Polymer Physics Exam #2 2008. 11. 19

Name______________________

1. (a) Polymer A is a rigid polymer and polymer B is a flexible polymer. If they have same contour length, compare their Kuhn length. (10)

   (b) There are several models about amorphous polymer dynamics. Name the models we've learned, and explain them briefly. (10)

2. With the advent of small-angle neutron scattering (SANS), molecular dimensions can now be determined in the bulk state. A polymer scientist determined the following data on a new deuterated polymer dissolved in a sample of polymer.

$\left[\frac{d\Sigma}{d\Omega}\right]^{-1}(cm)$	0.50	0.72	1.20
$K^2 \times 10^4$ (Å $^{-2}$)	1.00	3.70	10.1

   The constant C_N for this system was determined to be $10.0\text{x}10^{-5}$ mol/gcm.

   (a) What is the weight average molecular weight and the z-average radius of gyration of the polymer? (15)

   (b) From SANS data, we can confirm the value of $(Rg^2/M_w)^{1/2}$. What is the physical meaning of the value of $(Rg^2/M_w)^{1/2}$ (15)

   (Hint: for random coils, the end-to-end distance square (r) depends on the molecular weight (M) $r^2 = CM$; where C is a function of the chain molecular structure)

3. Compare and contrast the Avrami, Keith-Padden, and Hoffman theories of crystallization. (20)

4. Melting points of new polymers having lamella thickness 100 nm, 50 nm are 139.5℃, and 136.9℃, respectfully. Calculate the melting point of the polymer having 10nm lamella thickness. Use the following data: △f (heat of fusion) = 293 J/g, ρ_c = 1000 kg/m^{-3}, σ = 90 mJ/m^{-2}, and assume that it follows Hoffman's theory. (15)

5. There are three major types: crystalline, liquid crystalline and amorphous.

(a) Given an unknown polymer, what one experiment would you perform to identify which type you had? (10)

(b) What major behavioral differences would you expect among the three types? (10)

6. (a) There are two types of liquid crystal polymers; Lyotropic liquid crystal and thermotropic liquid crystal. Describe the reason why lyotropic liquid crystals form ordered state in concentrated solutions but thermotropic liquid crystals exist as ordered melts at high temperature. Consider molecular structures and physics. (10)

(b) Draw a viscosity-concentration graph of lyotropic liquid crystal and explain the reason why lyotropic liquid crystal polymer shows the behavior. Please draw the scheme of molecular orientation. (15)

7. (Challenge) The theory of scattering from anisotropic spheres at small scattering angle leads to the prediction that the intensity of scattering is given by

$$I = KV^2\left(\frac{3}{((4\pi R/\lambda)\sin(\theta/2))^3}\right)^2[(\alpha_t-\alpha_r)\cos^2(\theta/2)\sin\mu\cos\mu(4\sin((4\pi R/\lambda)\sin(\theta/2))$$
$$-((4\pi R/\lambda)\sin(\theta/2))\cos((4\pi R/\lambda)\sin(\theta/2))-3Si((4\pi R/\lambda)\sin(\theta/2)))]^2$$

$$,\ Si(t)=\int_0^t \frac{\sin x}{x}dx$$

K: numerical constant, V: volume of the sphere

α_t, α_r: tangential and radial polarizabilities of sphere

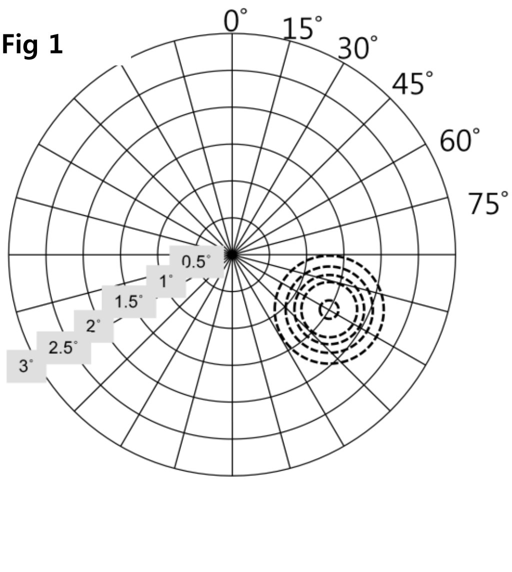
R: the radius of the sphere, λ: wavelength of the light

θ: angle between the incident and the scattered ray

μ: azimuthal scattering angle

Fig 1 shows a scattering pattern of a polymer. Dotted line is the contour line of scattering intensity. Calculate the radius of spherulite. (20)

Fig 1



8. The physical polymer science is usually the first course for the student interested in the polymer. Thus we have tried to introduce the broad fields of the polymer science and engineering. Comment whether or not the lecture covers properly what you want to learn about the polymer. If not, list the subjects in the polymer science which is in your interest and is wanted to learn from the lecture. (10)