Modeling ruthenium dissolution in direct-methanol fuel cells

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Direct-methanol fuel cells (DMFC) are a promising alternative to conventional energy conversion systems, especially for portable applications. However, in order to become competitive, the life time of DMFCs still has to be increased. Therefore, it is essential to understand and overcome the underlying degradation mechanisms.

To approach this goal, we develop a detailed 1D model to describe the DMFC on the electrode and cell level, based on the in-house modeling framework DENIS[1,2]. A two-phase flow model is implemented for the transport in gas diffusion layer (GDL) and catalyst layer (CL) at the anode side, whereas we consider only the gas phase at the cathode side. Electrochemistry is described by multistep mechanisms for the reactions occurring at anode and cathode CL, including adsorbed intermediate species on the platinum and ruthenium surfaces. Furthermore, we employ a detailed membrane model which includes methanol crossover. The cell model can be used to perform steady-state, transient as well as impedance simulations.

This model sets the basis to study the effect of degradation mechanisms, which influence the available catalyst surface and are expected to be crucial for the determining the lifetime of DMFC. Ruthenium dissolution is considered as a first degradation mechanism of this kind. We include this mechanism into the cell model and study its effect on the cell performance.

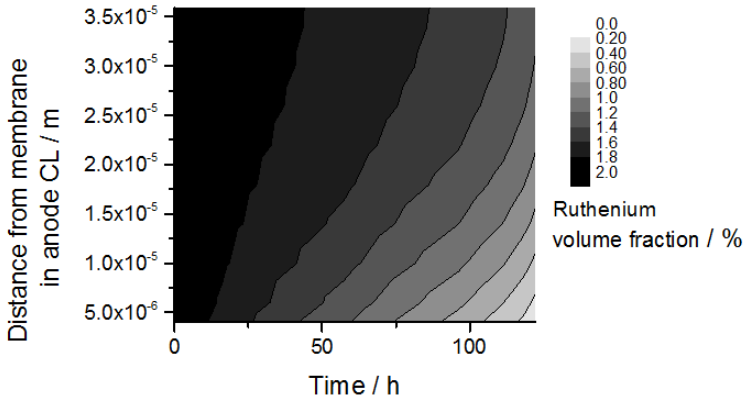

Figure 1. Spatially resolved analysis of Ru-dissolution in the anode catalyst layer

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