MATERIALS SCIENCE AND TECHNOLOGY

MUR DM 118 - Enhancing Electrochemical Applications by Microporous Polymer-Based Ion Exchange Membranes

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	There is a pressing need for the development of more efficient and cost-effective electrolyzers and fuel cells. Membranes are a critical component of these devices, and the development of new membranes that are fluorine-free, resistant to high temperatures and corrosion, and cost-effective is essential for the improvement of these devices. The optimization of innovative membranes is thus crucial for accelerating the energy transition and achieving a sustainable future. Progetto finanziato nell'ambito del PNRR – DM 118/2023 - CUP E14D23001890006
	Green hydrogen has emerged as a promising solution to achieve decarbonization, reducing our reliance on fossil fuels and mitigating the impacts of climate change. Green hydrogen is produced through the electrolysis of water using renewable energy sources such as solar and wind power. However, the high cost of hydrogen production remains a significant challenge that hinders its widespread use. To overcome this challenge, there is a pressing need for the development of more efficient and cost-effective electrolyzers and fuel cells. Membranes are a critical component of these devices, and the development of new membranes that are fluorine-free, resistant to high temperatures and corrosion, and cost-effective is essential for the improvement of these devices. Efficient and sustainable hydrogen production is critical for achieving the United Nations' Sustainable Development Goal (SDG) 7, which aims to ensure access to affordable, reliable, sustainable, and modern energy for all. The optimization of green hydrogen production through the development and optimization of innovative membranes can significantly contribute to the achievement of SDG 7. Additionally, the use of green hydrogen as a clean energy source can help reduce carbon emissions and thus contribute to the achievement of SDG 13, which focuses on taking urgent action to combat

Objectives	climate change and its impacts. Therefore, investing in research and development to enhance the efficiency of electrolyzers and fuel cells through the optimization of innovative membranes is crucial for accelerating the energy transition and achieving a sustainable future. The primary research objectives of this PhD thesis, while not limited to these, are: Synthesizing intrinsically microporous polymers containing benzo-imidazole groups or similar functionalities using scalable methods. Developing and studying membranes based on the previously synthesized polymers for efficient proton transport. The membranes will be fabricated using scalable methods and tested at both laboratory and pilot scales, with electrochemical characterization and study of gas diffusion through the membranes in case of fuel cell applications. Integrating the newly developed materials into electrochemical devices such as fuel cells and electrolyzers. The objective of this research is to advance the field of electrochemical technology by developing and optimizing intrinsically microporous polymer-based membranes for efficient proton transport. The scalability of the synthesis methods and fabrication of the membranes is of utmost importance to ensure that the technology can be commercialized and adopted on a larger scale. The integration of the developed materials into various electrochemical devices will further enhance the overall performance of the devices, leading to greater energy efficiency and sustainability.

Skills and competencies for the development of the activity	We are looking for candidates with a strong academic background in chemistry and a high level of motivation to engage in advanced research. Expertise in chemistry, polymer synthesis, film casting processes, thermochemical characterization methods and nanotechnologies is preferred for this position. Candidates should have excellent problem-solving abilities and laboratory experience. The ideal candidate should be independent while also being a strong team player.