Understanding heterogeneities in Direct Methanol Fuel Cells – A modelling approach

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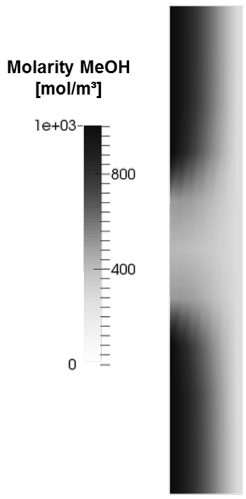
Among the technologies for alternative power sources, Direct Methanol Fuel Cells (DMFCs) are a promising option for the power supply of portable devices. Methanol and water can be supplied as a liquid, which is an advantage for certain applications. During operation, gaseous carbon dioxide is generated on the anode and liquid water is generated on the cathode, causing a two-phase flow within the cell. This behaviour leads to a rather heterogeneous distribution of species which needs to be modelled accurately.

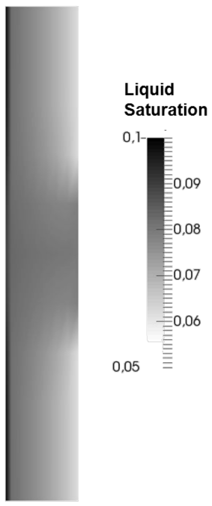
We present a transient, two-dimensional DMFC cell model that includes multicomponent transport in gas and liquid phase as well as electrochemical phenomena. The model is implemented in our in-house CFD code *Neopard-FC*, which is developed at DLR based on the open-source-software DuMuX[1]. A multiphase and multicomponent Darcy-approach is used for modelling the flow in porous GDL and CL on anode and cathode. The model describes a cross-section of a MEA and includes methanol and water crossover through the membrane. Electrochemical reactions are described with Butler-Volmer-type equations and the mixed potential at the cathode is taken into account.

With this 2D-model we aim to understand the formation of heterogeneities within a DMFC single cell under various modes of operation and their effect on the cell performance and degradation. Comprehension of the local conditions inside a DMFC is important for improving cell design and operating strategies in order to enhance cell performance and durability.



Figures 1 and 2:

2D-plots of DMFC anode and cathode subdomain in a channel/rib configuration. At high current densities, transport limitations for methanol occur in the anode gas diffusion layer and catalyst layer (picture on the left) and liquid water develops in the cathode catalyst layer (picture on the right).



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