Development of Measurement Technique for Cross Diffusion Coefficient and Soret Coefficient in Ternary Fluid Mixtures using Soret Forced Rayleigh Scattering (Theory and Experiment using Two Probing Lasers of Different Wavelengths)

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In fluid mixtures composed of more than three components, diffusive mass transport is driven not only by concentration gradient of the component but also by concentration gradient of other components (cross diffusion) and by temperature gradient (Soret effect). Although it is important to evaluate cross diffusion coefficient and Soret coefficient for understanding mass transport phenomena in fluid mixtures, there has not been an established measurement technique even for ternary systems. In the present study, we have developed the theory for measurement of cross diffusion coefficient and Soret coefficient in ternary fluid mixtures by Soret Forced Rayleigh Scattering (SFRS) method. SFRS is an optical measurement technique using lasers. Using this method, it is expected to realize high speed (less than 10 ms), small sample volume (less than 1 ml) and non-contact measurement for ternary solution. In the measuring principle, two probing lasers having different wavelengths are used. Difference in compositional dependence of refractive index by wavelength causes two different signals. Analyzing two signals in combination, it becomes possible to simultaneously evaluate two main diffusion coefficients, two cross diffusion coefficients and two Soret coefficients of ternary solution. We have constructed apparatus based on SFRS method with two probing lasers of different wavelengths (403 nm and 639 nm). Using this apparatus, we have preliminarily measured diffusion coefficient and Soret coefficient on the ternary mixture with n-dodecane, isobutylbenzene, and 1,2,3,4-tetrahydronaphthalene (equal weight fractions) at 25.0 °C by two probing lasers.