Effects of the Dielectric Contrast and Hydrogen Bond Between Polymer and Ionic Liquid on Macroscopic Phase Separations

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We consider the dielectric contrast and hydrogen bond between a homopolymer and an ionic liquid and the effect of fluctuations in the local density and electrostatic potential. Our coarse-grained mean-field theory shows that such an effect may rationalize the observed shift in the critical point and the asymmetry of the observed spinodal curve. The effect of the dielectric contrast between the polymer and the ionic liquid causes a significant shift in the critical point of the spinodal from a polymer-poor to a polymer-rich region. The fluctuation effect changes the trend of the phase boundary in a nonmonotonic manner. Hydrogen bonding also yields similar effects, but the spinodal curve rather exhibits a double-well structure or relatively flat structure when combined with the solvation energy of ions. We thus demonstrate that hydrogen bonding, ion solvation, and fluctuations have equal significance on the magnitude and trend of the spinodal curve.