Proton Exchange Membrane (PEM) Electrolyzers for green hydrogen production: from materials design to cell tests

Marco Etzi

Center for Sustainable Future Technologies, Istituto Italiano di Tecnologia, Via Livorno 60, 10144 Torino, Italy

marco.etzi@iit.it

Water splitting is regarded as a key technology to convert renewable energy into hydrogen, which can be later used as fuel or chemical. Among the different types of low-temperature electrolyzers, Proton Exchange Membrane (PEM) electrolyzers are especially suitable for the conversion of intermittent energy sources (such as wind or sun) into H_2 due to their high flexibility, short start-up time, and high efficiency when working at partial load.[1]

In this talk, first the components of a PEM electrolyzer (membrane, catalysts, binders, bipolar plates) will be introduced and their role will be discussed. The focus will then be on the design of materials that can address the challenges of high activity and extended durability.

The catalysts in PEM electrolyzers are typically made of noble metals, both at the cathode and anode. Pt/C and IrO_2 are the state-of-the-art catalysts for the hydrogen and oxygen evolution reactions, respectively, but their scarce availability and high price hinder the development of PEM electrolyzer at larger scale. Thus, efforts are spent on the development of catalysts with high activity, stability, and reduced noble content. With this regard, I will discuss some examples of catalyst preparation, characterization, and testing in a three-electrode cell [2,3].

Although catalyst design represents a main pillar, this is just the first step in the assembly process of a PEM electrolyzer. Challenges related to scaling up include catalyst deposition techniques and the development of ionomers that enable fast gas transport and high electrical conductivity in both the membrane and binder.

References

[1] T. Wang, X. Cao, L. Jiao, PEM water electrolysis for hydrogen production: fundamentals, advances, and prospects, Carbon Neutrality. 1 (2022) 1–19. https://doi.org/10.1007/s43979-022-00022-8.

[2] M. Etzi Coller Pascuzzi, A. Goryachev, J.P. Hofmann, E.J.M. Hensen, Mn promotion of rutile TiO2-RuO2 anodes for water oxidation in acidic media, Appl. Catal. B Environ. 261 (2020) 118225. https://doi.org/10.1016/j.apcatb.2019.118225.

[3] M. Etzi Coller Pascuzzi, J.P. Hofmann, E.J.M. Hensen, Promoting oxygen evolution of IrO2 in acid electrolyte by Mn, Electrochim. Acta. 366 (2021) 137448. https://doi.org/10.1016/j.electacta.2020.137448.