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. 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.

The resolution of computed tomography – a voxel size of 0.7 µm was used – is clearly sufficient to visualize the carbon fibers of gas diffusion layers [1, 2] in the new GDLs as well as GDLs integrated into membrane electrode assemblies. It is also possible to image the catalyst layer within the MEA, which allows the investigation of structural defects of the layer and allows a more comprehensive determination of layer thickness as compared to the conventional investigation of cross-sections.

Membrane electrode assembly of a used PEM fuel cell (thickness 700 µm) imaged by x-ray computed tomography.

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 [2]. The calculations show – in agreement with the expectation – that the through plane thermal conductivities are lower than the thermal conductivities in lateral direction.

[1] A. Pfrang, D. Veyret, G.J.M. Janssen, G. Tsotridis, Imaging of membrane electrode assemblies of proton exchange membrane fuel cells by X-ray computed tomography, J. Power Sources doi: 10.1016/j.jpowsour.2010.1009.1020.

[2] A. Pfrang, D. Veyret, F. Sieker, G. Tsotridis, X-ray computed tomography of gas diffusion layers of PEM fuel cells: Calculation of thermal conductivity, Int. J. Hydrog. Energy 35 (2010) 3751-3757.