WATER TRANSPORT IN A GAS DIFFUSION LAYER OF POLYMER ELECTROLYTE FUEL CELLS IN THE PRESENCE OF POLYTETRAFLUOROETHYLENE

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ABSTRACT

In polymer electrolyte fuel cells (PEFCs), the transport of liquid water is highly relevant for the efficient operation of the stack. The water is produced on the cathode side and must be transported through the thin porous structure of the gas diffusion layer (GDL). This medium is typically made of carbon fibers, and for hydrophobicity is often treated with polytetrafluoroethylene (PTFE). The total amount of PTFE in the thin layer is specified by the manufacturer, but the local distribution is usually not known. On the other hand, it is known that the PTFE distribution on the outer surfaces and inside the GDL is not homogeneous [1].

In this work, the impact of PTFE distribution inside the GDL on transport properties will be discussed. In earlier work, the random nature of fiber localizations was discussed [2, 3]. The distribution of PTFE is another stochastic element that can influence water transport. The first results on the impact of the PTFE distribution were presented by Yu et al. [4] and still use a simplified assumption of the local distribution of PTFE across the fibers. On the other hand, local preferences of PTFE accumulation have already been observed by Daino and Kandlikar [5], while Rofaiel et al. [6] found inhomogeneities in the global distribution of PTFE.

In this work, a more detailed view on PTFE distribution is given. The local accumulation of PTFE near fiber crossings is considered, as well as the global accumulation of PTFE in certain regions of the GDL.

Water transport in GDLs is based on micro-structures created by a stochastic geometry model [7] and transferred to Lattice Boltzmann (LB) simulations via a series of binary images. One color (white) represents the void space, while the other (black) represents the solid fraction. The hydrophobicity of the solid material can be specified by a local contact angle. PTFE can be applied randomly to the geometry representation by introducing three-colored images, the third color specifying positions where the fibers are hydrophobic because of being covered by PTFE. In this presentation, previous work presented by Yu et al. [4] is continued by analyzing the macroscopic impact of PTFE on water transport from a statistical viewpoint.

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References:

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