Dynamics of Water on Surface of Reverse Osmotic Membranes

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Reverse osmotic (RO) membranes are regarded as the most promising targets for seawater desalination and waste-water reclamation. In improving water quality, one of the most significant problems is the removal of boron which is harmful for human body. Boron usually exists as boric acid (HBO_3) in natural water. Recently, high boron removal and energy saving RO membranes for seawater desalination have been developed by Toray industries, Inc [1]. The functional surface material of this membrane is aromatic polyamide, which has a network structure with many 3-dimensional pores. Since the size of pore (ca. 7 Å) is larger than the molecular size of boric acid (4 Å), the mechanism of removal of boric acid may be not a simple molecular sieving effect, but a sort of adsorption process on the polyamide surface. Our purpose is to elucidate this mechanism by investigating the dynamics of water and polyamide using quasielastic neutron scattering (QENS).

We have measured two water/polyamide systems, $(C_{30}H_{20}O_7N_6)$-xH_2O (x = 1 and 1.5 in weight ratio), on IRIS (ISIS) using a PG(002) analyzer at several temperatures between 200 and 320 K. Figure 1 shows the QENS spectrum of $(C_{30}H_{20}O_7N_6)$-1.5H_2O at 300 K. The H atom ratio n(polyamide):n(water) are 1:3.2 for the $x = 1$ sample and 1:4.8 for the $x = 1.5$ sample. This means that the incoherent scattering from water is mainly observed in these samples. As is representative of Fig. 1, all of the data were fitted well by

$$S(Q,\omega) = R(Q,\omega) \otimes [L_1(\omega) + L_2(\omega) + \delta(\omega)] \quad (1)$$

where $L_i(\omega)$ $\delta(\omega)$ and $R(Q,\omega)$ denote Lorentzian, delta, and instrumental resolution functions, respectively. The symbol $\otimes$ represents convolution. This result demonstrates that there are two kinds of water in water/polyamide systems. The faster relaxation may be for "free" (but confined and not bulk) water and the slower one we presume is for water strongly bound by polyamide. We plan to measure the partially-deuterated samples to investigate the motions of water and polyamide separately.

References

[1] M. Henmi *et al.*, Water Science and Technology **62**, 2134 (2010).

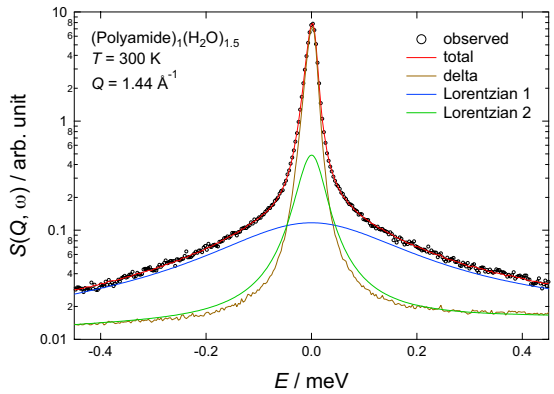

Fig. 1. QENS spectrum and results of fitting.