Ex-situ water saturation of PEMFC GDL materials

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Improvement of polymer electrolyte membrane fuel cells (PEMFCs) requires an in-depth understanding of the water transport mechanisms in the carbon fibre-based porous materials. These materials, known as the gas diffusion layers (GDLs), provide conductive electrical pathways for current collection. The fibrous microstructures also act as passages for water removal, which is necessary to prevent flooding and fuel starvation [1, 2]. Therefore, proper water management is the key to improving PEMFC performance. The current work explores the use of micro-computed tomography (micro-CT) to investigate water saturation of GDLs with different microstructures.

Using a previously designed millimeter-scale ex-situ apparatus designed to facilitate flow field compression [3], a GDL sample was injected with liquid water at a controlled flow rate from an opening with a 0.8 mm diameter. Figure 1 shows the components of the apparatus, which consists of a compression plate, a gasket, a GDL sample, and a back plate.

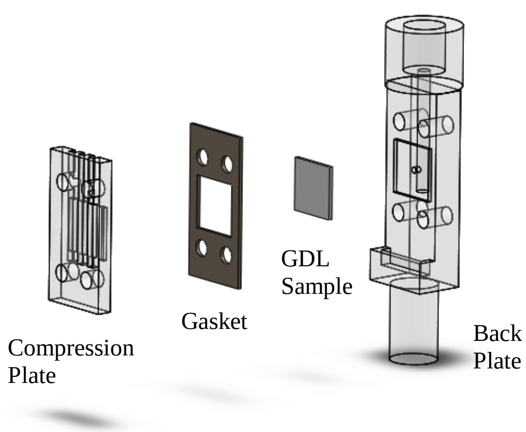

Figure 1. The components of the GDL water injection apparatus.

After liquid water breakthrough, the sample was scanned using micro-CT to obtain a high resolution, three-dimensional reconstruction. A scan was repeated after drying the GDL sample in an oven. Figures 2 and 3 show in-plane images of a paper GDL in the wet and dry states, respectively. Water was injected into the centre of GDL at a flow rate of 2 μL/min, representing a current density of 1.6 A/cm^2.

Image subtraction from the two sets of images (wet and dry) allowed liquid water patterns to be isolated within the fibrous GDL networks. Also, the effect of liquid water content on the through-plane porosity was determined. For this study, three different GDL microstructures were examined: paper (Toray), felt (Freudenberg), and cloth (AvCarb).

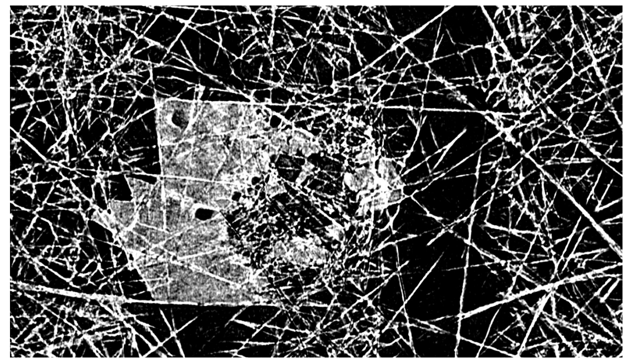

Figure 2. In-plane image of a paper GDL (Toray) after liquid water breakthrough (wet state).

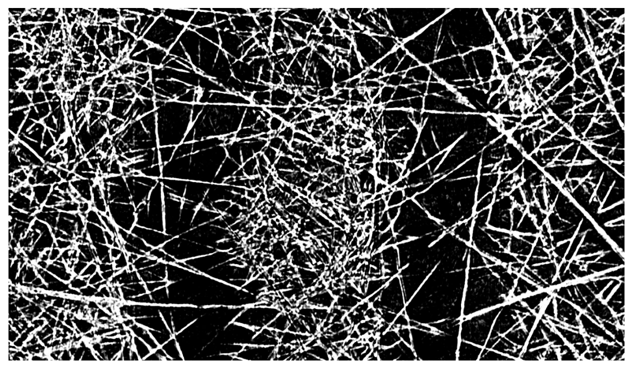

Figure 3. In-plane image of a paper GDL (Toray) in the dry state. This is the same GDL sample shown in Figure 2; both in-plane images were obtained at the same through-plane position.

References

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[2] Yang, X. G., Zhang, F. Y., Lubawy, A. L., 2004, "Visualization of liquid water transport in a PEFC," Electrochemical and Solid-State Letters, **7**(11) pp. A408-A411.

[3] Yip, R., Bazylak, A., 2012, "Investigation of liquid water content of a compressed PEMFC GDL using micro-computed tomography," Proceedings of the ASME 2012 10th Fuel Cell Science, Engineering and Technology Conference, July 23-26, 2012, San Diego, CA, USA.