CHEM-E2130: POLYMER PROPERTIES

Examination date: Monday 10th December 2018

(You may use: A calculator and an A4 sheet of notes, handwritten on one side, with your name on it, leave the notes with your exam aswers)

Total marks 33

1. Answer briefly **all** of the following: ***(6 marks)***

   i. Describe the stages of polymer dissolution process.

   ii. What are the requirements for the interactions between the polymer molecules and the solvent molecules to well dissolve the polymer?

   iii. In which way might a mixture of two solvents that alone cannot dissolve a polymer, together accomplish the dissolution.

2. Explain the operating principle of AFM, SEM, and TEM **(6 marks)**

3. In Figure 1 (next page) you find a representation of an idealized DMA curve for partially crystalline polymer. Complete the following tasks i and ii: **(10 marks)**

   i. Connect **regions** (marked with numbers in parenthesis) and **transition points** (arrows and numbers in parenthesis) **with** the **statements below** (letters A to H). Note that there are less statements than regions and transition points, and some numbers might be correct answer for more than one statement.

   (A) Below this temperature, all long range segmental motions cease
   (B) This transition temperature does not exist for highly crosslinked polymers
   (C) Above this temperature, there is sufficient energy for rotation about main chain carbon bonds
   (D) Below this transition temperature terms adjacent and non-adjacent re-entry become relevant
   (E) The height of this plateau is related to M_c between crosslinks or entanglements
   (F) These transition temperatures (two different) set the limits for operating temperature of partially crystalline polymers
   (G) In this region lie the processing temperatures of partially crystalline polymer
   (H) These transitions can only be measured quantitatively with DMA

   ii. Draw a figure similar to Figure 1 that demonstrated what the storage modulus curve of ideally (fully) crystalline polymer would look like as a function of temperature.

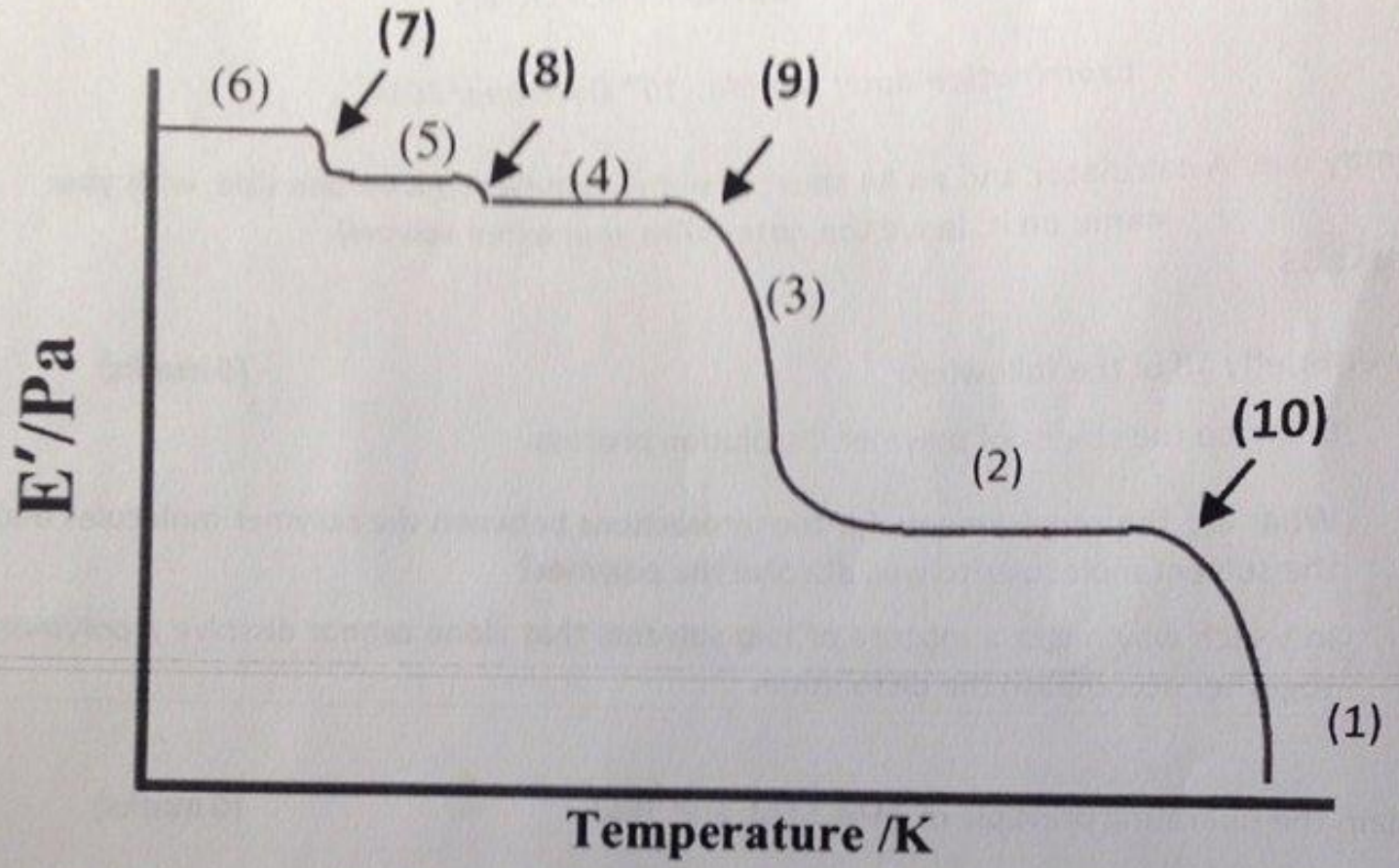
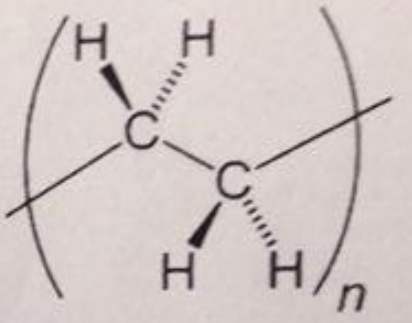


Figure 1. Idealized DMA curve for partially crystalline polymer

4. Below in Table 1 are presented four different weight fractions of polyethene (A to D) blended together. The total mass of the blend is 100 g. Answer the following. **(6 marks)**

Table 1. Polyethene weight fractions.

Fraction	weight fraction	Molecular weight [g/mol]
A	0.400	20000
B	0.100	22000
C	0.150	26000
D	0.350	30000



i. What are the number average- and weight average molecular weights of this sample, as well as the PDI?

ii. How would adding ethylene oligomer change the PDI? The added amount is 5 %wt of polymer and M=1000g/mol.

iii. What can you say about stereoregularity of polyethene? What about cis-trans isomerism?

5. It is Wappu and you have filled a round aluminum plated polyetheneterephtalate (Mylar) balloon with pure helium gas. Diameter of the ball is 30 cm, and the thickness of the Mylar film is 20 μm. How long time does it take until the balloon no longer floats in the air? Assume that the balloon shell weights 5 grams, and that the wall thickness does not change during the experiment. **(5 marks)**

Temperature is 20 °C, pressure 101.325 kPa, and the air density 1.2041 kg/m³. The mole fraction of helium in the air outside the balloon is 0.000524. Helium permeability coefficient is 8.25*10-4(cm3 (STP) cm)/(cm2*s*Pa).

Area of the ball: A= 4πr2, volume of the ball: V= (4/3)πr3, Ideal gas law: pV=nRT