
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2014/2015 Academic Session

June 2015

EBB 220/3 – Engineering Polymers [Polimer Kejuruteraan]

Duration : 3 hours
[Masa : 3 jam]

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

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

This paper consists of SEVEN questions.

[Kertas soalan ini mengandungi TUJUH soalan.]

Instruction: Answer FIVE questions. If a candidate answers more than five questions only the first five questions answered in the answer script would be examined.

[Arahan: Jawab LIMA soalan. 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.]

In the event of any discrepancies in the examination questions, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

1. [a] Figure 1 shows the effect of stretching of an elastomer (a) without crosslink and (b) with crosslink. Discuss the effect of crosslink in terms of deformation on an elastomer and outline the reason.

Rajah 1 menunjukkan kesan regangan terhadap elastomer (a) tanpa sambung-silang dan (b) dengan sambung silang. Bincangkan kesan sambung silang terhadap ubah bentuk elastomer dan nyatakan alasannya.

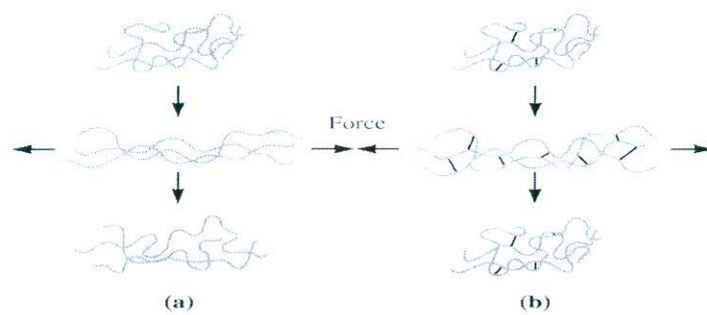


Figure 1

Rajah 1

(30 marks/markah)

- [b] Synthesis and polymerization of polymer resulted in different chain lengths of polymers. A typical distribution of mass of polymer with corresponding chain lengths of typical polymer is given in Table 1. Calculate the number average molecular weight (M_n), weight average molecular weight (M_w) and degree of polymerization (DP).

Sintesis dan pempolimeran polimer menghasilkan polimer rantaian panjang yang berbeza. Contoh taburan berat polimer berdasarkan ikatan-ikatan polimer diberikan di dalam Jadual 1. Kirakan berat purata nombor molekul, purata berat molekul dan darjah pempolimeran.

Table 1

Jadual 1

<i>Molecular Weight Range (g/mol)</i>	x_i	w_i
8,000–16,000	0.05	0.02
16,000–24,000	0.16	0.10
24,000–32,000	0.24	0.20
32,000–40,000	0.28	0.30
40,000–48,000	0.20	0.27
48,000–56,000	0.07	0.11

(50 marks/markah)

- [c] Polymer chain length, stereoregularity, polar groups and chain branching affect the crystallinity of polymers to a great extent. Define each of this factor and comment how each factor affect the crystallinity of the polymers.

Panjang ikatan polimer, stereoregulariti, kumpulan polar dan cabang rantaian ikatan memberi kesan yang ketara terhadap kehabluran polimer. Takrifkan faktor-faktor tersebut dan komen bagaimana setiap faktor ini mempengaruhi kehabluran polimer.

(20 marks/markah)

2. [a] Define viscoelastic material. Using suitable models relate its response to applied stresses and compare it with elastic solid and viscous liquid materials.

Berikan takrifan bagi bahan likatkenyal. Dengan menggunakan model yang sesuai, kaitkan tindak balas bahan ini terhadap tegasan yang dikenakan dan bandingkannya dengan bahan pepejal kenyal dan cecair likat.

(35 marks/markah)

- [b] Define rheology and state at least 4 importance of rheological studies in the processing of plastics.

Berikan takrifan reologi dan nyatakan sekurang-kurangnya 4 kepentingan kajian reologi dalam pemprosesan plastik.

(25 marks/markah)

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

Bincangkan DUA jenis kelakuan aliran non-Newton yang dicirikan berdasarkan perubahan kelikatan bendalir terhadap variasi dalam kadar ricihan.

(40 marks/markah)

3. [a] Amorphous and crystalline polymer shrinks differently upon cooling. Discuss this statement by giving reasons why the different exist.

Polimer amorfus dan hablur mengecut secara berbeza semasa penyejukan. Bincangkan kenyataan ini dengan memberikan alasan-alasan.

(30 marks/markah)

- [b] Figure 2 shows the effect of annealing and quenching on tensile stress-strain curves of typical semi-crystalline polymer. Comment on the effect of both treatments on the stress-strain behavior and mechanical properties of the polymer in general.

Rajah 2 menunjukkan kesan penyepuhlindapan dan pelindapkejutan ke atas lengkung tegasan-terikan polimer separa hablur. Komen terhadap kesan-kesan rawatan terhadap kelakuan tegasan-terikan dan sifat mekanikal polimer secara umumnya.

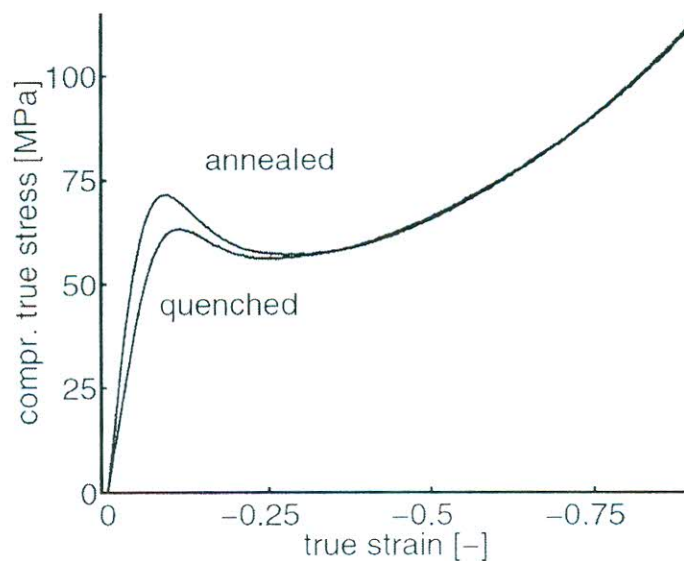


Figure 2

Rajah 2

(30 marks/markah)

- [c] The evolution of tensile deformation of typical semi-crystalline polymer can be represented as shown in schematic diagram, Figure 3 (a-f). Explain processes from a-f by taking into account the microstructural changes within the polymer structure.

Evolusi perubahan terikan bagi polimer separa hablur boleh digambarkan seperti yang ditunjukkan di dalam Rajah 3(a-f). Terangkan proses-proses (a-f) dengan merujuk kepada perubahan mikrostruktur polimer.

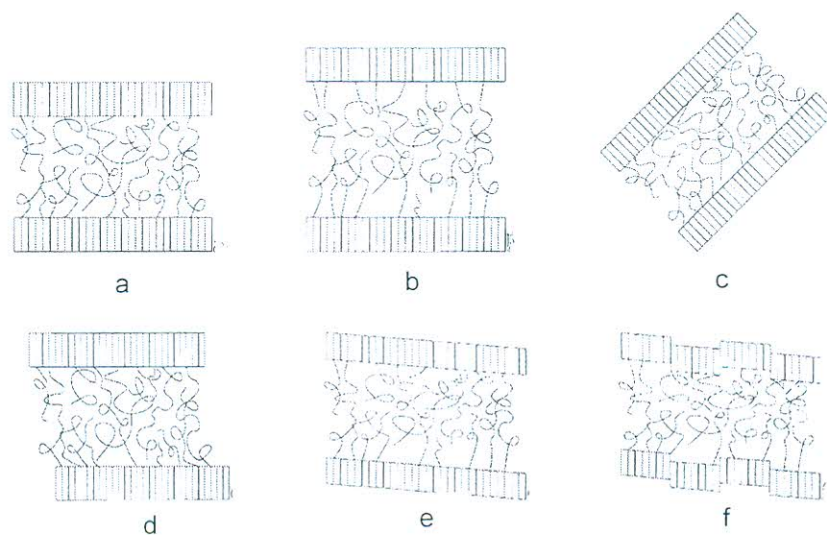


Figure 3

Rajah 3

(40 marks/markah)

4. [a] What are stabilizers and why they are used in some polymeric materials?

Apakah penstabil dan mengapa ia digunakan dalam sesetengah bahan polimer?

(20 marks/markah)

- [b] State THREE examples of special purpose additives and its function.

Nyatakan TIGA contoh bahan penambah untuk tujuan khas dan fungsinya.

(30 marks/markah)

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- [c] Polymeric materials may degrade over a period of time. List down FOUR types of polymer degradation and explain any TWO of them.

Bahan-bahan polimer boleh mengalami degradasi dalam suatu tempoh jangkamasa. Senaraikan EMPAT jenis degradasi polimer dan terangkan DUA daripadanya.

(50 marks/markah)

5. [a] Addition polymerization can occur in many ways including free radical polymerization, cationic polymerization, anionic polymerization and coordination polymerization. Write the polymerization reaction with brief explanation of the following polymers:

- (i) Polypropylene (PP)
- (ii) Polyethylene (PE)
- (iii) Polyvinyl chloride (PVC)
- (iv) Polystyrene (PS)

Pempolimeran penambahan boleh berlaku melalui pelbagai cara, antaranya pempolimeran radikal bebas, pempolimeran kationik, pempolimeran ionik dan pempolimeran koordinasi. Tuliskan penerangan ringkas mengenai tidakbalas pempolimeran bagi polimer-polimer di bawah:

- (i) Polipropilena (PP)
- (ii) Polietilena (PE)
- (iii) Polivinil klorida (PVC)
- (iv) Polistirena (PS)

(40 marks/markah)

- [b] Condensation polymerization occurs through condensation reaction where molecules join together and losing small molecules such as water or methanol. Write the polymerization reaction with brief explanation of the following polymers:

- (i) Polyamide
- (ii) Polyacetal
- (iii) Polyester

Pempolimeran kondensasi terjadi melalui tindakbalas di mana molekul-molekul bergabung dan kehilangan molekul kecil seperti air atau methanol. Tulis tindakbalas pempolimeran dengan penerangan ringkas bagi polimer-polimer di bawah:

- (i) *Poliamida*
- (ii) *Poliasetal*
- (iii) *Poliester*

(30 marks/markah)

- [c] Explain how intermolecular forces helps in formation of crystalline structure in polyamide

Terangkan bagaimana daya antara molekul membantu pembentukan struktur hablur di dalam poliamida.

(30 marks/markah)

6. [a] Briefly outline the processing steps involve in injection molding and pultrusion. State the type of end product produced by both methods.

Nyatakan secara ringkas langkah-langkah pemprosesan yang terlibat dalam pengacuan suntikan dan pultrusi. Nyatakan jenis produk akhir yang dihasilkan oleh kedua-dua kaedah.

(40 marks/markah)

- [b] Modes of mechanical failures include brittle failure and crazing. Discuss both types of the failure.

Mod kegagalan mekanikal termasuklah kegagalan rapuh dan peretakhalusan. Bincangkan kedua-dua jenis kegagalan tersebut.

(30 marks/markah)

- [c] What is liquid crystal polymers (LCPs)? List down TWO advantages and disadvantages of LCPs.

Apakah itu polimer hablur cecair (LCPs)? Senaraikan DUA kebaikan dan keburukan LCPs.

(30 marks/markah)

7. [a] List down the differences between elastomer and latex.

Senaraikan perbezaan antara elastomer dan lateks.

(20 marks/markah)

- [b] Briefly describe how creep test is performed. Discuss the effect of temperature on creep properties of a polymer.

Terangkan secara ringkas bagaimana ujian rayapan dilaksanakan. Bincangkan kesan suhu terhadap sifat sesuatu bahan polimer.

(40 marks/markah)

- [c] Name TWO processing methods used to produce plastic film or sheet and briefly describe the processing steps involved in any ONE of the suggested methods.

Namakan DUA kaedah pemprosesan yang digunakan untuk menghasilkan filem atau kepingan plastik dan terangkan secara ringkas langkah-langkah pemprosesan yang terlibat dalam salah SATU antara kaedah yang telah dicadangkan.

(40 marks/markah)