

Experimental report

14/09/2023

Proposal: 1-06-26

Council: 4/2023

Title: Impact of of a new concept for gasdiffusion layers omitting the fibre substrate on the water managementof PEM fuel cells

Research area: Engineering

This proposal is a new proposal

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Samples: Six small scale fuel cells
One full channel length cell

Instrument	Requested days	Allocated days	From	To
NEXT	5	2	27/08/2023	29/08/2023

Abstract:

Traditional PEM fuel cell setups include Gas Diffusion Layers (GDLs) on anode and cathode. The GDLs consist of a fibre substrate of ca. 150-200 μm thickness and a Microporous Layer (MPL) of 30-60 μm thickness. The functions of the GDLs are gas and water transport, providing electrical and heat conductivity and mechanical support. We are developing a new concept replacing the GDL substrate by a standalone layer of similar composition and thickness as the traditional MPL layer. By improving transport properties, higher cell power can be expected. The influence of this innovation on the water inventory of the layers inside the cell is still unclear. Water discharge capability can be enhanced by optimum engineering of porous structure in the GDL. An investigation of the influence of the pore structure as well as the surface treatment variation of the newly designed component on water management processes and cell performance will be conducted in this study. In addition, cells of full channel length will be investigated. Different material variations will be applied to evaluate the corresponding water management. Water management and thereby, performance is intended to be improved.

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Objectives:

The motivation for this experiment was to evaluate the impact of alternative designs for GDL on water management in the single-cell PEM fuel cell. By performing through-plane and in-plane radiography scans at different current densities, in addition to the tomography scan at high current density. It was intended to calculate the water thickness within different layers of the PEM fuel cell at the beginning of life, as well as the end of life. The planned investigation could lead to water management optimization, thus improving the power density of the PEM fuel cell.

General Report

A house-made portable test bench was brought to the ILL, and installed outside the beamline to operate the PEM fuel cells at the desired operating condition for experiments. This beam time was combined with another allocated beam time to the ZSW research group so that some time could be saved for the test bench installation. Due to the high demand for the instrument at the time, all requested days for the experiment could not be allocated. Thus, only two samples, applying new concepts GDLs with different MPL structures were prepared for this experiment. However, operating the test bench was not successful due to some primarily technical issues (please refer to the experimental report 1-06-5). In addition to that, unfortunately, not all the desired operating conditions were supplied by the test bench due to malfunctioning of extended heat gas tubes. Notwithstanding, in-plane radiography, as well as tomography were performed for two samples.

It is planned to apply for a continuation proposal, but considering another portable test bench for operating the PEM fuel cell, which has been already successfully employed at ILL in the NeXT and D22.