Low Pressure Liquid Extrusion Porosimetry for Determination of Pore Size Distribution in Gas Diffusion and Microporous Layers

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The gas diffusion layer (GDL) is a key component of PEM fuel cell electrodes. They are typically a carbon fiber-based porous material and usually have a microporous layer (MPL) applied to the catalyst layer side. The many roles of the GDL-MPL include removal of water from the cathode catalyst layer, facilitation of gas diffusion, and support of electronic and thermal conduction, all of which are strongly influenced by porous structure and pore size distribution. Currently pore size distribution in the GDL and MPL are determined using mercury intrusion porosimetry. This technique employs very high pressures (up to 4000 bar) in order to force mercury, a non-wetting fluid, into pores filled with air. (1) At such pressures, it is likely that the powder structure of the MPL is compressed, thereby decreasing the pore size and invalidating the measurement. In this work, a new technique was developed based on the displacement of a highly wetting fluid by gas. The wetting fluid used has a substantially lower surface tension than mercury, so drainage occurs at correspondingly lower pressure and pore compression is reduced.

The experimental setup is shown in figure 1. To begin, the system, sample and capillary barrier membrane are primed with the highly wetting fluid. The membrane is placed on the liquid distributor and the intermediate plate is then tightened onto the membrane. The sample is loaded into the cavity, and then the gasket and top plate are tightened. Capillary pressure is controlled by introducing nitrogen gas into the system. With each increase in pressure the mass of fluid displaced from the sample is recorded by an analytical balance. The pore volume invaded by nitrogen is determined from the density and the mass of fluid that was drained.

Figure 2 shows the results for two samples with and without an MPL. Both samples show the same expected behaviour as the larger pores in the GDL are drained at low pressure, followed by a plateau when the GDL pores are fully invaded. (2) The main difference is in the region where the much smaller MPL pores drain while the GDL with no MPL continues to plateau. At much higher pressures, another plateau is observed indicating the MPL has been emptied. One of the main challenges of this measurement has been finding a capillary barrier membrane with sufficiently small pores that allow the MPL pores to be drained without being breached itself.

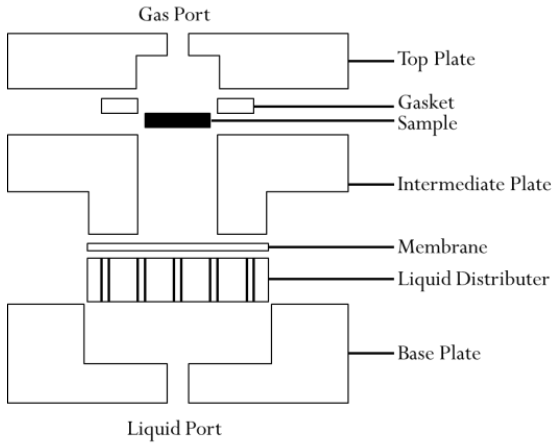

Figure 1: Experimental Setup

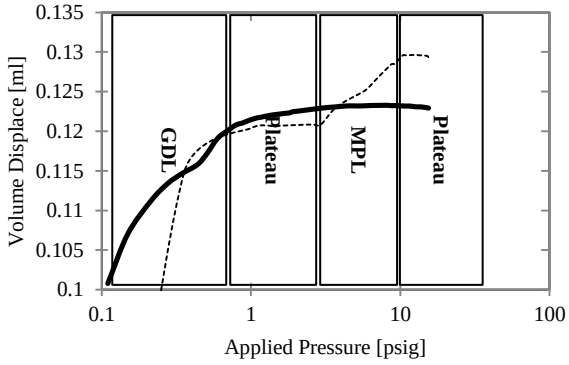

Figure 2: Volume versus Pressure for GDL sample (solid line) and sample with GDL and MPL (dashed line)

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REFERENCES

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