ChE 529 Polymer Experimental Methods University of Rhode Island
Professor Greenfield Fall 2008

Lab 2, Dynamic Light Scattering
Lab report information

Make sure that your report addresses the following questions, based on the series of dynamic light scattering experiments. Adding comments to graphs using a pen is fine with me. Also **include any observations** that you made during the experiment.

Experiment 1: Results for a known polystyrene standard

1. These experiments used spheres of a 30 nm radius of gyration (as measured in static light scattering). What sizes did you measure, as reported using the different interpretation methods (cumulants, NNLS, etc.)? How do your results compare with that nominal size? Explain the results.

2. How did the the size and diffusion coefficient results compare when different sampling times were used? (Comparing the raw data on an overlay plot is useful for this.)

3. Calculate the scattering vector q for 90° scattering in water, and (for one set of data) combine the result with the diffusion coefficient D and relaxation time Γ reported in the experiment to confirm self-consistency in the relationship $\Gamma = Dq^2$. Then use the measured values of $\langle I \rangle^2$ and $\langle I^2 \rangle$ with the value of Γ to calculate the function $C(t) = \langle I \rangle^2 + (\langle I^2 \rangle - \langle I \rangle^2) \exp(-\Gamma t)$. Compare (on the same plot) this function and your raw data. Define the axes so the plot resembles the plot shown in the light scattering software. Explain the agreement and/or disagreement between this function and your data.

Experiment 2: Effects of instrument parameters

4. Calculate q^2 for each angle that you used. Prepare a plot of Γ vs. q^2, using the values of Γ reported by the light scattering software. Calculate a diffusion coefficient from the slope of Γ vs. q^2, i.e. $\Gamma = Dq^2$. How did this calculated diffusion coefficient compare with the values reported by the software at each angle?

5. How did the diffusion coefficient and size results vary with scattering angle? Which value(s) do you trust the most, and why? If any results seemed anomalous and/or unusual, describe them and demonstrate how the behavior seemed different.

Experiment 3: Polydispersity, part I

6. Perform the same kinds of data analysis as in experiment 1. How do the size results compare with the nominal size of the polystyrene? How does the size distribution compare to what you measured for the 30 nm sample?

7. How does the average size compare to the size expected for this sample? Are the residuals random for each analysis method? Do other analysis methods improve the agreement? Report the size distribution (from NNLS).

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Experiment 4: Polydispersity, part II

8. Compare the size distributions from experiments 1, 3, and 4. Presumably the distribution in experiment 4 is a linear combination of the distributions in experiments 1 and 3, since that is how you prepared the sample. Test this idea by determining an optimal fraction x for which

$$P_4(r) = xP_1(r) + (1-x)P_3(r)$$

   The notation $P_1(r)$ means the size distribution reported in experiment 1, etc. This meaning is analogous to the fraction of strings (in the first lab) that had a particular end-to-end distance.

9. To what extent does the best-fit predicted distribution compare to the distribution found using the analysis software? In other words, to what extent is the dynamic light scattering experiment capable of recognizing simultaneously the multiple size distributions that are present in the mixture?