Small-Angle Neutron Scattering Study on the Miscibility and Concentration Fluctuation of Hydrogen Bonding Polymer Blends

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The effects of hydrogen bonding (H-bonding) on the composition fluctuation in miscible polymer blends were examined by utilizing small-angle neutron scattering (SANS) method. Specifically, we used the blends composed of poly(vinyl acetate-co-vinyl alcohol) (P(VA-VOH)) with various VOH content (fOH) and deuterated poly(ethylene oxide) (dPEO), since the formation of the H-bond between the hydroxyl group of P(VA-VOH) and the ether oxygen of dPEO is expected. Furthermore, the advantageous point of this system is that the degree of H-bonding can be changed by the variation of fOH. In this study, we prepared P(VA-VOH) samples having different fOH (molar fraction) (= 0, 0.10, 0.18, 0.28, 0.35) by the saponification reaction of PVA. The blend composition of P(VA-VOH):dPEO = 80:20 was mainly examined for the SANS measurements.

For all the blends, the SANS intensities increased with increasing temperature T implying the existence of lower critical solution temperature. For the P(VA-VOH)/dPEO (80/20) blends with fOH $<$0.28, the scattering profiles S(q) could be well represented by the random phase approximation (RPA) theory. Based on this theory, the interaction parameter X was determined as a function of T. Figure 1 shows the fOH dependence of X at T=343K. As seen in this figure, the X shows a minimum at around fOH=0.15, meaning that the blend at this particular fOH is the most miscible. Furthermore, we found that the random copolymer theory (solid curve in the figure) could quantitatively explain the fOH dependence of X.

For the blend of fOH=0.35, on the other hand, the RPA theory did not fit the S(q) well, especially at the small q region. The experimental data at the small q were found to be more suppressed than the theoretical prediction. This behavior suggests that the formation of larger number of H-bonds might suppress the composition fluctuation.

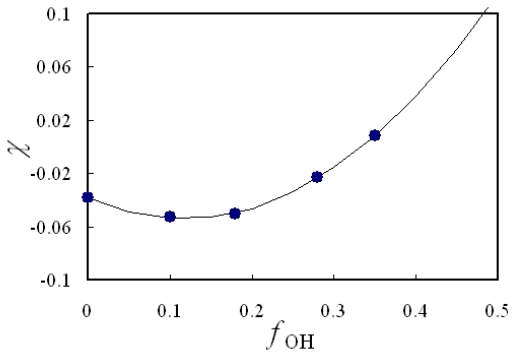

Fig. 1. fOH dependence of the interaction parameter X for P(VA-VOH)/dPEO (80/20) blends at T=343K. Solid curve represents the fitted result with the random copolymer theory.