

SULIT



First Semester Examination
2024/2025 Academic Session

February 2025

EBP 202 – Structure of Polymeric Materials
[Struktur Bahan Polimer]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of NINE (9) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEMBILAN (9) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions : Answer **FIVE (5)** questions. Answer **ALL** questions from PART A, **TWO (2)** question from PART B and **TWO (2)** question from PART C. All questions carry the same marks.

Arahan : Jawab **LIMA (5)** soalan. Jawab **SEMUA** soalan daripada BAHAGIAN A, **DUA (2)** soalan daripada BAHAGIAN B dan **DUA (2)** soalan daripada BAHAGIAN C. Semua soalan membawa jumlah markah yang sama.]

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

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

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PART A / BAHAGIAN A

- (1). (a). Explain how the structure of a polymer (linear, branched, cross-linked, and networked) affects its physical properties, mechanical strength and molecular weight.

Jelaskan bagaimana struktur polimer (linear, bercabang, tersambung-silang dan rangkaian) boleh memberi kesan ke atas sifat-sifat fizikal, kekuatan mekanikal dan berat molekulnya.

(10 marks/markah)

- (b). Elaborate the cold drawing process of polymer and its relationship with polymer molecular orientation and crystallinity. Your answers must include the necessary information on different types of polymers and their final thermal and mechanical properties.

Huraikan proses penarikan sejuk bagi polimer dan hubungannya dengan orientasi molekul dan sifat penghabluran polimer. Jawapan anda mestilah mengandungi maklumat berkaitan tentang jenis-jenis polimer yang berlainan dan sifat-sifat termal dan mekanikal polimer tersebut.

(10 marks/markah)

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PART B / BAHAGIAN B

- (2). (a). Draw the isotactic, syndiotactic, and atactic configuration of polystyrene. Compare their properties.

Lukiskan konfigurasi isotaktik, sindiotaktik dan ataktik bagi polistirena. Bandingkan sifat-sifat mereka.

(10 marks/markah)

- (b). Discuss the gauge- and trans-conformation of polyisobutylene. The answer should be supported by Newman projection and the potential energy of the conformation.

Bincangkan konformasi gauge dan trans bagi poliisobutilena. Jawapan harus disokong dengan unjuran Newman dan tenaga keupayaan konformasi.

(10 marks/markah)

- (3). (a). A linear amorphous polymer has a glass transition temperature of 25°C. At 50°C, it has a melt viscosity of 2.8×10^8 poise. Estimate its melt viscosity at 90°C and 110°C. What do you observe?

Suatu polimer amorfus linear mempunyai suhu peralihan kaca 25°C. Pada suhu 50°C, polimer itu mencatatkan kelikatan leburan 2.8×10^8 poise. Anggarkan kelikatan leburan bagi polimer itu pada suhu 90°C dan 110°C. Apa yang anda perhatikan?

(10 marks/markah)

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- (b). Discuss how the following factors influence the glass transition temperature of polymers.
- (i). side group
 - (ii). hydrogen bonding
 - (iii). copolymerization
 - (iv). plasticizer

Bincangkan bagaimana faktor-faktor berikut mempengaruhi suhu peralihan kaca polimer.

- (i). kumpulan sisi
- (ii). ikatan hidrogen
- (iii). ko-pempolimeran
- (iv). pemplastik

(10 marks/markah)

- (4). (a). The viscoelastic behaviour of polymethyl methacrylate can be determined by a dynamic mechanical analyser (DMA). Discuss the glass transition, rubbery plateau, and rubbery flow of polymethyl methacrylate.

Tingkah laku kelikatkenyalan polimetil metakrilat boleh ditentukan dengan menggunakan penganalisis mekanikal dinamik (DMA). Bincangkan peralihan kaca, dataran bergetah, dan aliran bergetah polimetil metakrilat.

(10 marks/markah)

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- (b). Predict the glass transition temperature (T_g) of poly(styrene-co-butadiene) which consists of 43 wt% styrene.

Given that the T_g of polybutadiene and polystyrene is -86°C and 103°C , respectively. The answer must be supported by calculation.

Jangkakan suhu peralihan kaca (T_g) poli(stirene-co-butadiena) yang mengandungi 43 wt% stirena.

Diberikan T_g polibutadiena dan polistirena ialah -86°C dan 103°C masing-masing. Jawapan mesti disokong dengan pengiraan.

(10 marks/markah)

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PART C / BAHAGIAN C

- (5). (a). Both spherulite and polymer single crystals are entities that describe the presence of crystallite region in some polymeric materials. Explain the major difference in their creation and describe the morphology of both entities.

Kedua-dua sferulit dan hablur tunggal polimer merupakan entiti yang menjelaskan kewujudan kawasan berhablur dalam sesetengah polimer. Jelaskan perbezaan utama dalam penghasilan entiti-entiti tersebut dan jelaskan morfologi yang terhasil dari kedua-duanya.

(10 marks/markah)

- (b). When Differential Scanning Calorimetry (DSC) tests were conducted on two samples of polyethylene terephthalate (PET), these results were obtained. PET virgin sample (pellet) weighing 13.640 mg gave a melting enthalpy, ΔH_m of 0.3375 Joule whereas another PET sample (weighing 12.650 mg), which has gone through an injection moulding process recorded a melting enthalpy, ΔH_m of 0.3885 Joule.

With the knowledge of melting enthalpy of a 100% PET crystal, ΔH_m° is 106 Joule/g, calculate the degree of crystallinity of both PET samples. Why there is a difference of melting enthalpy between these samples?

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Apabila suatu ujian Kalorimetri Penskanan Pembezaan dijalankan ke atas dua sampel polietilena tereftalat (PET), keputusan berikut diperolehi. Sampel asal (pelet) PET seberat 13.640 mg memberikan entalpi peleburan, $\Delta H_m = 0.3375$ Joule manakala sampel PET yang telah mengalami proses pengacuanan suntikan (seberat 12.650 mg) merekodkan entalpi peleburan $\Delta H_m = 0.3885$ Joule.

Berbantuan maklumat entalpi peleburan untuk 100% hablur PET, ($\Delta H_m^\circ = 106$ Joule/g), Kirakan darjah keterhabluran bagi kedua-dua sampel PET tersebut. Mengapakah terdapat perbezaan entalpi peleburan di sampel-sampel PET itu?

(10 marks/markah)

- (6). (a). Consider the following statements.
“Degree of crystallinity of a semi-crystalline polymer is dependent of interchain bonding”

“The melting of a semi-crystalline polymer is related to the destruction of crystallite region”

Using polyamide as an example, discuss the relevance of both statements. Support your answer with suitable diagrams.

Pertimbangkan pernyataan-pernyataan berikut;

“Darjah keterhabluran suatu polimer separa-hablur adalah bergantung kepada ikatan antara-rantai”

“Peleburan suatu polimer separa-hablur boleh dikaitkan dengan pemusnahan kawasan berhablur”.

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Dengan menggunakan poliamida sebagai contoh, bincangkan korelevanan kenyataan-kenyataan tersebut. Sokong jawapan anda dengan rajah-rajah bersesuaian.

(12 marks/markah)

- (b). Describe FOUR (4) factors that can affect melting temperature of a polymer.

Jelaskan EMPAT (4) faktor yang mempengaruhi darjah keterhabluran bagi suatu polimer.

(8 marks/markah)

- (7). (a). The following figures display changes of X-ray diffraction patterns for a certain polymer sample. Explain what could have caused such changes.

Rajah-rajah berikut mempamerkan perubahan yang berlaku kepada pola pembelauan sinar-X bagi suatu sampel polimer. Terangkan apakah punca kepada perubahan tersebut.

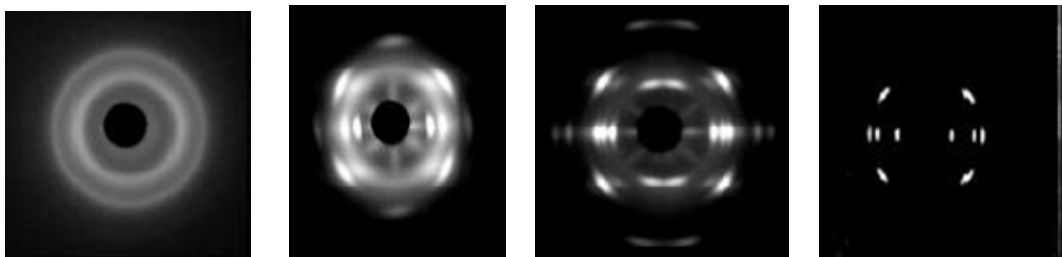


Figure 1: Changes in X-ray diffraction patterns for a polymer sample

Rajah 1: Perubahan pola pembelauan Sinar-X bagi suatu sampel polimer

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Also give example of a polymer processing technique that exploits advantages of the above phenomenon.

Berikan juga satu contoh teknik pemprosesan polimer yang mengeksploit kelebihan fenomena di atas.

(10 marks/markah)

- (b). Elaborate the method used in studying polymer crystallization using an optical microscope. State the effect of temperature on the crystallization rate.

Huraikan kaedah eksperimen yang digunakan dalam mengkaji penghabluran polimer menggunakan suatu mikroskop optik. Nyatakan kesan suhu ke atas kadar penghabluran.

(10 marks/markah)

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