A new polymer electrolyte electrochemical cell for measuring hydrogen permeation and diffusion in polymeric membranes tested on Nafion® and PDMS

B. Kienitz, H. Baskaran and T. A. Zawodzinski Jr.
Case Advanced Power Institute and Department of Chemical Engineering, Case Western Reserve University
Cleveland, OH 44106

Quantification of the rate of hydrogen gas transport through polymeric membranes has become increasingly important for applications in polymer electrolyte membrane fuel cells (PEMFC) and selective gas separators. Current methods of measuring hydrogen transport in these membranes are not accurate enough for measurements in small samples at low to moderate pressures. For this reason a new electrochemical cell for measuring hydrogen permeation and diffusion in polymeric membranes was fabricated and subsequently tested on Nafion® and PDMS samples. A particular advantage of this cell design is that it can be used to measure permeation through membranes without the necessity for making a membrane-electrode assembly and with excellent control of experimental conditions (e.g. membrane hydration).

The diffusion cell consists of a Nafion® 115 polymeric electrolyte membrane electrode assembly (MEA) separating two chambers. A voltage is applied to the MEA to create a hydrogen sink below the test sample. The MEA converts any hydrogen diffusing through the sample into protons and electrons which are subsequently counted using a potentiostat. The diffusion coefficient for the sample is then derived from the steady state current and time dependent current measured in the potentiostat by relating Fick's first law of diffusion to Faraday's law of electrolysis.

The cell was successfully tested on PDMS and Nafion® samples. Early results show that the diffusion coefficients for small polymeric samples of varying lengths can be accurately reproduced with less than 10% error. This cell could be used to accurately measure the hydrogen transport across a variety of small membranes. It could also be easily adapted to measure the transport of almost any electrochemically active species, such as oxygen or methanol, through these membranes.

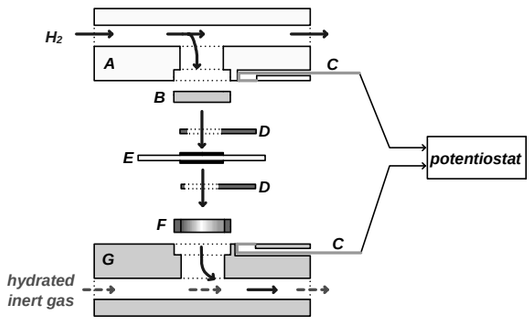

Figure 1. Exploded schematic of the diffusion cell. The filled arrows represent hydrogen flow and the dotted arrows represent inert gas flow. Hydrogen gas that diffuses across the test sample gets oxidized by the MEA and is counted by the potentiostat.

A	**Anode chamber**
B	**Test sample**
C	**electrical lead**
D	**Current collector**
E	**MEA**
F	**O-ring**
G	**Cathode chamber**

Acknowledgement

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