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Optimization of transport in the PEM-Fuel cells using 3D micro print method

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PEM fuel cells are promising zero emission power sources. They are alternatives for fossil fuels in automotive industry. In a PEM fuel cell transport of the reactants is the function of bipolar plates. Afterwards, gas diffusion layer (GDL) distribute the reactants on the membrane. Thus, the gas transport to the membrane electrode assembly (MEA) is governed by convection in bipolar plates and diffusion in GDL. In this study, we combine both elements to a so-called "membrane separator", which the gas transport is dominated by convection. This requires optimized channels with locally different reactant distribution to assure homogeneous current generation.
In this study, we introduce two membrane separators to optimize the transport for anode and cathode sides. We focus on optimization of parallel flow field based on the flow/geometry coupling for anode and cathode sides. In anode side the single phase flow field was considered and the channels are optimized specifically for hydrogen. Product of the reaction in the cathode side is water. Thus, in cathode side the flow has two phase form. Although, the water is essential for operation of fuel cell, excess water causes the flooding. In the design of the membrane separator for the cathode side a multiphase lattice-Boltzmann Method (LBM) is deployed to assure enhances of the water transport inside the flow field.
The membrane separator manufactured using high-resolution additive manufacturing process from metal powder. This method has known limits such as product dimension, minimum thickness for internal parts. Moreover, the layer by layer manufacturing process, constrain geometry design without a supporting structure. In this study we consider all these limits in our purposed geometry to increase the power and efficiency of the PEM fuel cell by improving the transport of the reactants and removing the reaction products.
Finally the simulation of membrane separator will be compared with the experimental data.

References

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