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Pore Graded Anodic Transport Layers in PEM Electrolysers: A Pore Network Study

Thursday, 3 June 2021 14:40 (15 minutes)

Porous structures have widespread importance in electrochemical processes. The specific morphology of the available porous materials, as well as their physical properties, crucially affect their applications, e.g. their use in fuel cells, batteries, or electrolysers. A key point is the correlation of transport properties (mass, heat, and charges) in the spatially—and in certain cases also temporally—distributed pore structure. In electrolysers, the drainage of oxygen through a water-saturated porous transport layer (PTL) significantly impacts the performance of the overall system [1][2]. The oxygen coverage of the catalyst layer obstructs the water supply towards the reaction zone; this can lead to a decrease in the rate of reaction. In more detail, the oxygen produced at the catalyst layer must be removed through the PTL in a way that the water supply adequately persists. Mathematical modelling is used to investigate the impact of the PTL pore structure on the distribution of wetting (water) and non-wetting phase (oxygen). For this purpose, pore network models (PNMs) together with upscaling strategies are applied [3]. PNMs conceptually represent the porous media. Micro computed tomography is used to extract the required information, e.g. porosity and pore size distribution, pore connectivity, pore shape etc. The model uses this information to generate an interconnected network of pores. Relevant two-phase flow physics are used to study the transport limitations at microscale. With the help of PNM, it is studied how a change of structure, i.e., the spatial grading of the pore size distribution and porosity, changes the transport properties. Several situations are investigated, including a vertical gradient ranging from small to large pore sizes and vice versa, as well as a dual-porosity network extracted from a commercial PTL. The simulation results indicate that the specific porous structure has a significant impact on the spatial distribution of species and their respective relative permeabilities. In more detail, it is found that the continuous increase of pore sizes from the catalyst layer side towards the water inlet interface yields the best transport properties among the investigated pore networks. This outcome could be useful for the development of grading strategies, specifically for material optimization for improved transport kinetics in water electrolyser applications and for electrochemical processes in general.

Time Block Preference

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

References

1. Grigoriev, S.A.; Millet, P.; Volobuev, S.A.; Fateev, V.N. Optimization of porous current collectors for PEM water electrolysers. International Journal of Hydrogen Energy 2009, 34, 4968–4973, doi:10.1016/j.ijhydene.2008.11.056.
2. Lettenmeier, P.; Gago, A.S.; Friedrich, K.A. Protective Coatings for Low-Cost Bipolar Plates and Current Collectors of Proton Exchange Membrane Electrolyzers for Large Scale Energy Storage from Renewables. In New Technologies in Protective Coatings; Giudice, C., Canosa, G., Eds.; InTech, 2017, ISBN 978-953-51-3491-6.
3. Vorhauer-Huget, N.; Altaf, H.; Dürr, R.; Tsotsas, E.; Vidaković-Koch, T. Computational Optimization of Porous Structures for Electrochemical Processes. Processes 2020, 8, 1205, doi:10.3390/pr8101205.

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Primary author: ALTAF, Haashir (Max Planck Institute for Dynamics of Complex Technical Systems Magdeburg)

Co-authors: VORHAUER, Nicole (Otto-von-Guericke University); Prof. TSOTSAS, Evangelos (Otto von Guericke University); Dr VIDAKOVIC-KOCH, Tanja (Max Planck Institute for Complex Dynamical Systems Magdeburg)

Presenter: ALTAF, Haashir (Max Planck Institute for Dynamics of Complex Technical Systems Magdeburg)

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