
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session of 2006/2007

October/November 2006

EBB 511/3 – Materials Characterisation Techniques

Time : 3 hours

Please ensure that this paper consists of FIVE printed pages before you proceed with the examination.

This paper contains SEVEN questions.

Answer FIVE questions. If a candidate answer 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 must be answered in English.

1. [a] Draw a schematic diagram of a diffractometer, and label each component and briefly describe them. (30 marks)
- [b] Phase identification is one of the main applications of XRD and Hanawalt method is one of the techniques used to sort out the XRD patterns. Explain this technique and use appropriate diagram to illustrate your answer. (50 marks)
- [c] The limit of phase detectability by manual XRD is usually about 1 – 2 % concentration range. With automated XRD this can be improved further. Discuss how can this be achieved. (20 marks)
2. [a] FTIR is one of the techniques used to identify materials. What is the underlying principle of this technique. What do you understand by the term IR active and IR inactive. (30 marks)
- [b] What are the advantages of FTIR compared to IR. (20 marks)
- [c] Briefly describe the ATR technique. (20 marks)
- [d] By using appropriate diagram explain the working of a Michelson interferometer. (30 marks)

3. [a] The electron gun is one of the important components in a SEM. Briefly describe the types of electron gun used in SEM and what are the advantages and disadvantages.

(50 marks)

- [b] Secondary electrons are the most widely used interaction with which to form image in SEM. Why?

(50 marks)

4. [a] Describe using a schematic diagram the working of a Scanning Tunelling Microscope (STM). The answer should include the underlying principle and the imaging process.

(60 marks)

- [b] What form of samples can be analysed by STM and what is its limitation.

(40 marks)

5. [a] In Atomic Force Microscopy (AFM) there are 3 modes of operation ie. Contact mode, Noncontact mode and Tapping mode. Describe these modes and what are the advantages and disadvantages.

(50 marks)

- [b] Write short notes on any two(2) of the following:

- (i) Lateral Force Microscopy
- (ii) Magnetic Force Microscopy
- (iii) Scanning Capacitance Microscopy

(50 marks)

6. [a] Schematically illustrate the method to measure the inflection temperature in a TG plot. (20 marks)
- [b] Mathematically describe the procedure to calculate the rate of mass change involved in a TG experiment. (30 marks)
- [c] Explain in brief the basic requirements that must be fulfilled while designing the furnace for a TG-DTA set up. (30 marks)
- [d] What are the effects of heating rate and sample mass on the results obtained from a TG-DTA experiment? (20 marks)

7. [a] Consider the reduction reaction of pure liquid FeO by carbon supplied through a carbon saturated liquid iron bath at three different constant temperatures. Assume that the reaction follows a first order reaction rate model. Also assume that the change in weight of the sample is only through the evolution of carbon monoxide (CO). Illustrate the steps involved to calculate the reaction rate and the activation energy by employing the integral method of kinetic analysis.
- (40 marks)
- [b] Outline the mechanism of a LASER dilatometer and mention its advantages over a conventional dilatometer.
- (30 marks)
- [c] Explain the importance of thermal conductivity of the sample and crucible and the role it plays on the results from a TG-DTA experiment.
- (30 marks)