Measurement of Peroxide Diffusivity in Polymer Films

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Hydrogen peroxide is an undesired product in the polymer electrolyte fuel cell (PEMFC). It is produced via the two electron electrochemical reduction of oxygen, which is a parasitic side reaction of the four electron process that completes the cell. The study of hydrogen peroxide in the PEMFC environment is of specific interest because it is believed to have degrading effects on cell components such as the membrane and bipolar plates. The kinetics of production and degradation under acidic conditions, such as the PEMFC environment, are not well understood. Also, the transport of hydrogen peroxide in the polymer is of significant interest. The diffusivity of hydrogen peroxide is of specific interest for comparison to its lifetime in order to determine its prevalence throughout a cell.

Electrochemical techniques were used to study the oxidation of dilute, acidic peroxide solutions. A limiting current dependence on the concentration of dilute hydrogen peroxide solutions at a Pt RDE motivated the investigation of the oxidation wave occurring between 1.2 and 0.80 V versus RHE. Measurements of the oxidation wave as a function of electrode rotation speed resulted in the measurement of a mass transport limited current, shown in figure 1, which was confirmed via the Levich relation.

The diffusivity of hydrogen peroxide produced is a critical parameter for cell design and current distribution modeling.The diffusivity discerned from the resulting straight line relationship in a Levich plot, figure 2, was used to quantify the transport of peroxide through a thin polymer film. This was accomplished by measuring the limiting current dependence of polymer filmed, Pt RDE on rotation speed. This limiting current is considered to depend on both transport of peroxide to and through the film. Thus, the relationship governing this dependence was used to extract the film diffusion coefficient of hydrogen peroxide.

The film diffusion coefficient for hydrogen peroxide is of considerable interest not only for determining its prevalence in a PEMFC, but also as a parameter for modeling a solvent-free model of cell operating conditions. A technique utilizing two planar microband electrodes to generate and collect hydrogen peroxide, in a thin polymer film, in an oxygen rich and solvent-free environment is being developed.

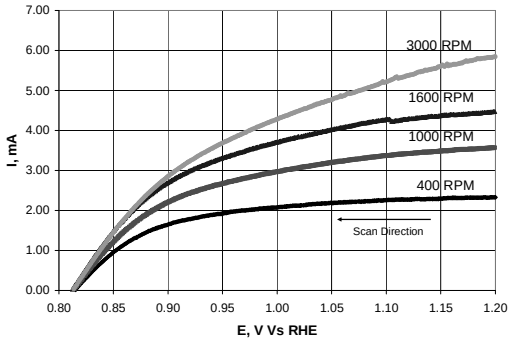

Figure 1. Anodic wave limiting current used to measure hydrogen peroxide diffusivity. Measured for 10mMol hydrogen peroxide on
0.5 *M* perchloric acid at 5 mV/sec/

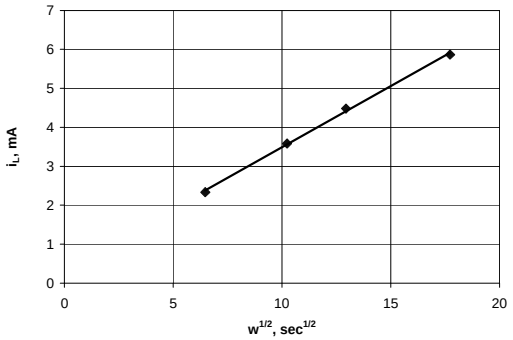

Figure 2. Levich plot for the mass transport controlled current exhibited for oxidation of hydrogen peroxide.

Acknowledgement
We gratefully acknowledge the financial support of the US DOE for this research.