Experimental report

14/05/2024

Proposal: 1-06-2 **Council:** 10/2022

Title: High-speed 4D neutron computed tomography for mass transport in proton exchange membrane water electrolysers

Research area: Engineering

This proposal is a new proposal

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Samples: Nafion, carbon, aluminium, Silicon, PTFE, Pt catalyst, titanium

Instrument	Requested days	Allocated days	From	To
NEXT	7	3	09/06/2023	12/06/2023

Abstract:

Energy demand and environmental pollution have become the two major problems to which societies are seeking immediate remedies. Proton exchange membrane water electrolysers (PEMWEs) are a potential solution to the increasing demand for inconsistent renewable energy technologies and seasonal storage. One of the long-standing challenges for efficient and reliable PEMWE performance is accomplishing effective mass transport of water and product gas. Novel flow-field and liquid-gas diffusion layer designs serve as a simple and effective means of optimising the mass transport processes. However, an appropriate characterisation tools for studying of the water dynamics within operating PEMWEs has not been established. The aim of this proposal is to use the unique benefits of NeXT-Grenoble instruments to provide the first-ever report of the 4D operando water distribution across different parts of PEMWEs. This has major implications for PEMWEs design and operation and be of interest to academics and technology developers alike.

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In these experiments we aim at determining the total liquid water content in operating proton exchange membrane water electrolysers (PEMWE) with different flow-field designs using neutron radiography. The experiment was conducted on D50 beamline which was in commissioning.

We have conducted the experiments on a specifically designed 0.95 cm^2 cell. Electrochemical testing was performed between 0.00 A cm 2 and 1.00 A cm^{-2}. Deionized water was circulated through the anode side of the PEMWE with an inflow temperature of 50 °C and a constant water flow rate of 200 ml min^{-1}.

We record an image every two seconds. We have also shown that we can extract valuable information on the correlation between water mass variation and flow field design.

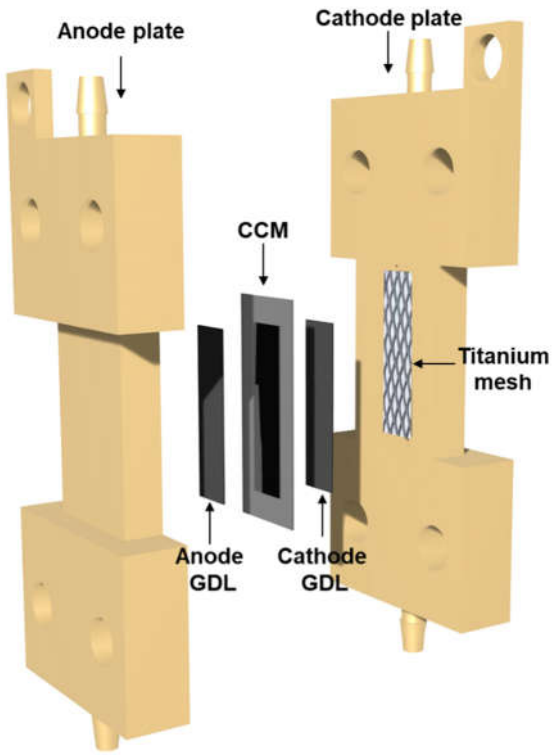

Fig.1 PEMWE cell used for experiments in this work.

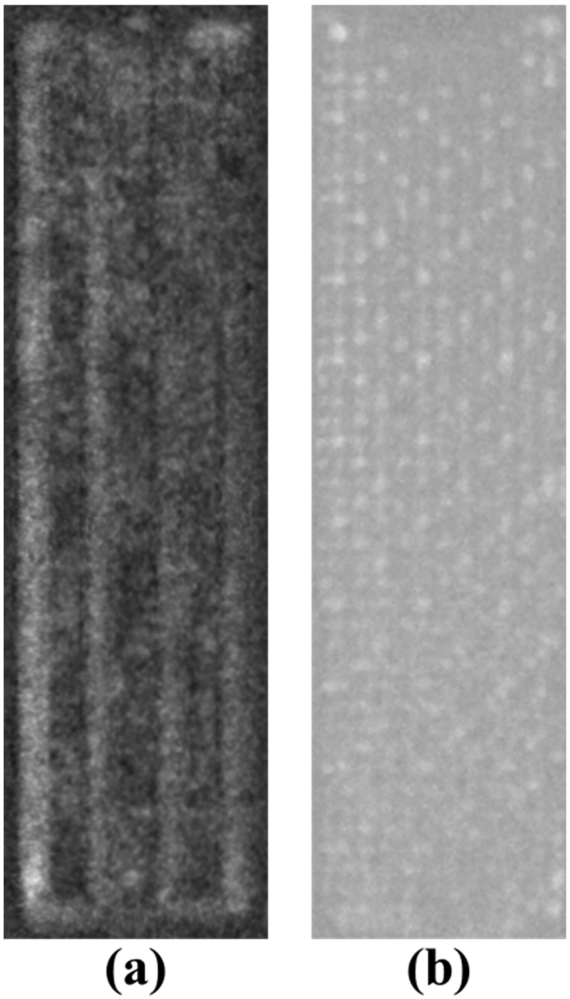

Fig.2 Neutron radiographs at a current density of 1.00 A cm^{-2} for PEMWE with (a) parallel and (b) titanium mesh flow field design.