# UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session of 2005/2006

November 2005

## EBB 511/3 - Materials Characterisation

Time : 3 hours

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Please make sure that this examination paper consists of FOUR printed pages before you begin with the exam.

This paper is made up of SEVEN questions.

Answer any FIVE questions. If a candidate answers more than five questions, only the first five answered will be examined and awarded marks.

Answer to any question must start on a new page.

All questions can be answered in Bahasa Malaysia or English.

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1. [a] Describe imaging of microstructures using secondary electrons and back scattered electrons in SEM. Discuss with neat diagram, the technique of imaging, detectors and processing of images.

(40 marks)

[b] What are the factors affecting aberration of lenses? How do you minimize lens aberration in SEM?

(30 marks)

[c] Discuss with a neat diagram the various events that take place when an electron beam interacts with a sample surface. How are these interactions used for sample imaging in SEM.

(30 marks)

2. [a] Give a schematic diagram of an x-ray diffractometer. Briefly explain each component.

(30 marks)

[b] What do you understand by the term structure factor. Illustrate your answer with an appropriate example.

(30 marks)

[c] Write a short note on the following applications of XRD in;

(i) Phase identification
(ii) Determination of crystal structure
(iii) Determination of lattice strain and crystallite size

(40 marks)

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3. [a] Explain the basic principle of IR spectroscopy. What is the difference between IR and FTIR spectrometer.

(50 marks)

[b] Write briefly on 3 applications of FTIR.

(50 marks)

4. [a] Explain the underpinning principles of Atomic Force Microscopy (AFM). Use appropriate diagram to illustrate your answer.

(30 marks)

[b] Briefly explain the short-range and long-range interactions between the tip of the probe end sample. What kind of information can be obtained from these interactions.

(40 marks)

[c] Describe the various modes of imaging based on atomic force.

(30 marks)

5. [a] Scanning Probe Microscopy (SPM) consists of a family of microscopy techniques that measure the morphology and surface properties on atomic scale. Scanning Tunneling Microscopy (STM) is one of them. Give a schematic diagram of an STM.

(30 marks)

[b] Describe the working operation of an STM. The explanation should include the basic principles such as tunneling effect, tip-sample distance and how images are produced.

(40 marks)

[c] What types of samples that can be examined by STM? What are the limitations of STM?

(30 marks)

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6. [a] Mathematically compare the basic principles involved in DTA and DSC.

(50 marks)

[b] Discuss the effects of sample size and heating rate on TG/DTA studies.

(20 marks)

[c] Outline the technique how DSC data can be used to determine the purity of a substance.

(30 marks)

7. [a] Discuss in brief the use of TG/DTA data in differential method to measure the reaction rate kinetics.

(50 marks)

[b] What is the principle of thermodilatometry (TD)?

(25 marks)

[c] Illustrate mathematically how the TD data can be interpreted to measure the coefficient of expansion of a solid.

(25 marks)

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