A Study of Morphology and Transport Properties of Perfluorosulfonic Acid PEM Doped with Heteropoly Acids

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Perfluorosulfonic Acid (PFSA) proton exchange membranes (PEMs) have great advantage in operating efficiencies, power densities and system versatility. However, their performance is heavily dependent on sufficient water uptake. It is beneficial for PEMs to operate at hotter and drier conditions to prevent poison of Pt catalyst and excessive swelling, [1] and to simplify heat exchange system. [2] One way to achieve this goal is through addition of inorganic particles such as HPAs. Due to HPAs' strong interactions with the sulfonic acid groups of ionomers,[3] morphological changes may occur upon doping, resulting in altering of performances and properties of the PFSAs.

We used Small Angle X-ray Scattering (SAXS) to investigate the morphology of HPA doped PFSA PEMs at different hydration levels (Fig 1). Morphological variation with different HPA loadings was observed. Pulse Gradient Spin Echo (PGSE) NMR was used to study the transport properties of PEMs under both maximum and minimum hydration states. We investigated the tortuous diffusion behaviour of proton in PEMs, with self diffusion coefficient obtained for different diffusion time. In combination with Electrical Impedance Spectroscopy (EIS), we have obtained valuable information about the effect of HPA presence to the proton transport behaviour of PEMs (Fig 2). FTIR was also used to study the HPAs' interaction with ionomer and their effects to the water uptake and proton transport. Further, MD simulation was carried out to study morphology and transport properties of HPA doped PEMs, with good agreement obtained between simulated and experimental results.

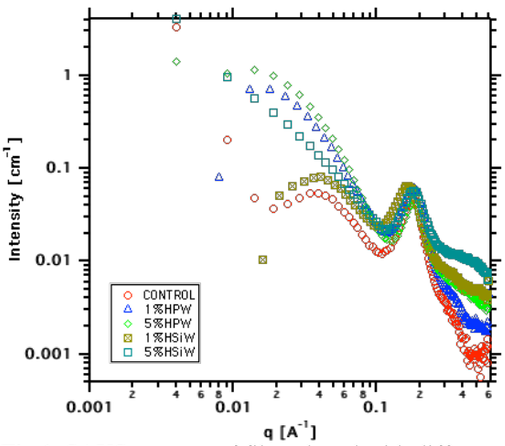
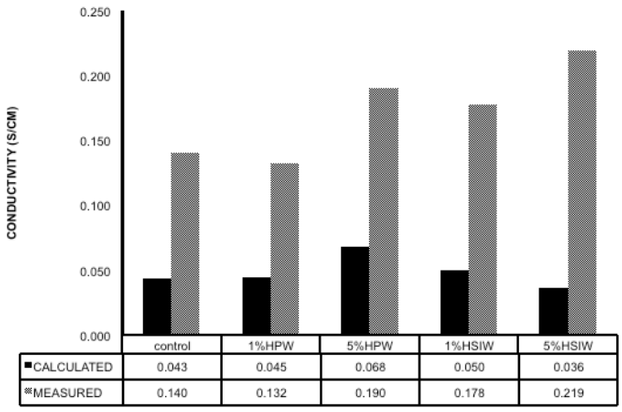


Fig 1. SAXS patterns of films doped with different types and loadings of HPAs at 95%RH.



	control	1%HPW	5%HPW	1%HSIW	5%HSIW
CALCULATED	0.043	0.045	0.068	0.050	0.036
MEASURED	0.140	0.132	0.190	0.178	0.219

Fig 2. Conductivity at 95%RH: measured and calculated from Nernst-Einstein equation.

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