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Anisotropic radio-chemically pore-filled composite proton exchange membranes for fuel cell

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Most electrochemical conversion and storage devices, such as fuel cells and redox-flow batteries, rely on the amazing properties of ion conducting polymer membranes. The development of polymer electrolyte membranes (PEMs) combining high ion conductivity and durability is a major challenge for materials chemistry. Nafion® (DuPont) is state of the art membrane due to its good mechanical strength, excellent proton conductivity and stability, but its limitation to low temperature operation, high cost and fuel crossover are major obstacles that renders its usage in commercialization of fuel cell. Various polymers have been synthesized and explored as an alternative membrane material to reduce cost and improved proton conduction to Nafion but most of these showed trade off properties. The membranes showing good conduction may have poor stability or mechanical strength. This fact impedes the technology to achieve commercialization status. In present study, radiochemical pore filled membranes were prepared in which porous polyethylene (PPE) substrate was radio-chemically grafted and filled with styrene/acrylic acid copolymer. Proton Exchange Membranes prepared through radiochemical pore filling process exhibited high ionic conductivity. High conductivity is attributed to the formation of micro level confinement within the membranes for ion transport is reported for the first time. Despite their simple preparation method, consisting single radiochemical grafting and pore-filling step using commercially available porous substrate, involves least amount of chemical. The polymer provides PEMs which exhibited exceptional proton conductivity at good but relatively lower ion-exchange capacity, as well as a high swelling resistance. An unprecedented hydroxide conductivity of 274 mS cm^{-1} is obtained at an ion-exchange capacity of 2.85 meq g^{-1} under optimal operating conditions. The exceptional ion conductivity appears related to the intrinsic microporosity of the charged polymer matrix, which facilitates rapid cation transport.

Biography

Tauqir A Sherazi is an Associate Professor and Head of Material Chemistry Group at Department of Chemistry, COMSATS Institute of Information Technology, Pakistan. His expertise is in the development of cost effective and highly efficient polymer electrolyte membrane materials through controlling the chemistry and morphology of the polymers.

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