Master Project (30 ECTS)/Semester Project (10 ECTS)

Administrative

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Location: Sion (travel allowance offered)

Project description:

Water electrolysis forms H2 and O2 bubbles at the cathode and anode respectively in three stages: nucleation, growth and detachment [1]. The produced bubbles decrease the anion exchange membrane water electrolyzer (AEMWE) efficiency by increasing what is known as the mass transport overpotential, since they reduce the electrochemically active area and the electrolyte conductivity by deposition on the active sites and by occupying the volume where the ions are transported, respectively. However, the relation between the bubble evolution mechanisms and electrochemical processes is still not fully known.

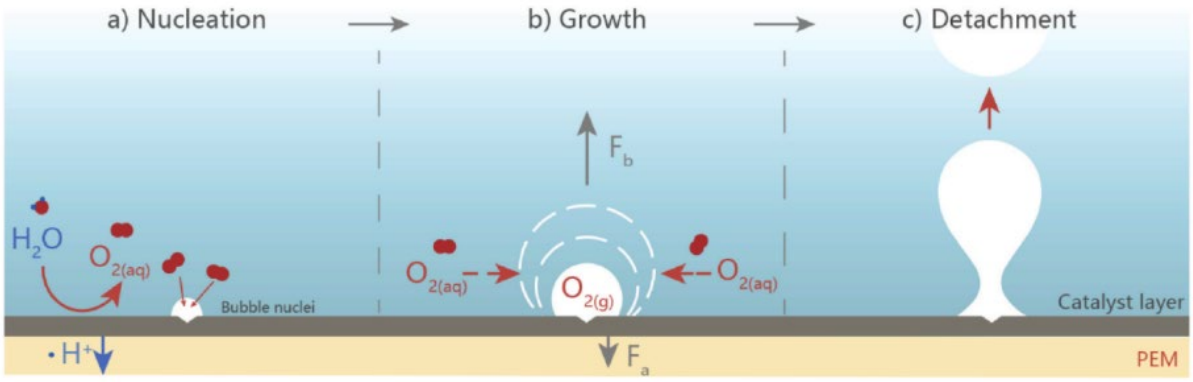

Figure 1: Bubble dynamics in the anode of an electrolyzer a) Nucleation b) Growth c) Detachment [1]

In this project, the goal is to build an AEMWE bubble imaging setup using a high-speed camera to record the bubble evolution process as a function of applied current. The bubbles in the recorded images will be segmented using an in-house developed code and their properties will be computed (e.g. bubble size distribution). This allows us to better understand the relation between the applied current and bubble growth dynamics. The process will be repeated for different porous transport layer (PTL) configurations (PTL are responsible for transporting bubbles from the reaction site to the flow channels, then out of the cell, or to a storage tank) for comparison.

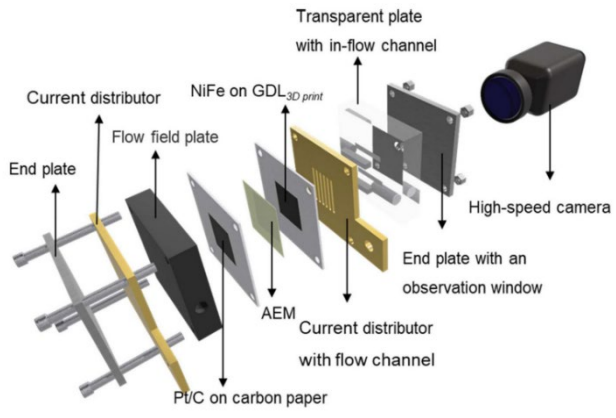

Figure 2: : Bubble imaging setup for AEMWE [2]

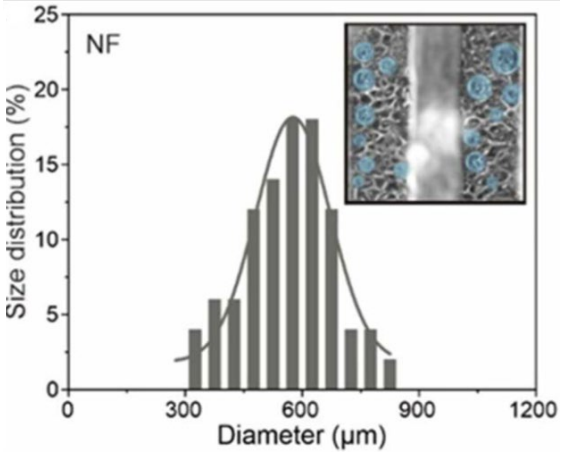

Figure 3: Bubble size distribution in a nickel foam PTL [2]

Your tasks:

1. Help in designing a setup for AEMWE bubble imaging (the setup includes transparent AEMWE endplates and a high-speed camera)
2. Record the bubbles produced during electrolysis
3. Compute the properties of the bubbles such as the bubble size distribution and occupied volume as a function of the applied current
4. Repeat tasks 2 and 3 for different PTLs (the data will be used to compare the efficiency of different PTL structures and to validate a multi-physics model done previously)

References

[1] Shu Yuan et al. 'Bubble evolution and transport in PEM water electrolysis: Mechanism, impact, and management'. In: Progress in Energy and Combustion Science 96 (May 2023), p. 101075. ISSN: 0360-1285. DOI: 10.1016/j.pecs.2023.101075. URL: https://www.sciencedire ct.com/science/article/pii/S0360128523000059

[2] B. Huang *et al.*, "Improving mass transfer in anion exchange membrane water electrolysis by ordered gas diffusion layer," *International Journal of Hydrogen Energy*, vol. 48, no. 91, pp. 35453–35462, Jun. 2023, doi: https://doi.org/10.1016/j.ijhydene.2023.04.331.