance of polymer electrolyte membrane fuel cells (PEFC), thin composite electrode catalyst layers developed at Los Alamos National Laboratory (LANL)[1] have been utilized in much of the recent work involving both hydrogen and direct methanol polymer electrolyte fuel cells. These composites consist of Nafion ionomer, and nanoparticle platinum catalyst supported on microparticle carbon. The Nafion polymer plays a vital role in determining the performance of a PEFC electrode because it serves both as a binder and as a proton conductor. Thus, sufficient Nafion in a catalyst layer can ensure the integrity of the electrode structure and good proton conductivity. On the other hand, excessive recast Nafion in a catalyst layer may result in hindrance of oxygen access to the catalytic sites and blocking of water dissipation. Therefore, the effective kinetics of the oxygen reduction, the proton conductivity and water dissipation all change with the ionomer content.

To study the effect of ionomer content on a cathode of PEFC, a series of membrane electrode assemblies (MEA) with different Nafion content in the composite cathodes was prepared. The electrochemical active areas of each cathode were measured by *in situ* cyclic voltammetry. Cathode electrochemical performance was determined from polarization curves of the MEAs. The cathode porosity was studied by mercury porosimetry and the structure of the cathodes was examined by both scanning electron microscopy (SEM) and atomic force microscopy (AFM).

Preliminary results show that the effective kinetics of the oxygen reduction reaction vary with ionomer content, which can be seen from the change of slope of the polarization curves of different cathodes. The porosimetric study of the catalyst layer reveals that the porosimetric profile (i.e. porosity, pore distribution, pore population, etc.) changes not only with ionomer content but also with different catalysts. This therefore suggests that application of catalyst to the carbon support alters the surface properties of the support, and different catalysts or different catalyst loading processes alter the carbon support differently. It was also concluded from the porosimetric study and confirmed by SEM that the boiling process, in which a cathode after hot pressing is boiled in sulfuric acid and deionized water successively, greatly increases the porosity of the cathodes.

Acknowledgments

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References

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