Neutron Radiography and Tomography on Fuel Cells

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Abstract. Water management is a key issue in the development of PEMFCs (polymer electrolyte membrane fuel cells). Water is produced by conversion of hydrogen and oxygen to electrical energy and exists mostly in liquid form as a result of the low operating temperature. On the one hand a certain humidity inside the reaction layers has to be maintained, because only the wet membrane is proton conductive. On the other hand the formation of too much liquid water strongly hinders the gas flow and has to be prevented. Thus investigation of the water distribution is of major interest for development of PEMFCs.

In this paper in-situ neutron-radiography investigations on PEMFCs are presented. Neutrons can easily penetrate metal components (e.g. the end plates of the FCs) while they are very sensitive to hydrogen. Therefore neutron imaging can be used as a tool for non-destructive analysis of the formation and transportation of water inside PEMFCs.

The radiographic images demonstrate that the initial water production starts under the ribs of the flow field. With increasing water accumulation water drops accrue and creep into the channels of the flow field where they agglomerate and move driven by the gas flow to the exit. The PEMFCs were investigated under different operating conditions applying realistic profiles of power consumption which are e.g. rapid changes of the power profile (accelerating and breaking in case of an automotive application).

Novel techniques for contrast enhancement and for visualization of the water flow dynamics inside the cell will be presented. Especially for multiple stack fuel cells radiography is not sufficient. In contrast quasi in-situ-tomography experiments allow for three-dimensional visualisation of the water distribution in the channels of each of the stacks.