UNIVERSITI SAINS MALAYSIA

Supplementary Semester Examination
Academic Session 2004/2005

May 2005

EBB 524/3 – Composite Materials

Duration: 3 hours

Please check that this examination paper consists of SEVEN pages of printed material before you begin the examination.

This paper contains SEVEN questions.

Instructions: 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.

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1. (a) What are the advantages and disadvantages of using glass fiber, carbon fiber and aramid fiber to reinforced polymer composites?

(50 marks)

(b) Discuss how the interface interaction between filler/fiber and polymer matrix can be enhanced.

(50 marks)

2. (a) Discuss the differences between

i. hybrid polymer composites and structural polymer composites

ii. particle reinforced polymer composites and fiber reinforced polymer composites

(50 marks)

(b) By using suitable diagrams, draw different type of patterns of fiber reinforcement in polymer composites.

(50 marks)

3. (a) In a unidirectional carbon fiber/epoxy composites, the modular ratio is 40 and the fibers take up 50% of the cross-section. What percentage of the applied force is taken by the fibers?

(30 marks)

(b) A metal carbide matrix composite is made with continues SiC fiber embedded in a metal carbide matrix [Fig 1]. (a) Calculate the elastic modulus of the composite under isostrain condition and (b) calculate the stress σ at which the cracks start to grow. Data are as follows:

Metal carbide matrix	SiC Fiber
E = 110GPa	E = 350 GPa
K_{1C} = 15 MPa(m)$^{1/2}$	K_{1C} = 4.8 MPa(m)$^{1/2}$
Largest preexisting flaw is 15 μm	Largest preexisting flaw is 10 μm

(35 marks)

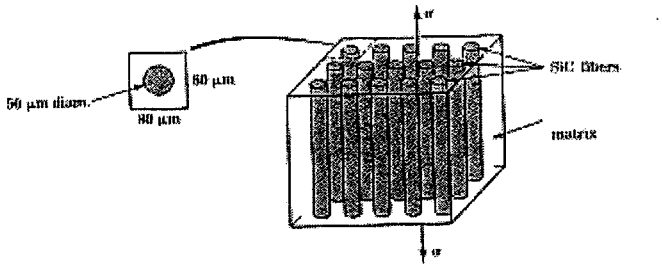

Figure 1

(c) Discuss the processing, properties and applications of SiC whisker reinforced alumina composites.

(35 marks)

4. (a) List and describe briefly with aid of diagrams the fabrication methods for MMCs materials.

(50 marks)

(b) A metal matrix composite is made from a boron (B) fiber reinforced aluminum alloy (Figure 2), to form the boron fiber, a tungsten (W) wire (r=10μm) is coated with boron, giving a final radius of 75μm. The aluminum alloy is then bonded around the boron fibers, given a volume faction of 0.65 for the aluminum alloy. Assuming that the rule of binary mixtures applies also to ternary mixtures, calculate the effective tensile elastic of the composite material under isostrain conditions.

Data: E_W = 450 GPa, E_B = 390 GPa and E_{AL} = 70 GPa

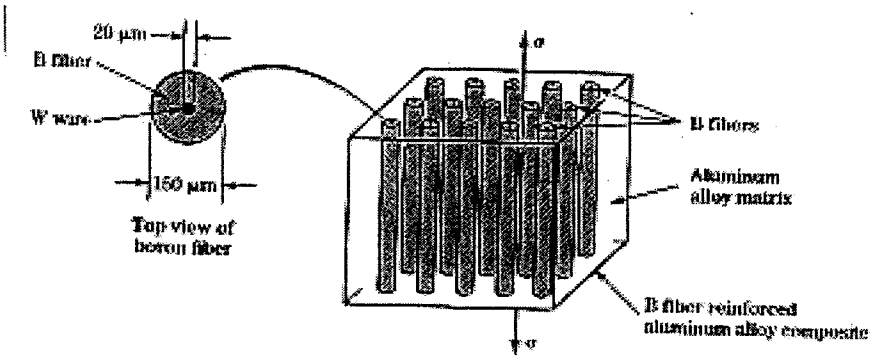

Figure 2

(50 marks)

5. (a) Indicate whether statements 1 to 13 are true or false.

1. Materials property charts always have Young's modulus for one of the axes.
2. The properties of a composite are essentially isotropic when the reinforcement is randomly orientated, equiaxed particles.
3. A laminate is an example of a particle reinforced composite.
4. The main objective in reinforcing a metal is to lower the Young's modulus.
5. A hybrid has a mixed metal and ceramic matrix reinforced with polymer fibres.
6. The performance indicator $E^{l/2}/p$ is applicable when considering the possibility of buckling under the action of a compressive force.
7. The most widely used composites are metal matrix composites.
8. Usually the matrix has a lower Young's modulus than the reinforcement.
9. The superconducting properties of a multifilamentary superconductor are determined by the Nb_3 Sn layer thickness and grain size.
10. Although MMC has higher room temperature strength than the matrix the converse is true at elevated temperatures.
11. The electrical conductivity of an MMC is usually less than that of the matrix.
12. In the squeeze casting process molten metal is forced by mechanical pressure into a perform.
13. Powder metallurgy is commonly employed for the fabrication of MMCs, but only if the reinforcement is continuous fiber.

(40 marks)

(b) For each of the statements of questions 1 to 11, one or more of the completions given are correct. Mark the correct completions.

1. The creep curve of a metal reinforced with continuous ceramic fibres
   (A) asymptopically approaches a zero creep rate,
   (B) exhibits a marked monotonically increasing tertiary creep regime,
   (C) is a classical three-stage creep curve,
   (D) is identical to that of a continuous in situ composite,
   (E) is a consequence of significant creep of the ceramic fibres.

2. The transverse tensile strength of an aligned continuous fibre composite
   (A) is obtained when testing normal to the fibre axis,
   (B) is obtained when testing parallel to the fibre axis,
   (C) is the lowest tensile strength,
   (D) is the highest tensile strength,
   (E) depends mainly on the properties of the matrix and of the fibre matrix interface,

3. The Young's modulus of an aligned continuous fibre metal matrix composite
   (A) increases with increasing volume fraction of fibre,
   (B) is independent of volume fraction of fibre,
   (C) is the same in the longitudinal and transverse directions,
   (D) is greater in the longitudinal direction,
   (E) is greater in the transverse direction.

(60 marks)

6. (a) Briefly explain the difference between glass and glass-ceramics.

(30 marks)

(b) With the aid of diagram, describe the slurry infiltration process.

(70 marks)

7. (a) Describe properties of ceramic matrix composite which is used for a cutting tool.

(30 marks)

(b) Describe the slurry infiltration process.

(40 marks)

(c) Explain the difference between monolithic ceramic and ceramic matrix composites.

(30 marks)

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