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X-Ray Computed Tomography of PEM Fuel Cells

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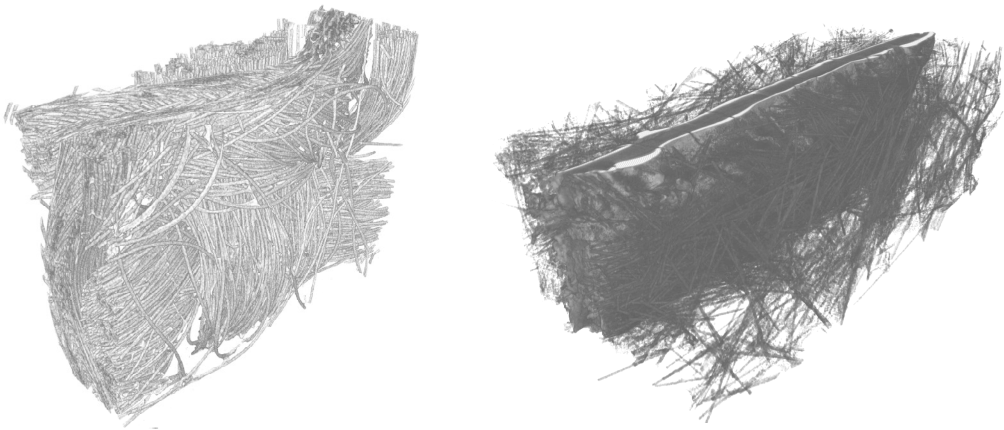
Proton exchange membrane (PEM) fuel cells were investigated by 3D x-ray computed tomography at a voxel size of 0.7 µm. It is shown that this lab-based technique is not only suitable for the investigation of gas diffusion layers (GDL) as well as the investigation of membrane electrode assemblies (MEA), but also allows the calculation of macroscopic physical properties.



Carbon cloth EC-CC1-060T (thickness 330 µm, left) and a membrane electrode assembly of a used PEM fuel cell (thickness 700 µm, right) imaged by x-ray computed tomography.

The resolution of computed tomography is clearly sufficient to image the carbon fiber structure of gas diffusion layers in the new GDLs as well as GDLs integrated into membrane electrode assemblies. It is also possible to visualize the catalyst layer within the MEA, which allows the investigation of layer thickness and structural defects on a larger scale than with conventional techniques.

The macroscopic effective thermal conductivities of the gas diffusion layers were calculated based on the 3D GDL structure reconstructed from tomography data by solving the energy equation considering a pure thermal conduction problem to produce more reliable input data for fuel cell modelling. The calculations show – in agreement with the expectation – that the through plane thermal conductivities are lower than the thermal conductivities in lateral direction.