UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session of 2004/2005

October 2004

EBB 511 - 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 any 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 answered in English.

1. [a] "The structure factor is independent of the shape and size of the unit cell'. Explain this statement. (You can cite appropriate examples to support your discussion).

(40 marks)

[b] Aluminium metal powder was obtained by filing a bulk specimen; i.e. it is effectively a cold-worked specimen. An X-ray diffraction of this specimen was recorded with Cu K_α radiation in the 2θ angular range of 30 to 70°. Three peaks were indexed in this range. For comparison purposes and to calculate the instrumental broadening, the sample was annealed and its XRD was also recorded. With the information given in the table below determine the lattice strain and the crystallite size.

Table 1 : Full-Width at Half-Maxima of Annealed Aluminum Specimen

Material: Annealed aluminum		Radiation: Cu Kα		λ = 0.154056 nm	
Peak #	2θ (°)	hkl	FWHM (°)	FWHM (rad) = B_i	B_O (°)
1	38.52	111	0.103	1.8×10^{-3}	0.187
2	44.76	200	0.066	1.2×10^{-3}	0.206
3	65.13	220	0.089	1.6×10^{-3}	0.271

B_O = observed broadening

B_i = instrumental broadening

(60 marks)

2. [a] Explain the basic principle of FTIR. Name the three techniques available in IR spectroscopy for surface analysis. Briefly describe one that can analyse surface layer in the range ~ 0.5 to 3 μm.

(50 marks)

[b] Give a schematic diagram of an atomic absorption spectrometer. Briefly describe the important components.

(50 marks)

...3/-

3. [a] Atomic Force Microscopy (AFM) is a very versatile technique for measuring surface topography. Describe the principle and operation of an AFM. What is the advantage(s) and disadvantage(s) of non-contact mode.

(50 marks)

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

(i) Scanning Tunneling Microscope (SPM)
(ii) Lateral Force Microscopy
(iii) Magnetic Force Microscopy
(iv) Scanning Thermal Microscopy
(v) Scanning Capacitance Microscopy

(50 marks)

4. [a] Give the definition of thermal analysis according to ICTAC. What is ICTAC?

(20 marks)

[b] You were given a polymer composite sample that contains carbon fibre and glass fibre with the composition shown below:

Material	Weight (%)
Polymer	60
Carbon fibre	Unknown
Glass fibre	Unknown

(i) Design a TGA test on how to determine the percentage of carbon and glass fibre in the sample given.

(ii) If the composition of carbon fibre is 15 %, plot TGA curve with test parameters shown below:

Test temperature: 50 - 600°C
Atmosphere: Oxygen

(60 marks)

...4/-

[c] Calculate the percentage of crystallinity for PE phase in a PE/EPDM blend (50/50 by weight). It was given that:

ΔH_f = 40.07 J/g

ΔH°_f (PE) = 209 J/g

(20 marks)

5. [a] Describe the principle of scanning electron microscope (SEM) with the help of a diagram. What happens when an electron beam is focused on a sample?

(50 marks)

[b] Write note on the topics listed below:

(i) Environmental scanning electron microscope (E-SEM)

(ii) Scanning electron microscope-energy dispersive analysis (SEM-EDA)

(iii) Thermal mechanical analysis (TMA)

(iv) Differential thermal analysis/differential scanning calorimetry (DTA/DSC)

(v) Thermogravimetry analysis (TGA)

(50 marks)

6. [a] Describe how viscoelastic property of a material can be determined using dynamic mechanical thermal analysis (DMTA) and describe also Argand chart.

(40 marks)

[b] A carbon black-filled rubber shows a 5 % loss of mass at 92 - 252°C and 75 % mass loss at 402 - 502°C. The test stops at 600°C and residue of 20 % remains.

(i) Plot the curve and interpret the result

(ii) If isothermal test was continued at 600°C for 30 minutes, plot the expected curve and interpret the result if no residue remains at the end

(60 marks)