

Modeling and simulation of transport- and degradation mechanisms in reinforced PFSA membranes

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Keywords: Modeling, PEMFC, Reinforced membranes, Chemical degradation.

In order to represent a reliable alternative to the internal combustion engine in automotive applications, durability and performance of PEMFCs need to be improved. For this, a detailed understanding of transport- and degradation mechanisms in reinforced state-of-the-art membranes is imperative. The membrane plays a central role in the cell water management and its structural integrity is vital to avoid cell failure.

To gain new insights, a 2D transient model for transport processes in the gas diffusion layers (GDLs), the catalyst layers (CLs) and the membrane has been developed. In the CLs and GDLs, two-phase flow of liquid water and gaseous species is modeled using multi-phase-multi-component Darcy flow equations [1]. Oxygen reduction and hydrogen oxidation are modeled with Tafel kinetics. The detailed description of the two-phase transport through GDLs and CLs is crucial to obtain realistic boundary conditions for the membrane model. For the transport through the membrane, an existing model [2] is extended to account for the influence of a PTFE reinforcement layer in the center of the membrane. It resolves Schröder's paradox and describes gas cross-over as well as the transport of radicals. The membrane degradation model incorporates H_2O_2 formation in the electrodes, radical formation [3] and degradation via "unzipping" and "side chain scission" mechanism [4]. A coupling between chemical degradation and the transport properties of the membrane will be presented.

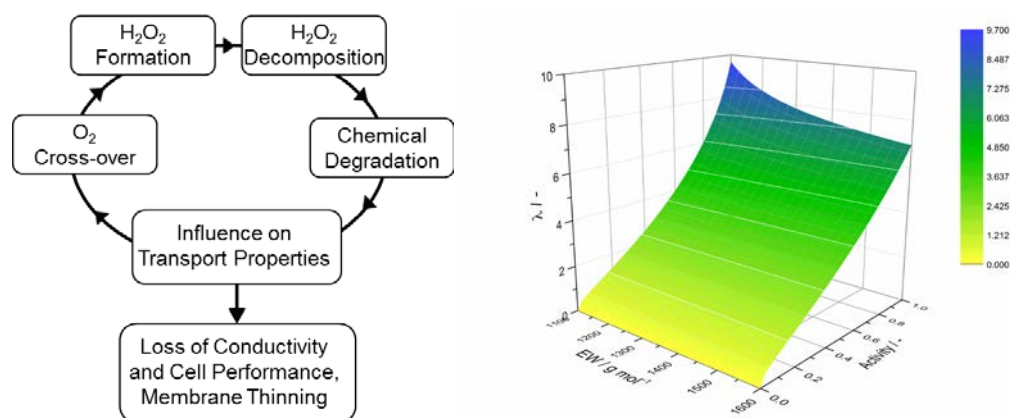


Figure 1. Left: Schematic overview of the degradation model. Right: Influence of chemical degradation on the sorption properties of Nafion®.

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