CHAPTER V

CONCLUSION AND DISCUSSION

Studies of polystyrene mixture in cycohexane solution with various weight fractions of molecular weight M = 100000 and M = 600000 have been performed. The temperature of the solution in this experiment was 37.2 – 49.8 °C. Different molecular weights gave different photon count rate, and therefore the signal of mixture could be seperated by using the information from the standard sample.

The wavelength of He-Ne is large when compared to the size of particles and therefore the scattering intensity is very weak as shown in Figure 4.4. To detect the weak signal the aperture of the lens system should be large enough more to cover coherent areas.

The autocorrelation function was fitted to a single exponential to observe the apparent diffusion of the system. The apparent diffusion coefficients of all samples, as shown in Table 4.6, increase with temperature. This could be explained as that the kinetic energy of particles is linearly dependent on the temperature. The particle will move faster at higher temperature.

The samples 3-7 were force-fitted to the sum of two exponentials with the parameter intensity ratio f (Table 4.3), and the experiment results show that the diffusion coefficient and other properties of polystyrene M = 100000 and M = 600000 can be explained separately as follows.

The diffusion coefficient of polystyrene M = 100000 in cyclohexane increases linearly with concentration and temperature as shown in Table 4.7. From Table 4.9, the zero-concentration (dilute) diffusion coefficient and hydrodynamic radius also increase linearly with concentration and temperature as shown in Figure 4.17 and 4.21 respectively. The constant k_D from the plot is positive as well as the k_D calculated from theory, but k_D from the plots have values from (4.54 - 5.3)x10^{-2} m^3/kg which are lower than the k_D which is calculated from theory of (5.02 - 10.58)x10^{-2} m^3/kg. The friction constant ς decreases linearly with the concentration as shown in Figure 4.23 - 4.29. The constant k_ς from analysis to the plot is negative and has a value between (-3.30 – -3.00)x10^{-2} m^3/kg, but from theory, values of k_ς are positive between (8.83 – 18.45)x10^{-2} m^3/kg.

The diffusion coefficient of polystyrene M = 600000 in cyclohexane increases linearly with concentration and temperature as shown in Table 4.8. From Table 4.10, the zero-concentration (dilute) diffusion coefficient increase linearly with temperature as shown in Figure 4.18, when the hydrodynamic radius seem to be constant with average value at 2.88×10^{-8} m. The constant k_D from the plot is positive as well as the k_D calculated from theory, but k_D from the plot has a value from 0.16 – 0.31 m^3/kg that is higher than the k_D calculated from theory of 0.19 – 0.21 m^3/kg. The friction constant ς decreases linearly with concentration as shown in Figure 4.29 - 4.34. The constant k_ς from analysis to the plots is negative and has the value of between $(-1.85 - -1.22) \times 10^{-2}$ m^3/kg, but from theory, values of k_ς are positive between $(3.28 - 3.58) \times 10^{-2}$ m^3/kg.

Moreover, by using Equation 4.4, we can evaluate the apparent diffusion coefficient from the diffusion coefficients D_1 and D_2 as shown in Table 4.15. The result for mixture solution, samples 3 – 7, is nearly to the apparent diffusion coefficient in Table 4.8.

In addition, according to the error in translational diffusion coefficient from force-fitting the autocorrelation function of two species system to the sum of two single exponentials as shown in Table 4.7 – 4.8 and in Figure 4.5 – 4.16, the error may come from polystyrene in mixture merging and moving together or the effect of multiple scattering in the system. However, by using the same conditions in data treatment processes, the experimental results are reliable.

In conclusion, by using the photon correlation technique (dynamic light scattering) and information from standards we can separate the signal from each species of polystyrene, when mixed in cyclohexane. Furthermore, by analyzing each component of the mixture, the properties such as diffusion coefficient and hydrodynamic radius match satisfactority with the monodisperse system. The constant k_ς of two species from the plots agree with none of the values from theories. It would obviously have been more satisfactory if the values of A_2 could have been obtained from the sample with the static light scattering technique. However, the experimental results would appear to be sufficiently accurate to test the theories.