Structural Features and Proton Conductivity of Nafion-$CsHSO_4$ Composite Membranes

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Anhydrous solid electrolyte membranes with high proton conductivity at intermediate temperatures (150 – 250 °C T-range) are considered key materials for obtaining high power density output in direct alcohol fuel cells (DAFC) and direct methane fuel cells (DMEFC) [1]. High proton conductivity (~10^{-2} Scm^{-1}) has been observed in solid acids (CSP) such as $CsHSO_4$ at T > 140 °C. The use of such materials in PEFCs has simplified the water management and provided high current densities at intermediate temperatures. However, CSP thin films are fragile, water soluble, and the fabrication of low thickness films is a hard task [1]. On the other hand, polymer electrolytes such as Nafion are flexible and easily obtained in a broad range of thicknesses. However, in anhydrous conditions these polymeric membranes are electrical insulators. In this context, the fabrication of composite membranes based on the addition of $CsHSO_4$ into Nafion matrix above the percolation threshold can substantially improve the proton conductivity at T > 140 °C. The composite membranes were prepared by the *in situ* incorporation of $CsHSO_4$ by the evaporation/precipitation method. The prepared membranes were characterized by infrared spectroscopy (FTIR), X-ray diffraction (DRX), small angle X-ray scattering (SAXS) and proton conductivity under N_2 flow. Highly-stable proton conducting membranes based on Nafion-CSPs were obtained. The addition of $CsHSO_4$ into Nafion at high loadings results in a pronounced increase of the proton conductivity at anhydrous condition. The proton conductivity of such composites is a result of the combination of the transport and physical properties of the host matrix and the inorganic filler.

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References

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