Advancing Polymeric Membranes for Hydrogen Production and Utilization

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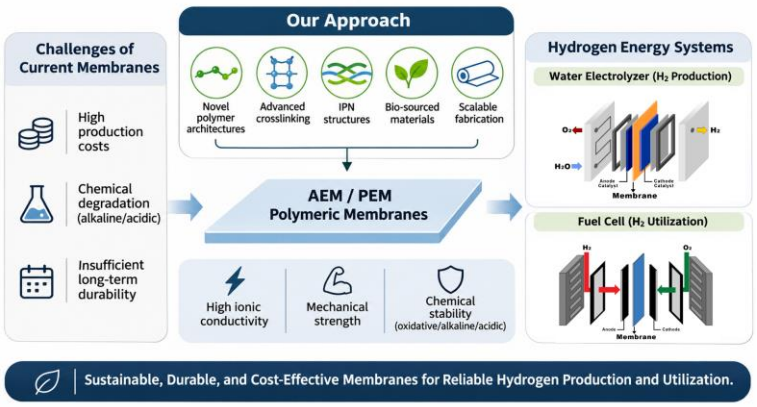
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Abstract

The development of hydrogen energy systems depends on components that are both reliable and cost effective to support production and utilization. Polymeric membranes, particularly anion exchange membranes (AEMs) and proton exchange membranes (PEMs), are critical to water electrolyzers and fuel cells. They enable selective ion transport, sustain system performance, and provide chemical and mechanical stability under demanding conditions. However, most commercial membranes are limited by high production costs, vulnerability to chemical degradation in alkaline or acidic environments, and insufficient long-term durability, which constrains their broader application in hydrogen technologies.

Our research addresses these challenges through the design and fabrication of low-cost, high-performance membranes based on novel polymer architectures. The strategy combines advanced crosslinking methods, interpenetrating polymer network (IPN) structures, and the use of bio-sourced materials to improve stability and minimize environmental impact. These membranes are developed to deliver high ionic conductivity, mechanical strength, and resistance to oxidative and alkaline or acidic degradation. A key focus is placed on scalable fabrication techniques to ensure industrial relevance for both AEM and PEM configurations.

By combining sustainable materials with robust polymer designs, this work aims to advance membrane technologies that support reliable, durable, and affordable hydrogen production and utilization, contributing to the wider deployment of hydrogen energy systems.



Recent Publications (maximum 5)

[1]. M. Jellab, A. Essate, L. Ahsaini, M. Matrouf, F. Semlali, and F. Ghamouss, J. Memb. Sci. 759, 126157 (2026).
[2]. M. Jellab, L. Ahsaini, M. Matrouf, and F. Semlali, RSC Adv. 15, 40823 (2025).
[3]. L. Ahsaini, M. Jellab, M. Matrouf, F. Semlali, and F. Ghamouss, J. Power Sources 669, 239425 (2026).
[4]. O. Bendalahcen, S. Ez-zahraoui, R. Bouhfid, and J. Alami, Int. J. Biol. Macromol. 333, 148853 (2025).
[5]. F.Z. Semlali, A. Ait Benhamou, K. El Bourakadi, A.E.K. Qaiss, R. Bouhfid, J. Jacquemin, and M. El Achaby, Chem. Eng. J. 473, 145268 (2023).

Biography



Dr. Fatima Zahra Semlali is an Assistant Professor in the Materials Science, Energy and Nanoengineering (MSN) Department at Mohammed VI Polytechnic University (UM6P). She holds a PhD in Mechanics and Materials Science.

Her research focuses on sustainable polymeric materials, including ion-conducting membranes for hydrogen technologies, cellulose-based functional papers, and advanced thermoplastic composites. She leads and contributes to national and international research projects, with publications (+70), patents (6), and prototypes developed from laboratory to industrial scale.

She is also the founder of ENPACT, a startup specializing in sustainable paper and packaging, and serves as Scientific Initiative Manager of the Moroccan National Energy Transition Consortium (MNETC).

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