Microscale mass transport in ternary polymer solutions observed by Soret forced Rayleigh scattering method

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We developed the experimental setup for the measurement of the microscale mass transport phenomena including the mass diffusion and the Soret effect. The driving force of the Soret effect is the temperature gradient, while the mass diffusion is driven by the concentration gradient. The Soret effect as well as the mass diffusion plays significant roles in various micro/nanoscale systems.

In our technique which we call the Soret forced Rayleigh scattering (SFRS) method [1], both the excitation and the probing of the mass transport are carried out optically. Three lasers of different wavelengths are employed for the measurement of ternary mixtures, one for the excitation of the mass transport and the others for the probing (Fig. 1). The heating laser (wavelength λ = 532 nm) crosses at the sample to induce the Soret effect by the temperature distribution with the interference grating. Usually the fringe spacing, which corresponds to the diffusion length, is adjusted to about five micrometers. The microscale mass transport in millisecond order is read out by the probing lasers (λ = 403 nm, 639 nm), which enter the sample at the Bragg angle. The photomultiplier tubes detect the temporal intensity change of the diffracted beams, which includes the information of the mass transport. This technique needs very small sample volume of 10^1–10^2 μL.

We experimentally examine the mass transport phenomena in ternary polymer solutions of cellulose acetate butyrate (CAB), styrene, and methyl ethyl ketone (MEK) at T = 298.2 K. Figure 2 shows the detected signals of the Soret effect. The complex behaviors of the ternary system have been observed by our technique.

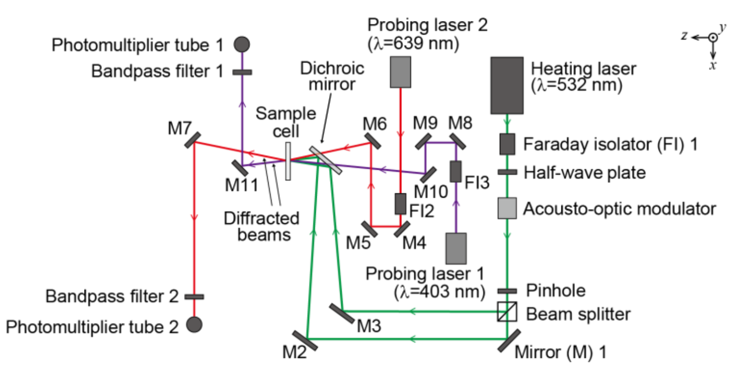

Fig. 1: Experimental setup for ternary systems.

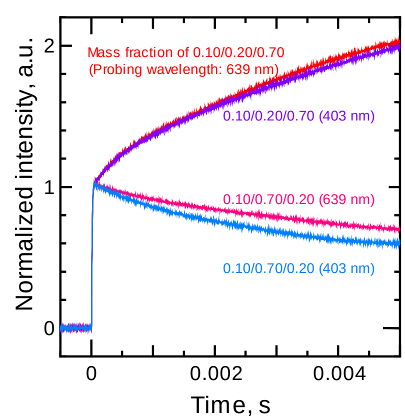

Fig.2: Detected signals of CAB/styrene/MEK.

[1] H. Matsuura, S. Iwaasa, and Y. Nagasaka, *J. Chem. Eng. Data* **60**, 3621–3630 (2015).