Contribution ID: **241** Type: **Oral Presentation**

Modelling liquid transport in PEM fuel cells: The effects of compressive stress

Tuesday, 31 May 2022 12:00 (15 minutes)

The performance of polymer electrolyte membrane fuel cells (PEMFCs) is greatly influenced by the residual water content generated during the cell operation, and a comprehensive understanding of water management is critical for elevating the efficiency of PEMFCs [1]. The liquid accumulation at the interfacial gaps between PEMFC components account for a substantial part for water flooding which impedes subsequent electrochemical reaction of hydrogen and oxygen [2]. In this study, the liquid transport and accumulation at the interfacial region of micro-porous layer (MPL) and catalyst layer (CL) of PEMFC is investigated numerically. The contacting membrane layers are featured with surface roughness and pore size distribution that are comparable to real MPL and CL properties. Different levels of compressive stress derived from fuel cell assembly pressure are applied on the MPL/CL components resulting in different interfacial morphology, and the corresponding influences on the liquid accumulation at the interface as well as within MPL/CL components is analysed. The effects of compression on the pore size distribution are further incorporated to reflect the change of MPL/CL pore structure. The wettability of MPL/CL material is adjusted to simulate the contact angle variation resulted from different working temperature during the start-up phase of cell operation. Finally, the liquid transport and accumulation at the MPL/CL interface are compared with available experimental observations, and a numerical framework is proposed for optimising compressive stress that best facilitates the water management. This study provides a parametric assessment on identifying the appropriate compressive stress for cell assembling and design of PEMFCs.

Keywords: PEMFC; contact mechanics; surface roughness; pore size distribution; lattice Boltzmann method.

References

1. Jiao, K. and X. Li, Water transport in polymer electrolyte membrane fuel cells. Progress in energy and combustion Science, 2011. 37(3): p. 221-291.

2. Mohseninia, A., et al., Influence of Structural Modification of Micro-Porous Layer and Catalyst Layer on Performance and Water Management of PEM Fuel Cells: Hydrophobicity and Porosity. Fuel Cells, 2020.

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Time Block A (09:00-12:00 CET)

Participation

Online

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Session Classification: MS09

Track Classification: (MS09) Pore-scale modelling