Quiz 8 Polymer Properties
March 6, 2020

a) The mass of a colloidal particle or of a polymer can be determined using membrane osmometry. This involves a solution of known mass concentration of the colloid/polymer separated from the pure solvent by a semipermeable membrane that allows solvent to pass but not the colloid/polymer. The solvent tries to dilute the colloidal solution and thereby increases the pressure on the solution side of the membrane. This pressure can be measured. Consider that the colloid/polymer particles are gas atoms moving with kT. The excess osmotic pressure on the colloid/polymer side can be calculated with the ideal gas law. Show how the molecular weight of the polymer/colloid can be determined in this measurement.

b) A light scattering measurement can be used to determine the radius of gyration for the colloid/polymer if the concentration is below the overlap concentration, c^*. Explain what c^* is and why you must be below c^* for this measurement (as well as for the membrane osmometry measurement) to work.

c) Describe the light scattering measurement by sketching a design of the light scattering instrument and showing the two important parameters that need to be determined in the measurement besides the scattered intensity, that is the parameters necessary for Bragg's law. What equation would you use to determine R_g from the scattered intensity? (Define the terms in the equation.)

d) Give expressions for R_g for a spherical colloid and for a polymer coil.

e) Explain how you could use the mass of the colloid/polymer and the radius of gyration to determine if the particles are colloidal or polymeric.

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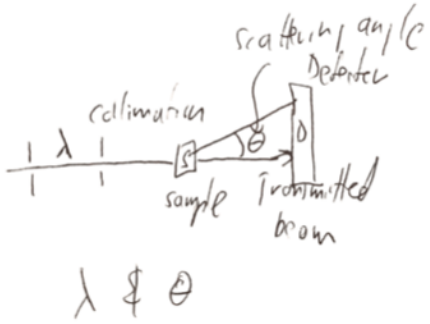
a) $\Pi = \phi_{molar}\, RT$

$\phi_{molar} = \phi_{mass}/MW$

So $MW = \phi_{mass}\, RT/\, \Pi$

b) $c^* \sim (MW/N_a)/R_g^3$
above c^* the coils overlap so you can't observe or measure any feature of a single coil such as its mass or size.

c)



Guinier's Law $I(q) = G \exp(-q^2 R_g^2/3)$
$q = (4\pi/\lambda) \sin(\theta/2)$

d) $R_{g,sphere} = \sqrt{(3/5)}\ R$
$R_{g,polymer} = R_{eted}/\sqrt{6} = n^{1/2} l/\sqrt{6}$

e) For a sphere $MW = N_a\, (4/3)\pi\, \rho\, R^3 = N_a\, (4/3)(5/3)^{3/2} \pi\, \rho\, R_g^3$
For a polymer $MW = n\, N_a\, M_0 = 6\, M_0\, N_a\, (R_{g,polymer}/l)^2$
So if you determine MW and R_g you can determine if it is a colloid or a polymer with a few constants.