

ABSTRACT:

Advanced Membrane Architectures for Sustainable Hydrogen Technologies

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Hydrogen technologies are increasingly central to the future of sustainable energy. Water electrolysis is one of the most promising routes for green hydrogen production, while fuel cells enable its efficient conversion back into electricity. Rapid advances in these technologies are currently focused on improving performance, efficiency, and long-term durability. Our research focuses on advancing membrane materials for key hydrogen technologies, including Polymer Electrolyte Membrane Water Electrolyzers (PEMWE) and Fuel Cells (PEMFCs and AEMFCs). In particular, we are engineering alternative polymer electrolyte membranes by leveraging radiation-induced grafting and electrospinning methods allowing precise control over membrane composition, morphology, and functionality, enabling the fabrication of hybrid membranes with organized hydrophilic/hydrophobic domains. to high-performance and cost-effective membranes [1,2]. Moreover, asymmetric membranes are designed to exhibit a gradual variation in properties across their cross-section using radiation-induced grafting approach. Furthermore, we are addressing the issue of hydrogen crossover in thin membranes by embedding recombination catalysts directly into the membrane matrix by electrospinning for PEMWE applications. Our integrated approach includes ex-situ and in- characterization techniques, to study membrane properties across multiple scales and optimize their integration into complete PEMFC, AEMFC and PEMWE.

[1] M. M. Nasef, S. A. Gürsel, D. Karabelli, O. Güven, Prog. Polymer Sci. 63, 1 (2016)

[2] N. R. Mojarrad, S. Sadeghi, B. Y. Kaplan, S. A. Gürsel, E. Güler, ACS Appl. Energy Mat. 3, 532 (2020)

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