Dynamics of hydrated electrolyte membranes for fuel cells

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In polymer electrolyte fuel cells (PEFCs), proton exchange membranes (PEMs), such as Nafion®, are commonly used. Anion exchange membranes (AEMs), synthesized in University of Yamanashi, are attracting attentions to be employed in future PEFCs using non-precious metal catalysts. In AEMs, the conductive ions are hydroxide ions. To investigate the anion paths in the AEM, QENS spectra were observed in hydrated AEMs.

QENS measurements were carried out with a time-of-flight type spectrometer, AGNES. The wavelength of the neutron beam was 4.22 Å, the momentum transfer range was 0.37-2.7 $Å^{-1}$, and the measuring temperature range 288 - 363 K. A resolution function of the instrument was determined with a vanadium foil. The half-width at half-maximum of the resolution function was ~150 μeV.

QPAF-4, an AEM, was measured. Nafion was also measured for comparison. The molecular structures of these polymers are shown in Fig. 1. Hydrated membranes were prepared under humidity- and temperature-controlled conditions. The membrane was sealed into an aluminum cylindrical cell. The measured samples are as follows:

Nafion + H_2O (80 – 40 %RH)

QPAF-4, IEC=2.0 + H_2O (80 – 40 %RH)

QPAF-4, IEC=2.0 + D_2O (80 – 40 %RH)

QPAF-4, IEC=1.5+H_2O (80 %RH)

QPAF-4, IEC=1.5+D_2O (80 %RH)

The dynamical structure factors $S(Q, \omega)$ were analyzed by a delta function and a Lorentzian function. Fig. 2 shows the Q dependence of full width half maximum (Γ) of the Lorentzian functions for Nafion + H_2O at 80 %RH and 60℃. The Γ values increased with increasing of Q. It could imply the dynamics of hydration water. More detailed information will be obtained from isotopic substitution results and activation energy analysis.

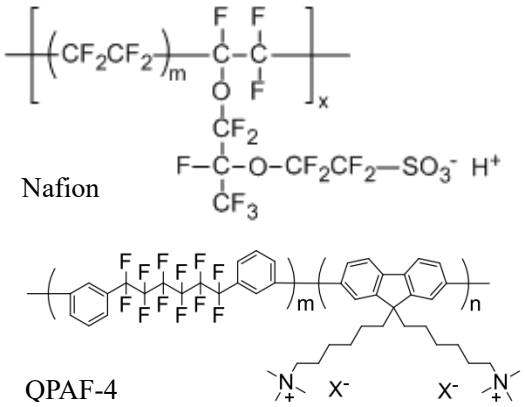

Fig. 1. The molecular structures of Nafion and QPAF-4

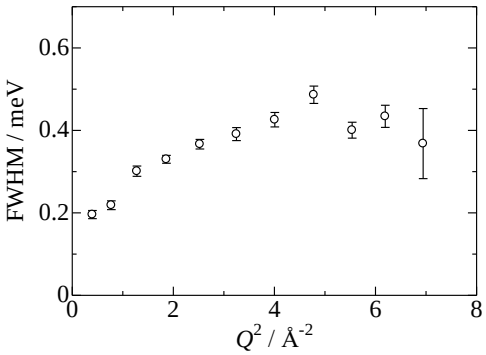

Fig 2. Q^2 dependence of full-width half-maximum of the Lorentzian functions for Nafion + H_2O at 80 %RH and 60℃