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Implementing Ionic Liquids in IT-PEMFCs

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In recent years, there has been growing interest in developing advanced membrane materials for hydrogen-based energy conversion systems, particularly polymer electrolyte membrane fuel cells (PEMFCs). Operating PEMFCs at intermediate temperatures (ca. 150 °C) offers several advantages over conventional low-temperature systems (ca. 80 °C), including improved fuel impurity tolerance, and both simplified water and thermal management [1]. However, conventional perfluorosulfonic acid (PFSA) membranes such as Nafion® exhibit a strong dependence on hydration for proton conduction, significantly limiting their performance above 80 °C.

To address these limitations, a variety of ionic liquid (IL)-based membrane systems have been investigated. One approach involves doping traditional polymers like Nafion® with ILs to extend their conductivity into the intermediate-temperature range. While this method introduces high-temperature proton conduction, it often suffers from IL leaching, particularly with hydrophilic protic ionic liquids (PILs). To overcome these stability challenges, polymerised ionic liquids (poly(ILs)) doped with PILs have been explored, offering partial mitigation of leaching but still presenting mechanical and thermal stability concerns at elevated temperatures [2,3].

A more recent and promising strategy involves the use of protic polymerised ionic liquids (protic poly(ILs)), which act as intrinsic proton-conducting polymers and eliminate the leaching problem. Despite this advantage, membranes based solely on protic poly(ILs) can exhibit insufficient mechanical robustness at intermediate temperatures [4,5]. To improve the structural integrity of these materials, co-polymerisation approaches have been introduced, where protic poly(ILs) are co-polymerised with other monomers to form mechanically reinforced membranes suitable for IT-PEMFC applications.

This study focuses on the comparative evaluation of these IL-based membrane strategies—PFSA-IL blends, PIL-doped poly(ILs), neat protic poly(ILs), and co-polymerised protic poly(ILs) in the context of their conductivity, thermal stability, and mechanical durability under intermediate-temperature fuel cell operating conditions.

References

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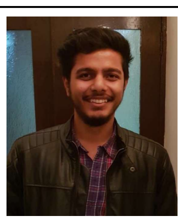

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