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EXPERIMENTAL STUDY ON PHASE SEPARATION DYNAMICS OF UNENTANGLED POLYMER BLEND WITH DYNAMIC ASYMMETRY

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ABSTRACT

To design intelligent polymeric materials, we are frequently required to predict phase separation behavior of polymer blends. Thus, it is important to understand the phase separation dynamics since the behavior is tightly related to the dynamics of each component in blends. To evaluate the component dynamics in blends, we focus on a combination of dielectric and viscoelastic measurements. Utilizing this combination of experimental methods, we attempted to obtain the mobility of the component fluxes Λ, which is required to predict the time evolution of the phase separation. We examined blends of dielectrically active polyisoprene (PI) and dielectrically inert poly(4-ethylstyrene) (PC2St) samples, having the molecular weights of $M = 7.5 \times 10^3$ and $M = 4.2 \times 10^3$, respectively. Here, we note that PI has a dipole parallel along the chain backbone and PC2St does not, the large scale molecular motion of PI chains can be exclusively detected by the dielectric measurements. The blend system with the low-M components shows the upper critical solution temperature, and thus exhibits an uniform state at temperatures higher than the phase separation temperature (T_s). For various PI/PC2St blends with different PI weight fractions w_PI, we first conducted dielectric and viscoelastic measurements at several temperatures above T_s to determine the friction coefficient ζ_i (i = PI or PC2St), which is needed to evaluate Λ. We found that the T-dependence of ζ_i is reasonably captured by the Williams–Landel–Ferry (WLF) equation. The WLF results were extrapolated to obtain the composition-dependent friction coefficient ζ_i^* at test temperature T^* below T_s. Then, Λ values were deduced from the incompressible theory[1] that relates Λ with experimental ζ_i^* values. Utilizing Λ values, we numerically solved the time-dependent Ginzburg-Landau (TDGL) equation with the composition-dependent Λ in a 2D system. From the TDGL simulation, we obtained the droplet-like and PI-rich phase, which is consistent with the observation by the optical microscope.[2]

REFERENCES

1. Brochard F., Jouffroy J., and Levinson P. Polymer-polymer diffusion in melts, *Macromolecules*, **16**, 1638 (1983).
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