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Your Abstract Submission

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Author 1	Christos Georgiadis Division of Materials and Process Engineering, Université Catholique de Louvain
Author 2	Kevin Van Droogenbroek Division of Materials and Process Engineering, Université Catholique de Louvain
Author 3	Joris Proost Division of Materials and Process Engineering, Université Catholique de Louvain
Title	Towards pore-resolved multiphase simulations of electrolyte-bubble flow through 3D electrodes for alkaline water electrolysis.
Abstract	Green hydrogen production by water electrolysis gains more and more traction as a promising solution for mitigating the adverse effect of climate change and reducing carbon emissions. While alkaline water electrolysis is considered a mature technology to this end, recent work has shown that we can achieve further process intensification with forced electrolyte flow through macro-porous 3D electrodes. At the same time though, there is limited effort on utilizing modeling and simulation techniques to investigate the mechanisms underlying electrolyte-bubble interaction and help design flow-engineered electrode geometries that optimize such interactions. In this work we present a pipeline to model complex porous, foam-based electrodes and we investigate the two-phase electrolyte-hydrogen flow through them. Two foam electrode samples of characteristic pore size of 450 μm and 3000 μm respectively are scanned using high-resolution micro-CT (computed tomography). The initial surface models of the foam surfaces are not suitable for numerical simulations, as they are highly detailed and consist of geometric and topological inconsistencies. A surface reconstruction is therefore performed by using an alpha shapes algorithm to generate a valid bounding surface mesh of the foam matrix. The discrepancy between the initial surface and the reconstructed one, computed by the Hausdorff distance, is then less than 1% on average. A single-phase simulation of electrolyte through our electrodes is performed by solving the incompressible Navier-Stokes equations on OpenFoam software, and the results are validated by comparing the pressure drop – velocity graphs with the Darcy-Forchheimer model predictions. In order to obtain a performance indicator, we first consider the hydrogen phases as a passive scalar and we solve a transport equation to obtain the Residence Time Distribution (RTD) of hydrogen bubbles through our domain. These RTDs are then associated with our experimental results. Finally, we present initial results of two-phase flow through pore-resolved foams, by using an Euler-Euler model. These simulations provide valuable insight into the complex transport phenomena that occur within the porous materials, including the interactions between the hydrogen gas, electrolyte, and solid matrix.
Preferred kind of contribution	Oral
Corresponding email address	christos.georgiadis@uclouvain.be