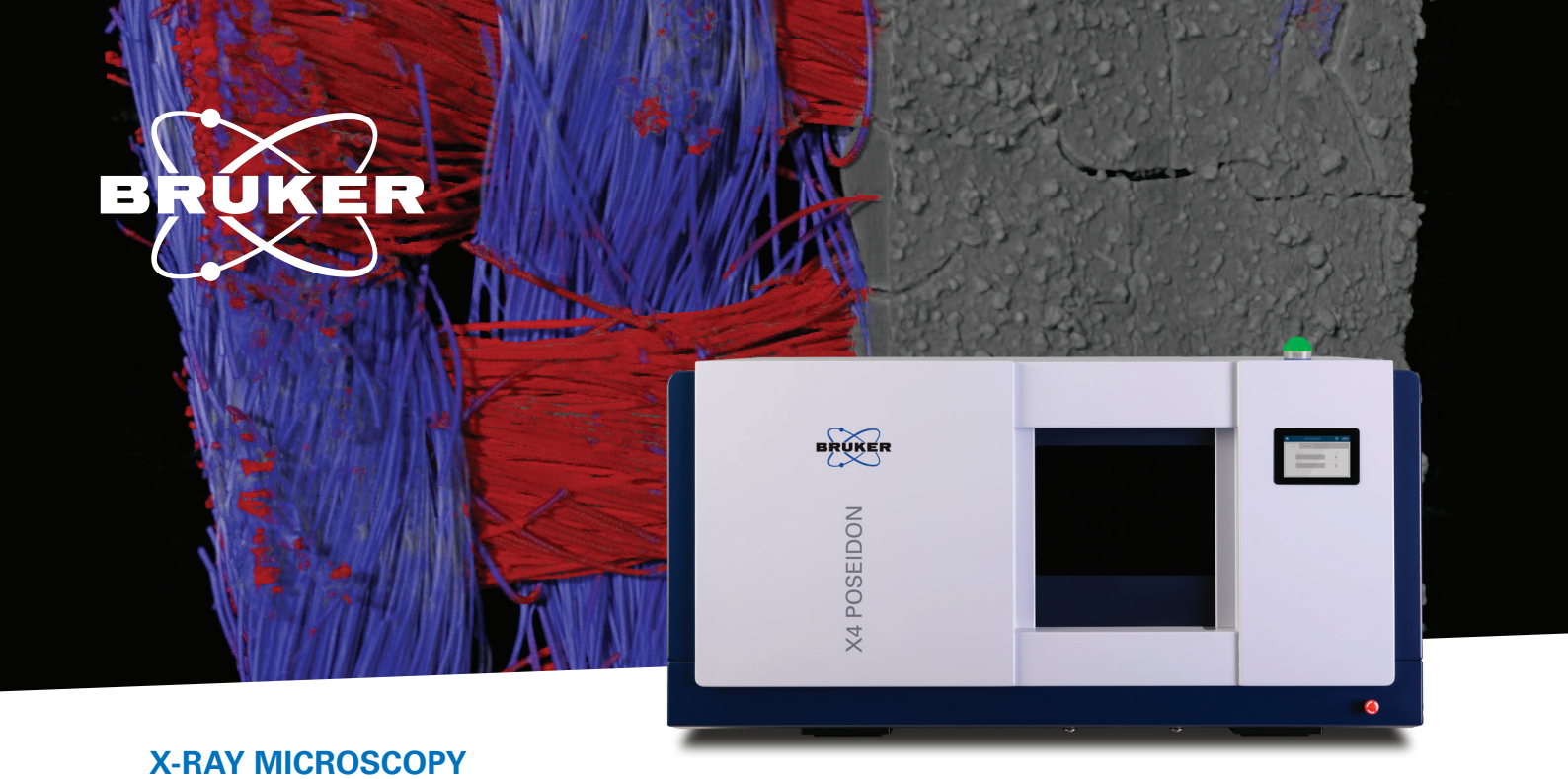

X-RAY MICROSCOPY

X4 POSEIDON – PEMFC Gas Diffusion Layer

Application Report 2

The global energy sector is actively working on transitioning away from fossil fuels and moving toward more environmentally friendly energy production methods. One promising approach is the use of Proton exchange membrane fuel cells (PEMFC) for energy production. As a result, many companies are focusing their resources on the development of more efficient versions of these PEMFCs with higher yields.

These PEMFCs consists of many layers. One of the most important components of a PEMFC is the gas diffusion layer (GDL) that is placed between the catalytic layers inside the PEMFC. The GDL plays a vital role in the performance and efficiency of the PEMFC. Therefore, it is important to have a detailed understanding of the GDL structure. Like the PEMFC, the GDL also consists of different layers that each have a specific function as part of the PEMFC. The main components of a GDL consists of is the micro-porous layer (carbon powder and hydrophobic agent), macro-porous carbon substrate (carbon paper or carbon cloth) and flow field.

The size of the components that make up the layers of the GDL can be as small as a couple of microns. XRM is the ideal technology for this application as it provides the required resolution to investigate these small components non-destructively. With the new X4 POSEIDON it is now possible to get a high-resolution detailed overview of these GDLs in a versatile desktop XRM that can fit in most lab spaces.

The X4 POSEIDON microCT imaging workstation is a benchtop 3D imaging core facility for your lab. The following settings were used for this study:

- 16 Mpixel sCMOS X-ray camera
- 70 kV, 30 µA
- Scan duration: 5 hours 9 min
- Voxel resolution: 500 nm

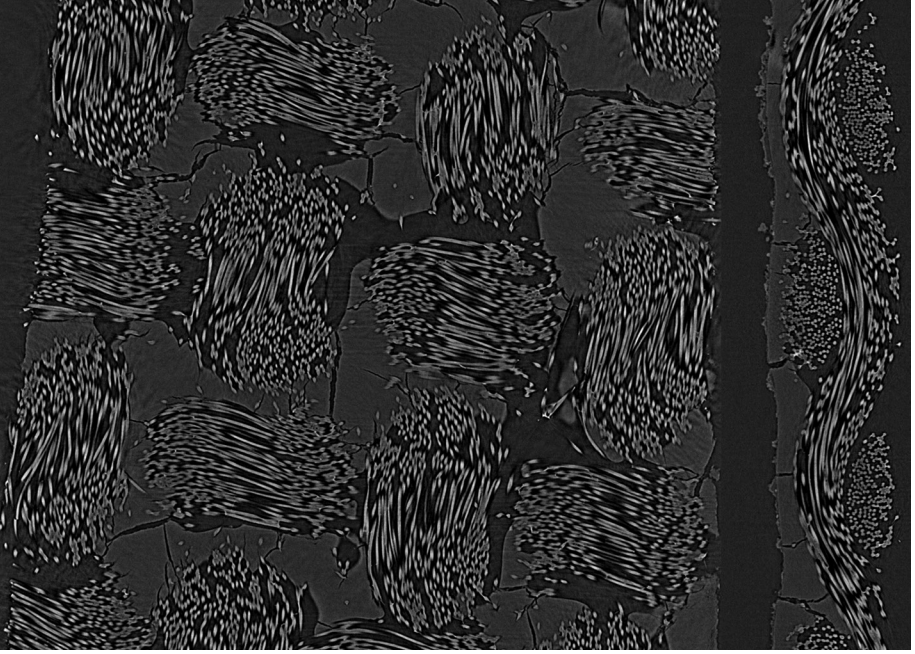

Figure 1
Orthogonal slice through the GDL

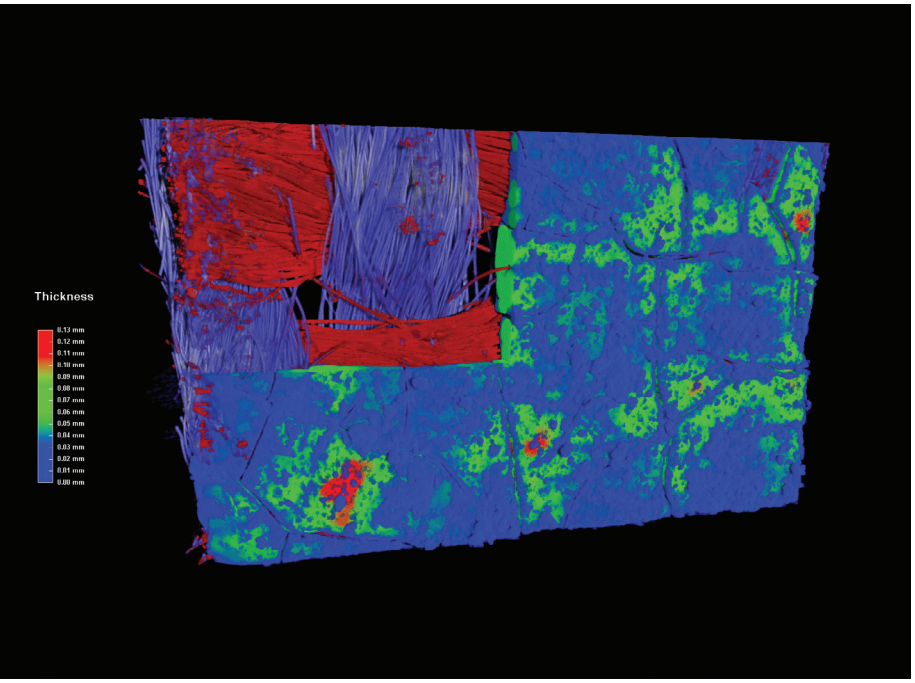

Figure 2
Local fiber orientation of the fiber bundles that form the carbon cloth inside the GDL

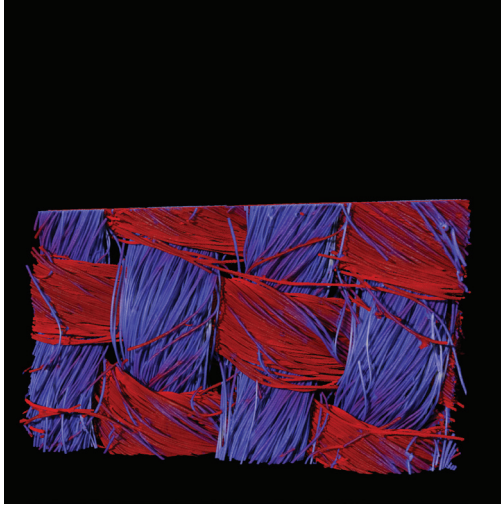

Figure 3
Thickness analysis of the micro-porous layer inside the GDL

The orthogonal slice (Figure 1) through the GDL provides a clear view of how the micro-porous layer (MPL) adheres to the carbon cloth. There are visible cracks that permeate all the way through the MPL to the carbon cloth. A thin layer of particles is also visible at the surface of the MPL.

For optimum GDL performance, the MPL must be layered homogeneously over the carbon cloth. This ensures that the reaction inside the PEMFC is consistent throughout the cell. Figure 2 illustrates a layer thickness analysis of the MPL. The change in color indicates the change in thickness - red highlights the thickest part and blue the thinnest. The results indicate that some individual fibers do not remain inside the bundles and are imbedded inside the MPL (Figure 2).

The direction of the fiber bundles inside the carbon cloth can be calculated with the local orientation algorithm found in CT Analyzer (CTAn). Figure 3 illustrates the orientation in Theta of the fiber bundles.

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