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Investigation of Catalyst Layer and Microporous Layer Liquid Water Saturation Level in Polymer Electrolyte Fuel Cell by Operando Small&Wide Angle X-ray Scattering

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In recent years, substantial research and development endeavors are dedicated to enhancing the performance of polymer electrolyte fuel cells (PEFC) as a promising candidate for transport application. However, the power density still needs improvement for large-scale operations with one of the core issues being water management. The convoluted water balance in the PEFC requires proper water management to ensure high cell performance. Excess water retention in the pores results in blockage of the gas diffusion to the active sites of the electrochemical reaction, thus reducing performance and efficiency. Appropriate membrane humidification is needed for high proton conductivity. The deployment of a microporous layer (MPL) located between the gas diffusion layer (GDL) and the catalyst layer (CL) has been demonstrated to enhance water management. Operando scanning small and wide angle X-ray scattering (SAXS&WAXS) is utilized in this study as a practicable tool to explore the water level in the nanoscale CL and correlate it with the neighboring MPL material design at the cSAXS beamline of the Swiss Light Source. The use of a small beam size (≈7x30 microns) and ≈0.6 microns vertical step size resolves the bulk CL (≈7 microns thick) and additionally allows for a precise registration in case of membrane movement during operation. Due to the electron density difference between solid-void and solid-liquid interfaces, the water saturation level is quantifiable (see Fig. 1a). Relevant PEFC operating conditions (80^{0}C, relative humidity 100%, 1.7 and 3 bar abs.) were enforced to compare the impact of two different MPL modifications (pore former inclusion, and higher PTFE content) to the water saturation of a base case MPL (Li100, 20% PTFE). The presentation will detail the material modification consequences on the CL and MPL saturation levels to reveal pore size-specific filling mechanisms. (see Fig. 1b-c).

Participation

In-Person

References

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