Stochastic 3D–Modeling of the Gas Diffusion Layer in Polymer Electrolyte Membrane Fuel Cells

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A mathematical model is proposed to describe the microstructure of the gas diffusion layer (GDL) in polymer electrolyte membrane (PEM) fuel cells based on tools from stochastic geometry. The GDL is considered as a stack of thin sections. This assumption is motivated by the production process and the visual appearance of relevant microscopic images; see Figure 1. The thin sections are modeled as planar (2D) random line tessellations which are dilated with respect to 3D. Our three–dimensional model for the GDL consists then of several layers of these dilated line tessellations. We also describe a method to fit the proposed model to given GDL data provided by scanning electron microscope (SEM) images which can be seen as 2D projections of the 3D morphology. In connection with this, we develop an algorithm for the segmentation of such images which is necessary to obtain the required structural information from the given grayscale images.

This talk is based on results which have been obtained in a joint research project of ZSW Baden–Württemberg and Ulm University; see R. Thiedmann, F. Fleischer, C. Hartnig, W. Lehnert, and V. Schmidt (2007) Stochastic 3D-Modeling of the GDL in PEM Fuel Cells, Based on Detection of Thin Sections. Preprint (submitted)

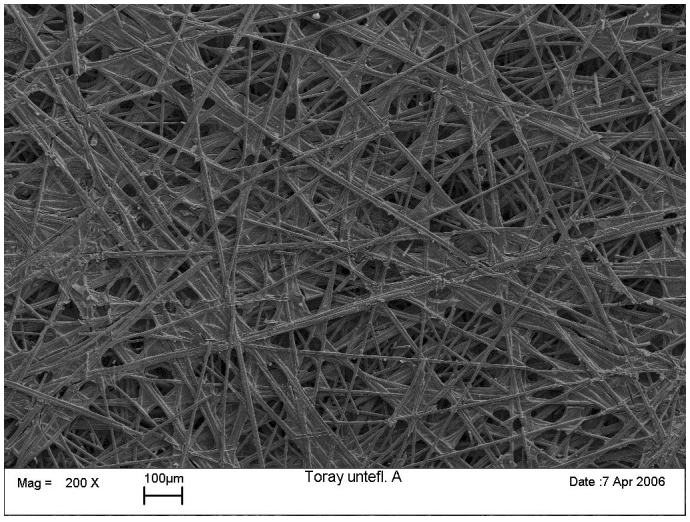

Figure 1: SEM image of a GDL