UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009

November 2008

EBB 524/3 - Composite Materials

Duration : 3 hours

Please ensure that this examination paper contains FIVE printed pages before you begin the examination.

This paper contains SEVEN questions.

Instructions: Answer **FIVE** questions. If a candidate answers more than five questions only the first five questions in the answer sheet will be graded.

Answer to any question must start on a new page.

All questions must be answered in English.

1. [a] By considering a polymer composite with uni-directional continuous aligned fibres at longitudinal direction, show that

$$E_{CL} = E_f V_f + E_m V_m$$

(20 marks)

[b] PEEK is to reinforced with 30% by volume of uni-directional carbon fibres and the properties of the individual materials are given below. Calculate the fraction of the applied force and the ratio of the stresses which will be taken by the fibres in the composite.

Material	Density (Kg/m^3)	Tensile strength (GN/m^2)	Modulus (GN/m^2)
PEEK	1300	0.058	3.8
Carbon fibre	1800	2.1	400

(30 marks)

[c] If the polymer composite in section [a] is made from uni-directional continuous aligned fibres at transverse direction, show that the resultant modulus is:

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

(20 marks)

[d] Calculate the transverse modulus, E_{cT} of the PEEK/carbon fibre composite in section [b] using both the simplified solid mechanics approach and the empirical approach.

Given:

[i] Halpin-Tsai equation

$$E_{cT} = E_m (1 + 2\beta V_f / 1 - \beta V_f)$$

[ii] Brintrup equation

$$E_{cT} = E'_m E_f / E_f (1 - V_f) + V_f E'_m$$

[iii] For PEEK, $V_m = 0.36$

(30 marks)

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2. [a] Discuss the various type of thermoplastic materials which can be used in the polymer composites.

(40 marks)

[b] Discuss briefly the various fibre arrangements in thermosets and any three (3) forming processes to reinforced plastics.

(30 marks)

[c] What do you understand about 'Biodegradable Polymer Composites'? Discuss the 4 types of biodegradable polymers.

(30 marks)

3. [a] Describe the fabrication of dispersion strengthened Cu–TiB_2 composite via powder metallurgy method using ex-situ and in-situ processing approaches. Explain the main differences in both approaches, including their advantages and disadvantages.

(60 marks)

[b] A metal matrix composite is made from a boron (B) fiber reinforced aluminum alloy (Figure 1). To form the boron fiber, a tungsten (W) wire (r = 20μm) is coated with boron, giving a final radius of 100 μm. The aluminum alloy is then bonded around the boron fiber, giving a volume fraction of 0.80 for the aluminum alloy. Assuming that rule of mixture is applied also to ternary mixture; calculate the effective tensile elastic modulus of the composite material under isostrain conditions. Data E_w = 410 GPa; E_B= 379 GPa; E_{Al} = 68.9GPa.

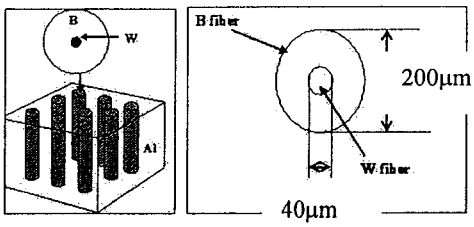

Figure .

(40 marks)

4. [a] Discuss the effect of the following material processing parameters on physical and mechanical properties of metal matrix composite.

(i) Reinforcement size

(ii) Reinforcement volume

(50 marks)

[b] With a schematic diagram, outline the fabrication of Al-SiC composite by liquid melt infiltration under gas pressure.

(50 marks)

5. [a] Ceramic matrix composite's development has lagged behind MMC and PMC for reasons, discuss it.

(30 marks)

[b] With the aid of appropriate diagrams, describe the processing of ceramic matrix composite's including its advantages and disadvantages using these methods:

(i) Slurry Infiltration

(ii) Sol-Gel

(70 marks)

6. Ceramic Matrix Composite is an approach to improve the toughness of ceramic materials. Discuss four toughening mechanisms in CMC.

(100 marks)

7. [a] What are the advantages and disadvantages of using polymer nanocomposites as compared to polymer microcomposites?

(30 marks)

[b] Discuss the application of metal matrix composites in ground transportation area.

(30 marks)

[c] Discuss on the significant of wettability in processing of CMC using melt-infiltration.

(40 marks)

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