
UNIVERSITI SAINS MALAYSIA

First Semester Examination
2014/2015 Academic Session

December 2014 / January 2015

EBB 202/3 – Crystallography & Bonding In Solids [Kristalografi & Ikatan Dalam Pepejal]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains EIGHT printed pages and ONE page APPENDIX before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN muka surat beserta SATU muka surat LAMPIRAN yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of SEVEN questions. ONE question in PART A, THREE questions in PART B and THREE questions in PART C.

[Kertas soalan ini mengandungi TUJUH soalan. SATU soalan di BAHAGIAN A, TIGA soalan di BAHAGIAN B dan TIGA soalan di BAHAGIAN C.]

Instruction: Answer FIVE questions. Answer ALL questions from PART A, TWO questions from PART B and TWO questions from PART C. 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. Jawab SEMUA soalan dari BAHAGIAN A, DUA soalan dari BAHAGIAN B dan DUA soalan dari BAHAGIAN C. 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 digunakan.]

PART A / BAHAGIAN A

1. [a] Materials are made of crystalline and amorphous structures. With the help of appropriate diagrams, explain what are crystalline and amorphous structures. Briefly explain why study of crystallography is important as a materials engineer.

Bahan adalah dibuat dari struktur hablur dan amorfus. Dengan menggunakan gambarajah bersesuaian, terangkan apakah yang dimaksudkan dengan struktur hablur dan amorfus. Jelaskan dengan ringkas kenapakah kajian tentang hablur penting sebagai seorang jurutera bahan.

(50 marks/markah)

- [b] Production of X-rays:

Pengeluaran sinar-X:

- (i) List the materials that can be used as X-ray target

Senarai bahan-bahan yang boleh digunakan sebagai sasaran sinar-X.

(25 marks/markah)

- (ii) Explain why Cu is the best material for X-ray target?

Terangkan mengapa Cu adalah bahan yang terbaik untuk sasaran sinar-X?

(25 marks/markah)

PART B / BAHAGIAN B

2. [a] As a materials engineer, you are given the following materials. With the help of appropriate diagrams, explain bonding types in the said materials. What are typical properties of these materials?
- (i) Alumina, Al_2O_3
 - (ii) Titanium, Ti
 - (iii) Magnesium, Mg

Sebagai seorang jurutera bahan, anda diberikan sampel seperti di bawah. Dengan bantuan gambarajah yang bersesuaian, terangkan jenis-jenis ikatan di dalam bahan tersebut. Apakah sifat-sifat utama bahan-bahan tersebut?

- (i) Alumina, Al_2O_3
- (ii) Titanium, Ti
- (iii) Magnesium, Mg

(75 marks/markah)

- [b] State typical properties of materials that have the following bonding.
- (i) Metallic bond
 - (ii) Covalent bond

Nyatakan sifat-sifat biasa bagi bahan dengan ikatan berikut:

- (i) ikatan logam
- (ii) ikatan kovalen

(25 marks/markah)

3. [a] By giving appropriate **examples**, explain the effect of symmetry and crystal structure on the following properties.

- (i) Piezoelectricity
- (ii) Ferroelectricity

Dengan memberikan contoh-contoh yang bersesuaian, terangkan kesan simetri dan struktur hablur kepada sifat-sifat berikut:

- (i) *Piezoelektrik*
- (ii) *Feroelektrik*

(70 marks/markah)

[b] Describe TWO symmetry elements below:

- (i) Inversion
- (ii) Rotoinversion

Terangkan dua unsur simetri di bawah:

- (i) *Penyongsangan*
- (ii) *Roto-penyongsangan*

(30 marks/markah)

4. [a] Draw clearly illustration of **operations** and **stereographic projection** for the following:
- (i) $\bar{3}$ (bar 3)
 - (ii) 622
 - (iii) 4 mm

Lakarkan dengan jelas operasi dan unjuran stereografi berikut:

- (i) $\bar{3}$ (bar 3)
- (ii) 622
- (iii) 4 mm

(30 marks/markah)

- [b] Stereograms are two-dimensional of the relationships between planes and directions within a crystal. Explain the information you can get from a stereographic projection.

Stereogram merupakan salingkait dua-dimensi di antara satah dan arah di dalam hablur. Terangkan maklumat yang boleh anda perolehi daripada unjuran stereografi.

(25 marks/markah)

- [c] Appendix 1 shows three crystals namely (a) Struvite, (b) Aragonite (CaCO_3), and (c) PbMoO_4 . Identify the symmetry elements that each of the crystals have and suggest the point group symmetry that these crystals could belong to. **(Please draw and explain on Appendix 1 and attach with your answer sheets).**

*Lampiran 1 menunjukkan 3 jenis hablur iaitu (a) Struvite, (b) Aragonite (CaCO_3), dan (c) PbMoO_4 . Kenalpasti unsur simetri setiap hablur tersebut dan cadangkan kumpulan titik simetri hablur tersebut. **(Sila lukis dan terangkan di dalam Lampiran 1 dan lampirkan Lampiran 1 berserta kertas jawapan anda).***

(45 marks/markah)

PART C / BAHAGIAN C

5. [a] Explain what is "Bremsstrahlung" rays? (Use appropriate sketches to explain your answers).

Terangkan apakah sinar "Bremsstrahlung"? (Guna lakaran yang sesuai untuk menjelaskan jawapan anda).

(30 marks/markah)

- [b] Explain what is X-ray of minimum wavelength (λ_{\min}) during production of X-ray? (Use appropriate sketches to explain your answers).

Terangkan apakah nilai panjang gelombang minimum (λ_{\min}) semasa sinar-X dihasilkan? (Guna lakaran yang sesuai untuk menjelaskan jawapan anda).

(30 marks/markah)

- [c] Starting with potential of electron (E),

prove $\lambda_{\min} = \frac{12.43}{V} \text{ (\AA)}$

Bermula dengan potensi elektron (E),

buktikan $\lambda_{\min} = \frac{12.43}{V} \text{ (\AA)}$

(40 marks/markah)

6. [a] Explain the similarity and different of crystallography properties of polymer and glass (use appropriate sketches to explain your answers).

Terangkan persamaan dan berbeza sifat-sifat penghabluran polimer dan kaca (guna lakaran yang sesuai untuk menjelaskan jawapan anda).

(40 marks/markah)

- [b] Figure 1 shows XRD pattern of Chitosan and SiO₂ polymer composite. Calculate the percentage of crystallinity of the sample.

Rajah 1 menunjukkan corak XRD polimer komposit Chitosan dan SiO₂. Kira peratusan penghabluran sampel.

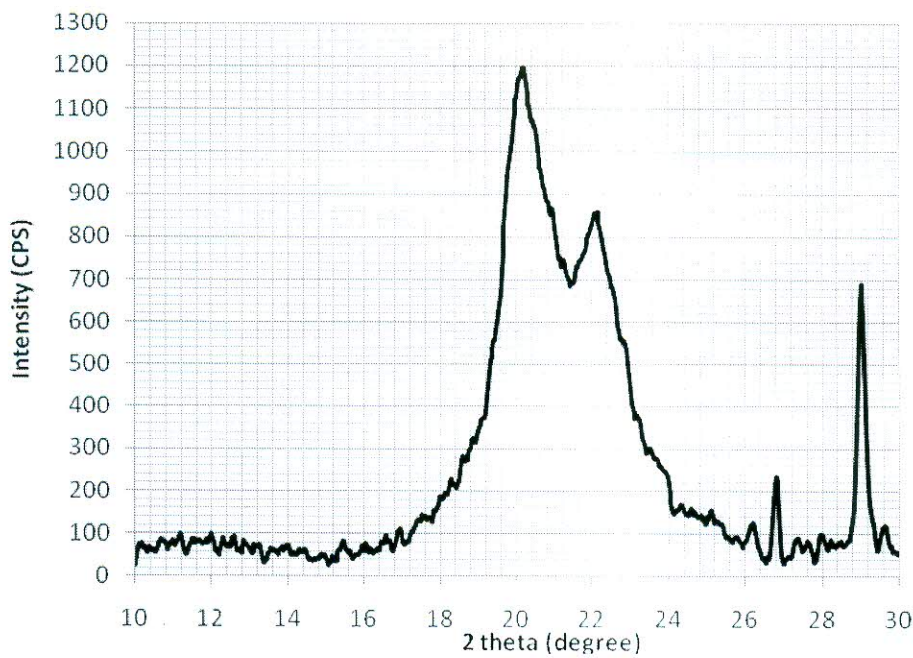


Figure 1

Rajah 1

(60 marks/markah)

7. [a] For scattering and diffraction analysis, explain why do we need to calculate structural factor (F_{hkl})?

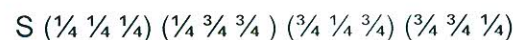
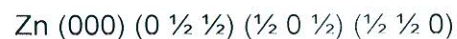
Untuk penyebaran dan analisis pembelauan, terangkan mengapa kita perlu mengira faktor struktur (F_{hkl})?

(20 marks/markah)

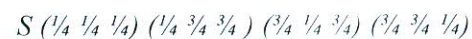
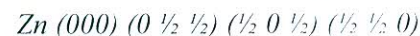
- [b] Structural similarity between an element and a compound materials is frequently found, for examples diamond and zinc blends (β - ZnS)

Persamaan struktur antara bahan elemen dan sebatian adalah kerap ditemui, sebagai contoh berlian dan blende zink (β - ZnS)

- (i) Draw structure of β - ZnS based on diamond structure, when the atomic positions of Zn and S in the unit cell of β - ZnS are given in the following



Lukiskan struktur β - ZnS berdasarkan struktur berlian, apabila kedudukan atom Zn dan S dalam sel unit daripada β - ZnS diberikan dalam berikut



(40 marks/markah)

- (ii) Determine the structure factor of β - ZnS and indicate the cases where intensity can be observed.

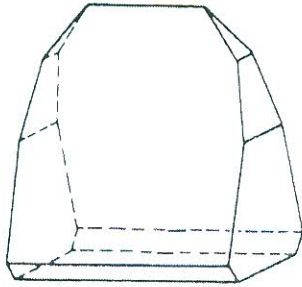
Tentukan faktor struktur daripada β - ZnS dan nyatakan kes-kes di mana intensiti boleh diperhatikan.

(40 marks/markah)

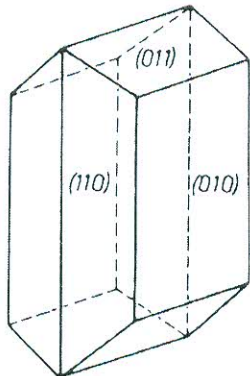
APPENDIX 1 (Please detach and include in your answer sheets).

LAMPIRAN 1 (Tanggalkan dan sertakan bersama kertas jawapan anda).

(a) Struvite



(b) Aragonite (CaCO_3)



(c) PbMoO_4

