UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session of 2003/2004

September/October 2003

EBB 524/3 - Composite Materials

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 can be answered in Bahasa Malaysia or English.

...2/-

1. [a] By using a suitable examples, explain what do you understand with hybrid composites and structural composites?

(30 marks)

[b] For fibre reinforced composites, one of the importance factor to determine the strength of composites material is critical fibre length, ℓ_c

$$\ell_c = \frac{\sigma_f d}{2\tau_c} \qquad \text{---------- (1)}$$

Explain the meaning of equation (1) above. By using suitable figure, draw stress-position profiles for a fibre reinforced composites that is subjected to a tensile stress for fibre length, ℓ (i) is equal to the critical length, ℓ_c (ii) is greater than ℓ_c and (iii) is less than ℓ_c.

(30 marks)

[c] By referring to specific examples, discuss how the interface interaction between filler/fibre and polymer matrix can be enhanced.

(40 marks)

2. [a] By considering a polymer composite with uni-directional continuous aligned fibres at longitudinal and transverse direction, show that the resultant modulus is :

$$E_{cL} = E_f V_f + E_m V_m \qquad \text{and}$$

$$E_{cT} = E_f E_m / (V_f E_m + V_m E_f)$$

(50 marks)

[b] In a unidirection Kevlar/epoxy composite the modular ratio is 20 and the epoxy occupies 60% of the volume. Calculate the modulus of the composite and the stresses in the fibres and the matrix when a stress of 50 MN/m^2 is applied to the composite. The modulus of the epoxy is 6 GN/m^2.

(50 marks)

...3/-

3. There are 4 type of polymeric materials which can be used in polymer composite i.e. :

(a) Rubber

(b) Thermoplastic

(c) Elastomer thermoplastic

(d) Thermoset

By selecting one example for each polymeric material, discuss how they can be used to produce polymer composite

(100 marks)

4. [a] Write a short note on liquid-metal infiltration technique used for manufacturing Metal Matrix Composites (MMCs) together with their advantages and limitations.

(40 marks)

[b] Describe the strength and ductility of Metal Matrix Composites (MMCs) at room temperature with respect to the monolithic metal.

(30 marks)

[c] MMCs has been used successfully in producing multifilamentary superconducting material based on intermetallic compound of Nb_3Sn. Describe the process of manufacturing this material.

(30 marks)

...4/-

5. [a] Describe the advantages and disadvantages of solid state and liquid state processing techniques of manufacturing Metal Matrix Composites (MMCs).

(25 marks)

[b] Give your comments on the creep behaviour of MMCs at elevated temperature as compared to monolithic metal.

(40 marks)

[c] Write a short note on the application of MMCs in automobile engine fabrications.

(35 marks)

6. [a] Write a short note on conventional processing technique of producing particulate ceramix-matrix composites.

(30 marks)

[b] Describe the processing stages of producing whisker reinforced ceramic composites

(30 marks)

[c] Several types of toughening mechanisms involve in whisker reinforced ceramic composites. Gives short explanations on crack pinning, crack deflection, micro-cracking, crack bridging and whisker pull-out mechanisms of toughening in this composite.

(40 marks)

...5/-

7. [a] With referring to a specific example, discuss the oxidation behaviour of the particulate ceramic-matrix composites.

(30 marks)

[b] Describe the three stages technique of producing glass-ceramic composites.

(30 marks)

[c] Explain some micro-structural parameters affecting the properties of particulate composites.

(40 marks)

- ooo O ooo -