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Understanding the impact of the gas diffusion layer structure on catalyst utilization in the PEM water electrolyser

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ABSTRACT

A multiphysics half-cell model of a polymer electrolyte membrane water electrolyzer (PEMWE) was developed to probe impacts of the detailed three-dimensional pore structure of the gas diffusion layer on performance characteristics. We show that pores in the titanium gas diffusion layer (GDL) mesh led to significant underutilization of the catalyst layer (CL), with only 45% of the catalyst effectively utilized. This contradicts the assumption of uniform electron flow across the CL, as near-zero current was observed near GDL pore regions. Instead, oxygen generation was primarily concentrated under the solid titanium regions, diffusing out around the pore walls. High current density peaks were also noted at the GDL-catalyst contact, correlating with degradation hotspots that were directly observed in companion experiments. Collectively, these findings point to the critical importance of the heterogeneous GDL porous architecture not only for PEMWE efficiency but also for uneven degradation of the CL.

KEY WORDS

PEM water electrolyser, electron distribution, COMSOL, oxygen generation, catalyst efficiency

BIOGRAPHY

Yuyao Huang is a doctoral candidate at the University of Auckland after obtaining his master's degree and bachelor's degree from the Department of Metallurgy Engineering, at Northeastern University. He has a background in materials and metallurgy, especially in scrap aluminum and aluminum alloys, research experience in the electrochemistry behavior of ions, nucleation and growth of aluminum on electrodes, and electrolysis cell design. At present Yuyao is engaged in research in green hydrogen production and water electrolysis cell design.

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