ADVANCED WATER ELECTROLYSER BASED ON A HIGH-TEMPERATURE DOUBLE-LAYER SOLID ELECTROLYTE

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ABSTRACT

Hydrogen emerges as a pivotal element in forthcoming sustainable energy systems, serving as a non-polluting energy carrier across diverse sectors. H_2 and fuel cells facilitate integrated energy systems, addressing significant energy and environmental challenges. Water electrolysis offers localized H_2 supply, enhancing distribution efficiency and sustainability[1–3]. The aim of this project is to design and develop an original, highly efficient, and durable high-temperature polymer electrolyte membrane (HT-PEM) electrolyser for producing high-purity hydrogen gas. The proposed electrolyser operates at temperatures ≥ 180°C. The innovative concept revolves around a high-temperature multi-layer membrane electrode assembly comprising a HT-PEM and a thin Inorganic Proton Conducting Layer (IPCL) between the PEM and the anodic electrocatalyst. The ultimate milestone is the advanced design and development of individual components and their integration into an efficient high-temperature PEM/IPCL electrolyser. By operating at temperatures above 180°C, the overall device efficiency is greatly improved due to decreased thermodynamic energy requirements and faster electrokinetics of oxygen evolution. Additionally, the higher operating temperature enables efficient coupling with High Temperature PEM fuel cells in a regenerative fuel cell water electrolysis cycle, utilizing the heat produced as a byproduct. The proposed research activities include the development and characterization of a thin inorganic layer with proton conductivity comparable to PEMs, preventing direct contact of active electrocatalysts with the polymeric membrane. Candidates for the IPCL that have been developed and characterized in our lab, including functionalized silica nanoparticles (with amine, sulfonic acid and phosphonic acid groups), solid acid compounds ($CsHSO_4$, CsH_2PO_4) and silica-based materials functionalized with phosphotungstic acid, each offering unique advantages in terms of stability and proton conductivity[4–6]. Overall, a novel approach to high-temperature electrolysis will be presented, addressing challenges through innovative material design and integration, with potential applications in various industries requiring high-purity hydrogen production.

KEYWORDS: PEM electrolyser, high-temperature, Multi-layer MEA, Inorganic electrolyte

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