Membrane Electrode Assembly Simulation Of Anion Exchange Membrane Water Electrolyser

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Abstract

Anion exchange membrane water Electrolysers (AEMWE) have gained prominence recently with their ability to replace platinum group materials (PGM) with non-PGM catalysts, which are Ni, Fe, and Mo based. However, more mathematical models must be explored involving membrane electrode assem-blies of AEMWE. Currently, the Sustainion X-37 50 membrane series have been vastly explored for water electrolysis with a proven durability study1. In this study, SS316L Fibre felt, and Nickel Fibre are used as anodic and cathode substrates, respectively, to develop a numerical model using COMSOL Multiphysics® and the Fuel Cell & Electrolyzer Module. The membrane electrode assembly (MEA) architecture consists of Raney® Ni || X37-60RT || NiFe2O4-SS316L as layers.

Stationary and time-dependent two-phase studies have been performed for the 1D, 2D, 3D and 3D MEAs with and without flow channels. A base case for the model is established, where the cell is op-erated at 60◦C, 1 M KOH and atmospheric pressure. Polarisation curves and electrochemical imped-ance spectroscopy have been simulated based Butler-Volmer equations and a standard AEMWE equivalent circuit model2, respectively. An attempt is made to verify the simulation with experimental measurements. The overpotentials of the catalysts in aqueous KOH were calculated and verified based on three electrode measurements and adapted to the model. A model-sensitivity analysis on i) Membrane Thickness, ii) Temperature, iii) KOH Concentration, iv) applied Current Density iv) Wet and Dry Cathode feeds have been performed. Finally, the sensitivity parameters have been ranked based on changes in the HHV Efficiencies.

Reference

[1] Li, D.; Motz, et.al. Energy Environ. Sci. 2021, 14 (6), 3393–3419. DOI:10.1039/D0EE04086J.
[2] Vincent, I.; et.al. Scientific Reports 2021, 11 (1), 293. DOI: 10.1038/s41598-020-80683-6.

Figures used in the abstract

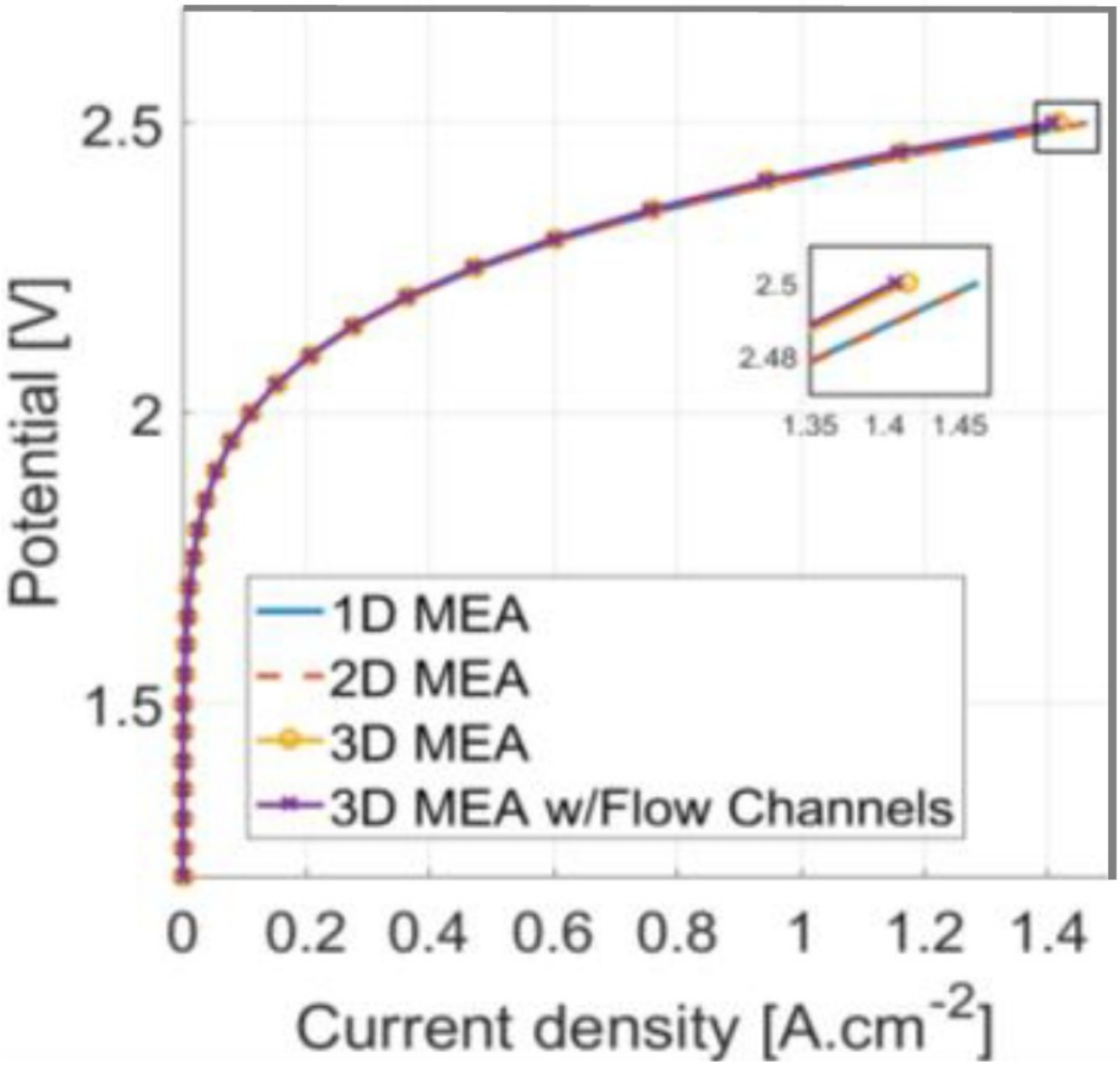

Figure 1 : Simulated JV Curve

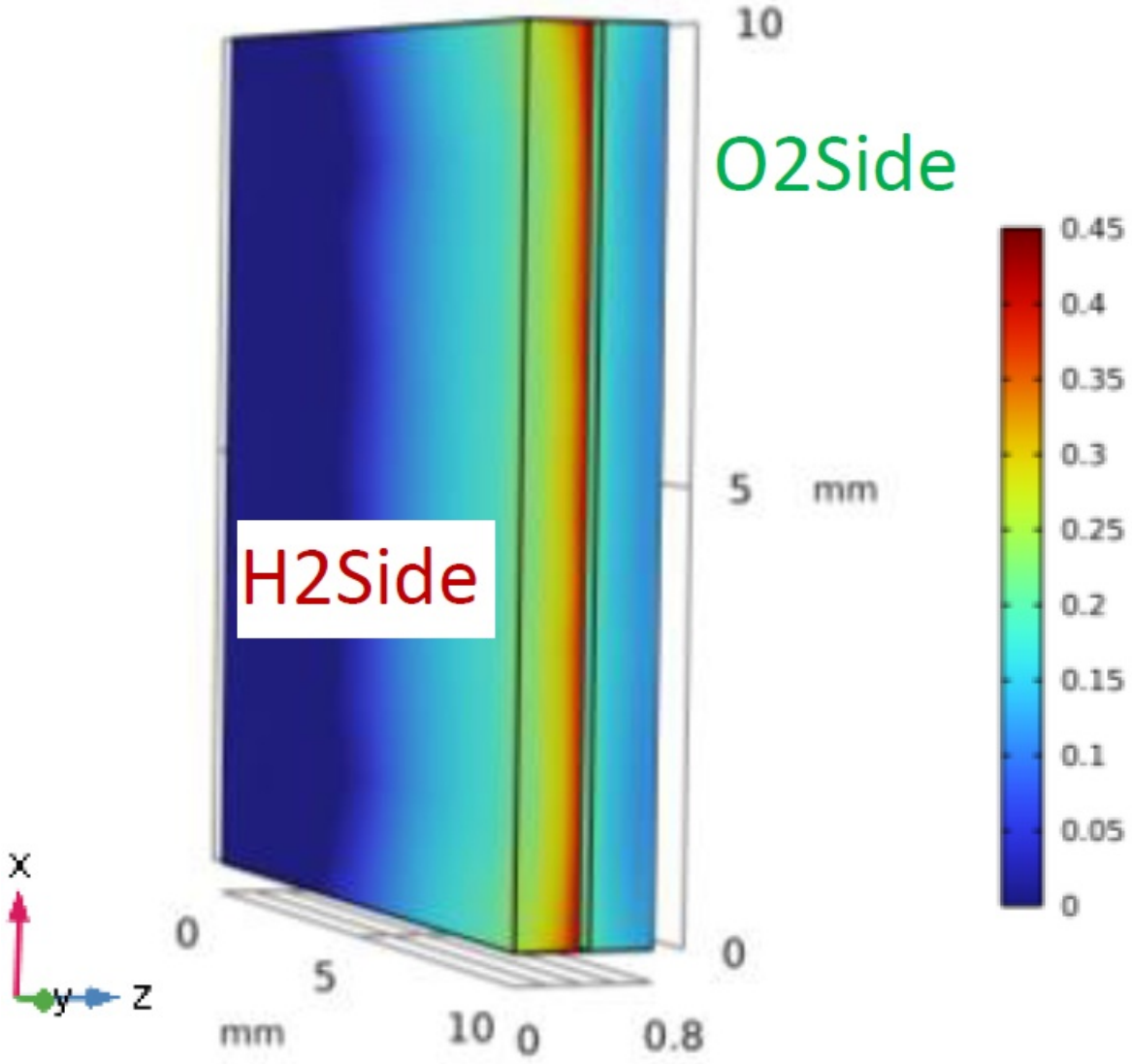

Figure 2 : 3D MEA Gas Fraction

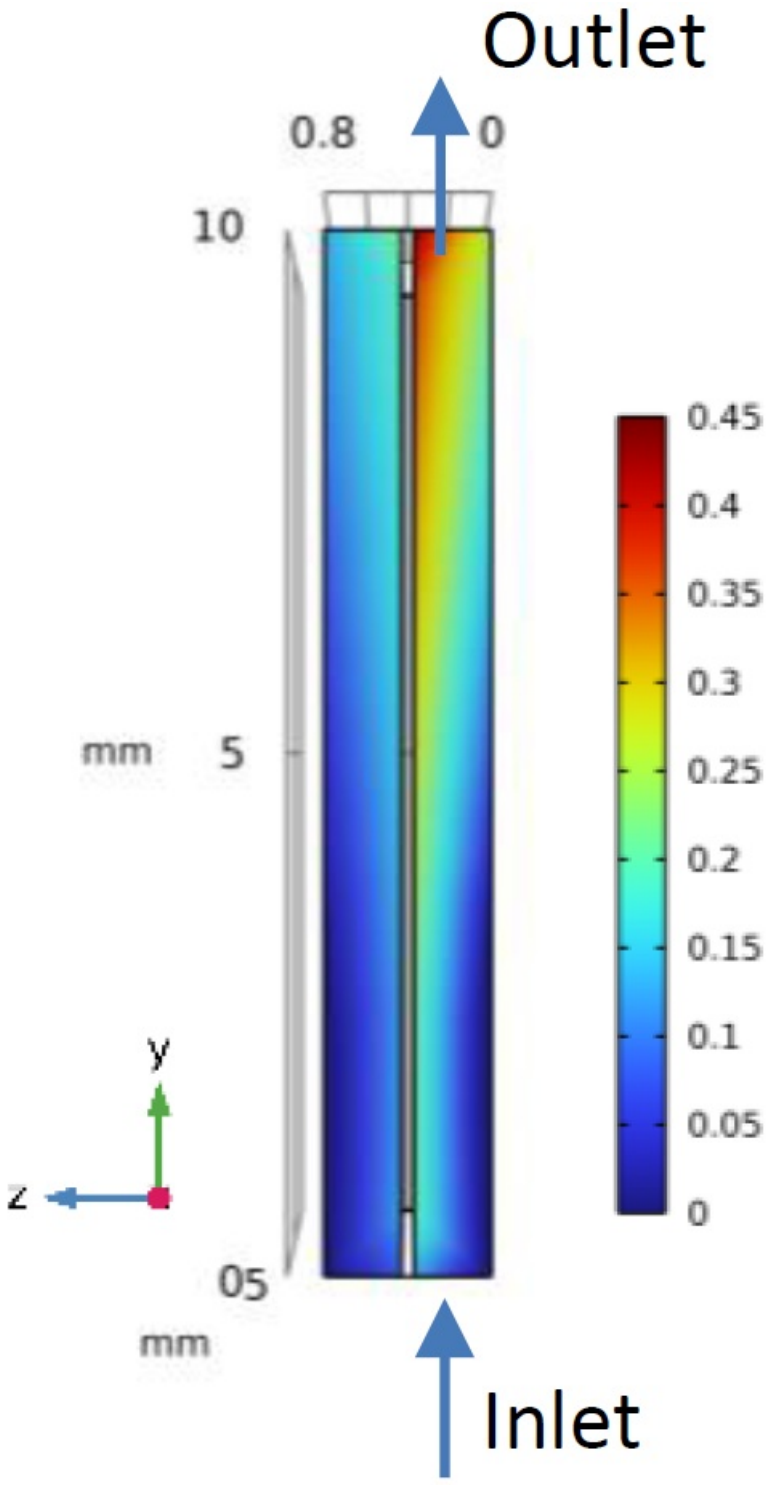

Figure 3 : 2D Gas Fraction