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Nafion® based hybrid composite membrane containing GO and dihydrogen phosphate functionalized ionic liquid for high temperature polymer electrolyte fuel cell

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Abstract

A new hybrid composite proton exchange membrane has been synthesized from dihydrogen phosphate functionalized imidazolium ionic liquid (IL-H_2PO_4), graphene oxide, and Nafion 117 solution. The chemical structure and thermal stability of the dihydrogen phosphate functionalized imidazolium ionic liquid (IL-H_2PO_4) have been analyzed by ^1H nuclear magnetic resonance (NMR) spectroscopy, Fourier transform infrared (FTIR) spectroscopy, and thermogravimetric analysis (TGA). The structural, thermal, and surface properties of synthesized membrane have been confirmed by FTIR spectroscopy, X-ray diffraction, TGA, and scanning electron microscopy. The proton exchange membranes have been characterized by their ionic conductivity and unit cell performance. The incorporation of IL-H_2PO_4 and graphene oxide in the Nafion membrane increases its thermal stability. The ionic conductivity of the membranes increases with temperature and amount of IL-H_2PO_4. The highest ionic conductivity of 0.061 Scm^{-1} has been achieved at 110°C under anhydrous conditions which is 1.3 times higher than that of commercial Nafion 117. The synthesized membrane, Nafion/IL/GO, shows the best unit cell performance with a power density of 0.02 W cm^{-2}, which is 13 times higher than that of the commercial Nafion 117 membrane at 110°C.