Structural study on Tetra-PEG ion gel using aprotic ionic liquids studied by SANS

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In development of polymer electrolytes and membranes based on ionic liquids (ILs), i.e. ion gels, a major and/or serious problem is the requirement of high polymer content in the ion gel to obtain a freestanding gel with high mechanical properties. The performance of the ion gel is limited mainly by this requirement; therefore, we need to realize a freestanding ion gel with much lower polymer concentrations. Recently, we have prepared ion gels containing a much lower polymer concentration from 1-methyl-3-methylimidazolium bis(trifluoromethansulfony)amide, [C2mIm][TFSA] and 3-6 wt% tetra-arm poly(ethylene glycol), Tetra-PEG. As well known, the mechanical properties of gels strongly depend on their structure. In this work, we thus carried out small-angle neutron scattering (SANS) measurements for the Tetra-PEG ion gels.

SANS measurements were carried out using SANS-U spectrometer with the camera length 4 m. SANS profiles corrected for background using an empty cell were normalized with respect to the scattering of polyethylene as a secondary standard material. The SANS profiles thus obtained were further corrected for the incoherent scattering to obtain the scattering intensity, I(q).[1]

Figure 1 shows the SANS profile observed for 3.2 wt% Tetra-PEG ion gel with fully deuterated [C2mIm+][TFSA-], together with the corresponding Tetra-PEG macromer solution. The SANS profile observed for the macromer solution could be represented by theoretical scattering function for star-polymer, i.e., a Debye type function with an asymptote of I(q) ~ q-2. In the Tetra-PEG ion gel system, it was found that the profile is almost similar to that for the corresponding macromer solution. No peak and/or upturn originated from network inhomogeneities were observed in the SANS profile. This strongly suggests that the Tetra-PEG successfully forms a homogeneous network structure in the [C2mIm+][TFSA-], resulting in the high mechanical properties of Tetra-PEG ion gel examined here.

[1] Shibayama M., Matsunaga T., and Nagao M. J. App. Cryst. 2009, 42, 621.

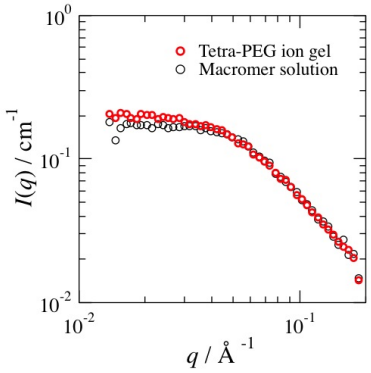

Fig. 1. SANS profiles observed for 3.4 wt% Tetra-PEG ion gel and the corresponding macromer solution.