

PEO Characterized by MALS-QELS

On-line quasi-elastic light scattering (QELS) is quickly gaining popularity for its ability to measure the radius of molecules whose size is below 10 nm, the lower size limit of multi-angle light scattering (MALS) detection. Another useful application of QELS is to determine the conformation of polymers when both the root-mean square (RMS) radius (R_g) and hydrodynamic radius (R_h) are measured by the respective MALS and QELS detection. As Burchard, Schmidt, and Stockmayer observed⁽¹⁾, the ratio of R_g to R_h reveals the *shape* of a polymer. For solid spheres, the ratio is 0.77; for random coil polymers, the ratio equals to 1.50. In this note, we demonstrate such an application.

A polyethylene oxide (PEO) sample was characterized by size-exclusion chromatography (SEC) combined with DAWN EOS, WyattQELS, and Optilab differential refractive index (DRI) detectors. We found that the PEO sample is quite monodisperse, as indicated by the RMS radius versus elution volume plot in Figure 1.

For such a monodisperse sample, the DAWN detector alone determines the absolute molar mass and RMS radius, but not the conformation. With the addition of the WyattQELS, R_h is also measured, as shown by the correlation function of the PEO sample in Figure 2.

The ratio of R_g to R_h for this PEO sample is 1.6, close to the value for a polymer with a linear chain conformation. The discrepancy between the value of 1.6 and 1.50 (predicted for linear polymers) is likely due to non-theta solvent conditions, and this PEO behaves more like a random coil in solution.

In conclusion, the WyattQELS detector complements the MALS detector by providing a means to measure *small* sizes (e.g. less than 10nm) and the ratio between R_g and R_h renders insights on the structure of polymers. As a result, branching degree of branched polymers may be quantified without references to their linear counterparts.

⁽¹⁾ W. Burchard, M. Schmidt, and W.H. Stockmayer, *Macromolecules*, **13**, 1265 (1980).

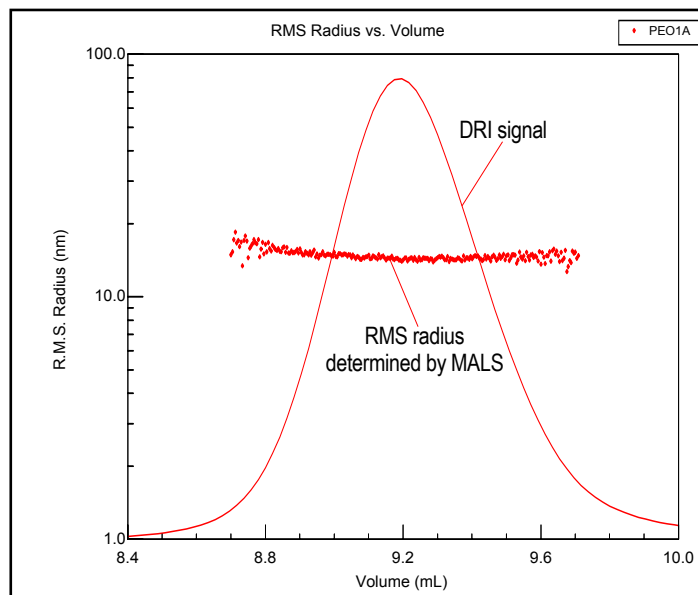


Figure 1. RMS radius versus elution volume plot of the PEO sample obtained from SEC-MALS analysis. The average RMS radius across the peak is 14 nm.

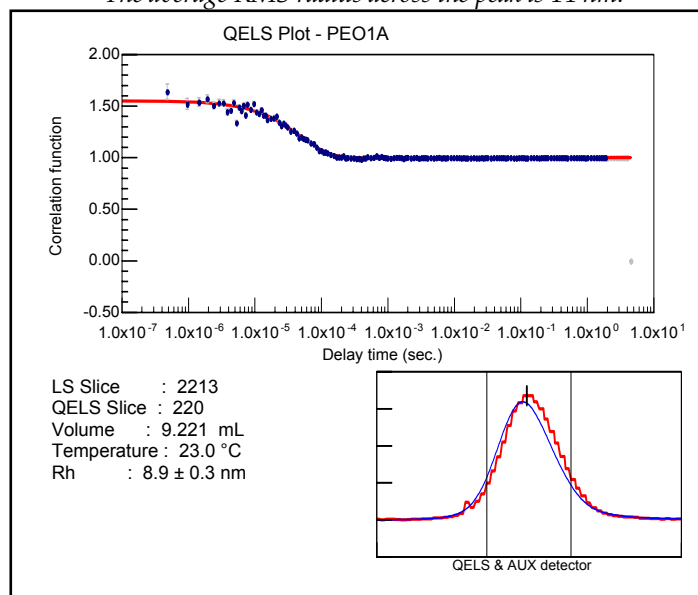
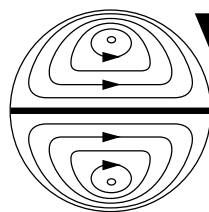


Figure 2. A correlation function of one data slice from the PEO sample obtained from SEC-QELS analysis. The hydrodynamic radius here is approximately 9 nm.



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