Soft Matter Exercise - Chapter 5: Polymers

1. Polyethylene

For a linear polyethylene molecule with a molar mass of 128242 g/mol, calculate:

a. the contour length
b. the root mean square end-to-end distance

(Assume a bond angle of 109° and a C-C length of 0.155 nm)

2. Poly(ethylene glycol)

Calculate the radius of gyration of poly(ethylene glycol) (PEG) with a molecular weight of 6000 g/mol if dispersed in:

a. a good solvent
b. a poor solvent
c. What is the coil overlap concentration if PEG is dispersed in a good solvent?
d. What would be the PEG concentration in mol/L where $c = c_m^*$?

(Assume bond angles of 109° and C-C bond lengths of 0.155 nm and C-O bond lengths of 0.143 nm)

3. Polymers in Solution

You are asked to design a poly(ethylene glycol)-poly(lactic acid) (PEG-PLA) block-copolymer that forms polymersomes. The PLA block is given; its molecular weight is 5 kDa and its cross-section area is 6 nm^2. You are told that the hydrophilic block should be composed of PEG and can be considered to be dissolved in a good solvent. What molecular weight would you choose?
(Assume bond angles of 109° and C-C bond lengths of 0.154 nm and C-O bond lengths of 0.143 nm)

4. Polymer Melts

You have a product composed of polyethylene chains, each having 1000 repeat units for which you have optimized the processing conditions. You now decide that the properties would be better if you increase the number of repeat units by 100.

a. What would change in your processing and why?
b. How would you compensate for these changes?

5. Poly(styrene)

Measurements of the plateau modulus of poly(styrene reveal $G = 2 \times 10^5$ Pa at $T = 160$°C. Using a density of 1.05 g/cm^3, determine the molar mass between two entanglements (M_X) using:

$$G = \frac{\rho RT}{M_X}$$