Home assignments for the Course of Polymer Physical Chemistry

Fourth section of the course: Polymer Solution and Blends

1. Polymer with N segments is in a solution. The polymer-solvent interaction parameter χ=100K/T. How the temperature range of miscibility changes with the length of the chain?

$$T_C = \frac{B}{\frac{1}{2}\left(1+\frac{1}{\sqrt{N}}\right)^2} = \frac{200}{\left(1+\frac{1}{\sqrt{N}}\right)^2}\text{K}$$

This is the case of Upper Critical Solution Temperature because the c parameter decreases with temperature increase. The miscibility temperature range $T>T_C$. T_C increases from 50K for N=1 up to 200K at N->∞.

2. Polymer with N=100 segments in a solution has the polymer-solvent interaction parameter χ=-50K/T+0.8. Define the temperature range of miscibility of the polymer in the solvent.

$$T_C = \frac{B}{\frac{1}{2}\left(1+\frac{1}{\sqrt{N}}\right)^2 - A} = \frac{-50K}{\frac{1}{2}\left(1+\frac{1}{10}\right)^2 - 0.8} \approx 256K$$

This is the case of Lower Critical Solution Temperature, because χ increases with temperature increase. Thus the miscibility range is $T<T_C$~256K.

3. Two polymers have lengths N_1=100 and N_2=400 and polymer-polymer interaction parameter χ=0.5K/T+0.01. Estimate the temperature range of miscibility and critical volume composition.

$$T_C = \frac{B}{\frac{1}{2}\left(\frac{1}{\sqrt{N_1}}+\frac{1}{\sqrt{N_2}}\right)^2 - A} = \frac{0.5K}{\frac{1}{2}\left(\frac{1}{10}+\frac{1}{20}\right)^2 - 0.01} = 400K$$

This is an Upper Critical Solution Temperature because c decreases with temperature. Then the miscibility range $T>T_C$=400K.

$$\phi_C = \frac{\sqrt{N_2}}{\sqrt{N_1}+\sqrt{N_2}} = \frac{2}{3}$$

Critical volume composition is ϕ_1=1/3 and ϕ_2=2/3.