
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2008/2009

April/Mei 2009

EBB 220/3 - Engineering Polymers [Kejuruteraan Polimer]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper contains SEVEN questions. TWO questions in PART A and FIVE questions in PART B.

[Kertas soalan ini mengandungi TUJUH soalan. DUA soalan di BAHAGIAN A dan LIMA soalan di BAHAGIAN B.]

Instruction: Answer FIVE questions. Answer ALL questions from PART A and THREE questions from PART B. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.

[Arahan: Jawab LIMA soalan. Jawab SEMUA soalan dari BAHAGIAN A dan TIGA soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]

The answers to all questions must start on a new page.

[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.

[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

PART A**BAHAGIAN A**

1. [a] Define the melting temperature (T_m) and glass transition temperature (T_g) of a polymer. With the aid of a heat versus temperature plot, explain the differences between T_m and T_g of polymer.

Takrifkan suhu peleburan (T_m) dan suhu peralihan kaca (T_g) untuk polimer. Dengan bantuan gambarajah haba melawan suhu, terangkan perbezaan-perbezaan antara suhu peleburan dan suhu peralihan kaca bagi polimer.

(25 marks/markah)

- [b] T_g of a polymer is highly influenced by the mobility of the polymer chain. Discuss the factors that affect the value of T_g of a polymer with respect to the chain mobility.

T_g polimer amat dipengaruhi oleh kelincahan rantaian polimer. Bincangkan faktor-faktor yang mempengaruhi T_g sesuatu polimer.

(50 marks/markah)

- [c] The physical characteristics of a polymer material depend not only on molecular weight and shape, but also on molecular structure. Explain four categories of polymer molecular structure and cite one example of a polymer for each structure.

Sifat-sifat fizikal sesuatu polimer tidak hanya bergantung kepada berat molekul dan bentuk, tetapi juga terhadap struktur molekul. Terangkan empat kategori struktur polimer beserta satu contoh untuk setiap struktur.

(25 marks/markah)

2. [a] Figure 1 represents the tensile test behavior of the same polymer at two different conditions.

Rajah 1 mewakili ujian tegangan bagi polimer yang sama pada dua keadaan yang berbeza.

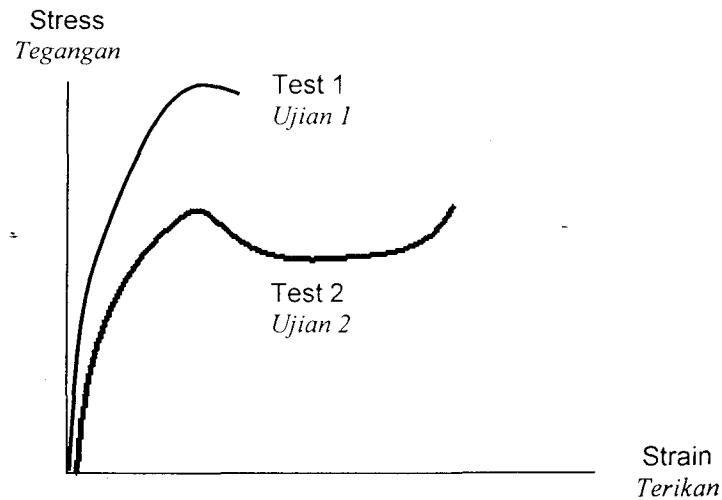


Figure 1

Rajah 1

- (i) If the different conditions are temperature, identify the testing temperature conditions for Test 1 and Test 2.

Sekiranya keadaan yang berbeza tersebut adalah suhu, kenalpasti keadaan suhu pengujian bagi Ujian 1 dan Ujian 2.

(10 marks/markah)

- (ii) If the different conditions are strain rate rather than temperature, identify the relative strain rates for Test 1 and Test 2.

Sekiranya keadaan yang berbeza tersebut adalah kadar terikan, kenalpasti keadaan kadar terikan bagi Ujian 1 dan Ujian 2.

(10 marks/markah)

- [b] Compare thermoplastics, thermosets, elastomers and thermoplastic elastomers in terms of their deformation properties in the solid state.

Bandingkan termoplastik, termoset, elastomer dan termoplastik elastomer dari segi sifat-sifat deformasi dalam keadaan pepejal.

(40 marks/markah)

- [c] Plot creep strain versus time under a constant load. Label and briefly describe the three stages of creep and their characteristics.

Lakarkan terikan rayapan melawan masa bagi ujian rayapan. Labelkan dan secara ringkas terangkan tiga peringkat rayapan dan ciri-cirinya.

(40 marks/markah)

PART B**BAHAGIAN B**

3. [a] Figure 2 shows syndiotactic and atactic structures of polystyrene (PS). Discuss the differences between the two configurations with respect to ability to crystallise and their properties.

Rajah 2 menunjukkan struktur syndiotaktik dan ataktik bagi polistirina. Bincangkan perbezaan-perbezaan antara dua konfigurasi tersebut dari segi keboleh habluran dan sifat-sifatnya.

(20 marks/markah)

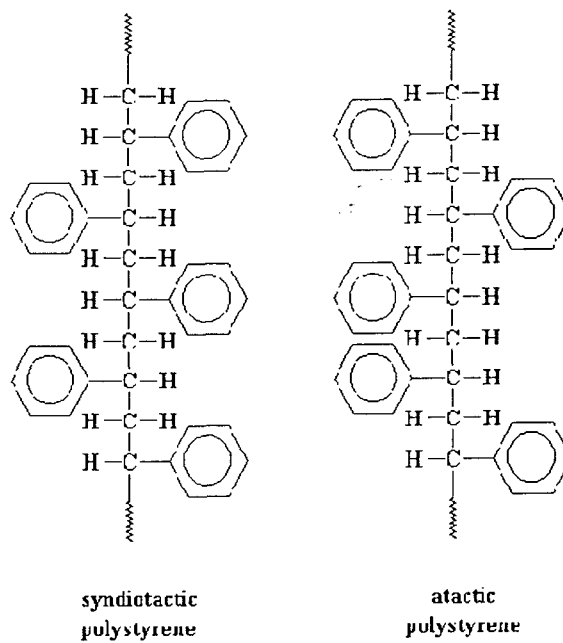


Figure 2

Rajah 2

- [b] Figure 3 shows the structure of polyphenylene sulfone and polyethersulfone. Describe the properties of polyphenylene sulfone and how the ether linkages modify the properties of polyethersulfone.

Rajah 3 menunjukkan struktur polyphenilinasulfona dan poliethersulfona. Terangkan sifat polyphenilinasulfona dan bagaimana ikatan ether mempengaruhi sifat asal poliethersulfona.

(30 marks/markah)

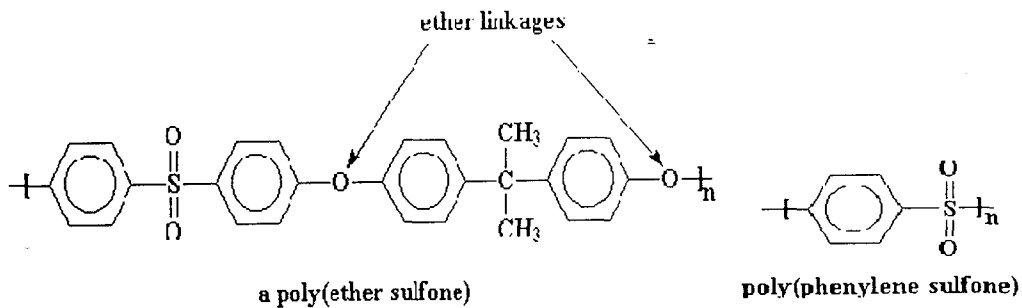


Figure 3

Rajah 3

- [c] Deformation of semicrystalline polymers under tensile loading is schematically illustrated in Figure 4. Explain the progress of change in molecular structure of a semicrystalline polymer as the load increases.

Deformasi bagi polimer separa hablur di bawah bebanan tegangan adalah seperti Rajah 4. Terangkan perkembangan perubahan-perubahan dalam struktur molekul polimer separa hablur tersebut dengan pertambahan bebanan.

(30 marks/markah)

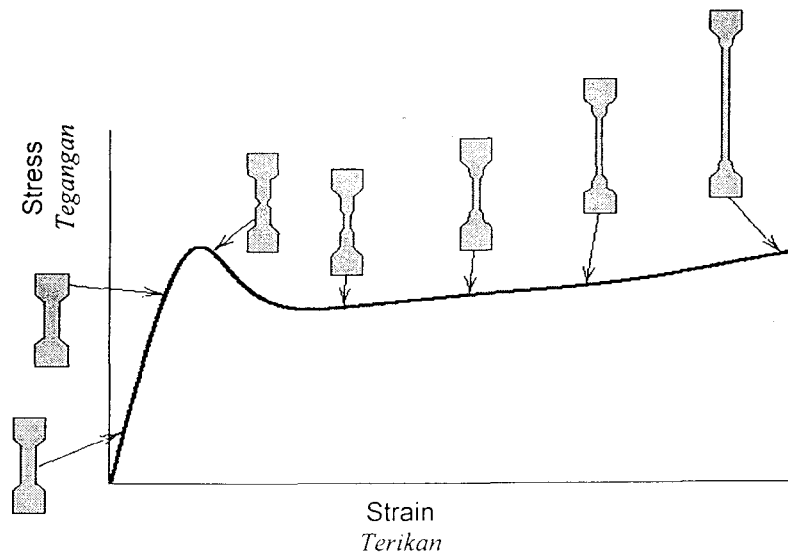


Figure 4

Rajah 4

- [d] Using a plot of specific volume versus temperature, show the difference in specific volume change with temperature for amorphous, semicrystalline and highly crystalline polymers.

Berdasarkan lakaran isipadu spesifik melawan suhu, tunjukkan perbezaan perubahan isipadu spesifik terhadap suhu bagi polimer amofos, separa hablur dan hablur.

(20 marks/markah)

4. [a] Define the differences between number average molecular weight, weight average molecular weight and viscosity average molecular weight. Consequently, illustrate the differences between three different molecular weight expressions using a plot of number of molecules versus molecular weight.

Takrifkan perbezaan-perbezaan antara berat molekul purata nombor, berat molekul purata berat dan berat molekul purata kelikatan. Seterusnya, ilustrasikan perbezaan-perbezaan antara ketiga-tiga berat molekul purata tersebut menggunakan lakaran bilangan molekul melawan berat molekul.

(30 marks/markah)

- [b] Explain addition and condensation polymerizations. Using a suitable example, illustrate the reaction for producing polymers using both polymerization techniques.

Terangkan pempolimeran tambahan dan pempolimeran kondensasi. Dengan menggunakan contoh yang sesuai, tunjukkan tindakbalas penghasilan polimer melalui kedua-dua kaedah pempolimeran.

(30 marks/markah)

- [c] Define tensile strength at yield, tensile strength at break, elongation at break and toughness. Label these terms on a stress versus strain plot.

Takrifkan kekuatan tegangan pada takat alah, kekuatan tegangan dan pemanjangan pada takat alah serta keliatan. Berdasarkan kepada lakaran tegasan melawan tegangan, tunjukkan setiap titik dengan jelas.

(40 marks/markah)

5. [a] Briefly discuss THREE factors to enhance the failure resistance of polymers in service.

Bincangkan dengan ringkas TIGA faktor untuk meningkatkan rintangan kegagalan bagi polimer semasa penggunaan.

(50 marks/markah)

- [b] Provide a brief definition of the term "non-Newtonian fluid".

Berikan definisi ringkas bagi "cecair tidak Newtonan".

(10 marks/markah)

- [c] Discuss TWO types of non-Newtonian flow behavior which were characterized by the way a fluid's viscosity changes in response to variations in shear rate.

Bincangkan DUA jenis sifat aliran tidak Newtonian yang dicirikan dengan perubahan kelikatan cecair hasil tindakbalas terhadap variasi dalam kadar ricihan.

(40 marks/markah)

6. [a] By using schematic diagrams, describe the similarities and differences of blow molding and blown film extrusion. Explain the general steps involved in these processing methods.

Dengan menggunakan gambarajah skema, terangkan persamaan dan perbezaan antara pengacuanan peniupan dan penyemperitan tiupan filem. Terangkan langkah-langkah umum yang terlibat dalam kaedah pemprosesan ini.

(60 marks/markah)

- [b] What is liquid crystal polymers (LCPs)? By using a suitable schematic diagram, explain the differences of these LCPs with amorphous and semicrystalline polymer (in terms of molecular arrangement, and in liquid and solid forms).

Apakah itu polimer hablur cecair (LCPs)? Dengan menggunakan gambarajah skematik yang sesuai, terangkan perbezaan di antara LCPs dengan polimer amorfus dan semihablur (dari segi penyusunan molekul dalam keadaan cecair dan pepejal).

(40 marks/markah)

7. [a] (i) Provide a definition for the term "drawing" (in the context of a polymer specimen).

Berikan definisi "penarikan" (dalam konteks spesimen polimer).

- (ii) What does it mean that a drawn polymer specimen is *anisotropic*?

Apakah yang dimaksudkan dengan spesimen yang ditarik adalah tidak isotropik?

(30 marks/markah)

- [b] Briefly define stress relaxation and viscoelasticity.

Berikan definisi ringkas relaxation tegasan dan viskoelastisiti.

(20 marks/markah)

- [c] Define strength, toughness, elongation and modulus of materials. Using stress-strain curves, illustrate the typical stress-strain curve for the following polymers:

- (i) Strong but not tough
- (ii) Strong and tough
- (iii) Not strong and not tough

Takrifkan kekuatan, ketahanan, pemanjangan dan modulus bahan. Menggunakan graf tegasan melawan terikan, tunjukkan graf tegasan tipikal melawan terikan bagi polimer berikut:

- (i) *Kuat tapi tidak liat*
- (ii) *Kuat dan liat*
- (iii) *Tidak kuat dan tidak liat*

(50 marks/markah)