Fuel Cell Electrode Analysis with Nano-scale X-ray Computed Tomography

Shawn Litster, William K. Epting, Pratiti Mandal
Department of Mechanical Engineering
Carnegie Mellon University
Pittsburgh, PA 15213

This presentation will report on our recent applications of nano-scale X-ray computed tomography (nano-CT) to analyzing polymer electrolyte fuel cells (PEFC) materials and the related transport processes. In particular, our work has focused on the cathode catalyst layers of PEFCs where the oxygen reduction reaction occurs. The cathode is commonly studied because of the costly, high platinum loadings necessary to achieve satisfactory PEFC performance.

The nano-CT we use in our research (UltraXRM-L200, Xradia, Inc., Pleasanton, CA) is capable of achieving 50 nm resolution with a 16 µm field of view. Three-dimensional X-ray CT imaging is based on capturing X-ray radiographs for a large number of incremental sample rotations and then computationally reconstructing the local X-ray attenuation within the sample. The high resolution of the lab scale nano-CT is obtained using an efficient capillary condenser lens and a high aspect ratio Fresnel zone plate objective. For enhanced resolution of samples with low contrast, such as carbon, the nano-CT uses a gold ring for phase contrast imaging. Since X-ray CT instruments are non-destructive and do not require a vacuum, they are amenable to transient, four dimensional imaging as well as in-situ and in-operando experiments.

Our previous reports on using nano-CT have included demonstrations of the imaging of carbon supported platinum catalyst layers as well as the quantification of porosity and pore and solid phase size distributions (1). Figure 1 shows an image of the three-dimensional internal pore structure of a catalyst layer. We have also used the nano-CT data to evaluate the effects of an agglomerate size distribution on the predictions of a commonly used agglomerate model for the catalyst layer (2). More recently, we have performed detailed computational simulations using the nano-CT data to extract diffusion and conduction correlations. The presentation will highlight these and other developments in using nano-CT to elucidate PEFC material morphology and transport phenomena.

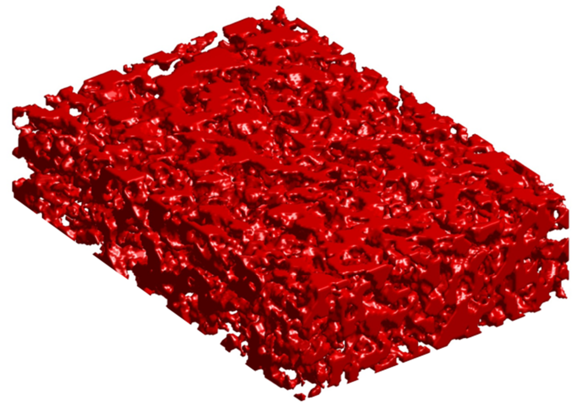

Figure 1: Pore structure of a PEFC catalyst layer from nano-CT imaging.

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References

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2. W. K. Epting and S. Litster, *International Journal of Hydrogen Energy*, **37**, 8505 (2012).