

Nafion/Exfoliated-ZrP Hybrid Membrane for DMFC Applications

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Nafion/exfoliated-Zirconium Phosphate (e-ZrP) hybrid membrane was developed in this research for direct methanol fuel cell (DMFC) applications. The hybrid membrane was made by dispersed e-ZrP nano-sheet in Nafion solution with different solid content as a methanol barrier material. The ZrP inorganic proton conductor used in this study were prepared by in-situ synthesis method and swelled by swelling agents (Propylamine, PA) than identified by XRD (Fig1) and TEM (Fig3).

The physico-chemical properties of hybrid membranes were investigated by proton conductivity and methanol permeability measurement (Table1). The most advantage of nano exfoliated-ZrP sheet was its large surface area and which exhibits uniform distribution and miscibility in Nafion polymer matrix. ZrP also has proton conduction group on its surface hence the hybrid material can have lower methanol permeability but still good conductivity. The TGA result also shows that hybrid membrane has better thermal properties than Nafion (Fig4).

Reference

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Table1. Proton conductivity and methanol permeability of hybrid membrane

	Conductivity (S/cm)	Methanol Permeability (cm ² /s)
Nafion117	6.0×10^{-2}	2.6×10^{-6}
Nafion/PPA-ZrP 1phr	4.5×10^{-2}	1.0×10^{-6}
Nafion/PPA-ZrP 3phr	5.5×10^{-2}	0.4×10^{-6}
Nafion/PPA-ZrP 5phr	2.5×10^{-2}	0.6×10^{-6}

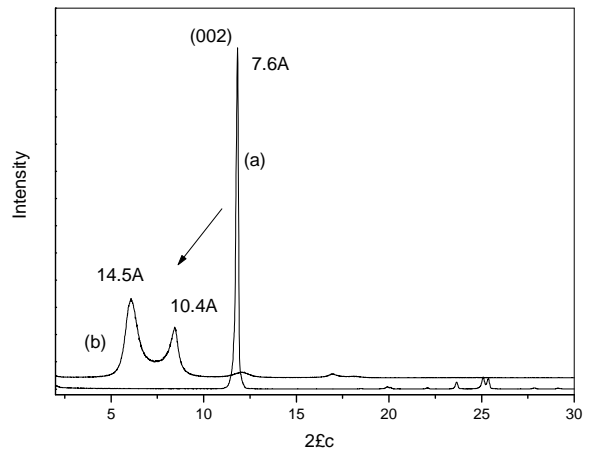


Fig1. XRD patterns of (a) α -ZrP (b) propylamine swelled ZrP

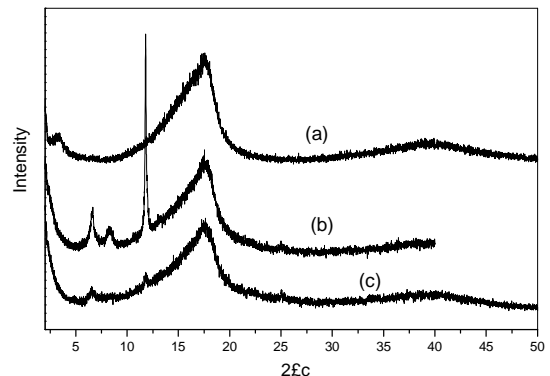


Fig2. XRD patterns of (a) Nafion (b) Nafion/ZrP (c) Nafion/propylamine swelled ZrP

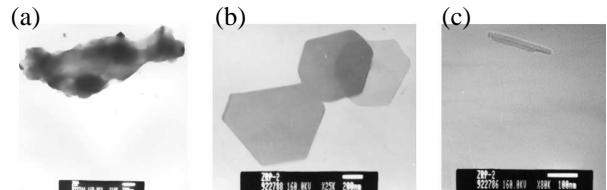


Fig3. TEM Micro graph of (a) ZrP before swelling (b) e-ZrOP single sheet (Top view) (c) e-ZrOP single sheet (side view)

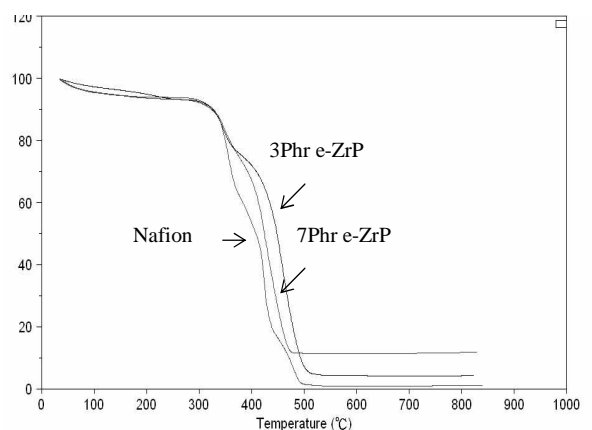


Fig4. TGA result of Nafion/e-ZrP hybrid PEM with different e-ZrP content