UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2010/2011

November 2010

EBB 524/3 - Composite Materials

Duration : 3 hours

Please ensure that this examination paper contains <u>FIVE</u> printed pages before you begin the examination.

This paper consists of SEVEN questions.

Instruction: Answer **FIVE** questions. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.

The answers to all questions 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 and transverse direction, show that the resultant modulus is:

$$E_{cL} = E_f V_f + E_m V_m \quad \text{and}$$
$$E_{cT} = E_f E_m / (V_f E_m + V_m E_f)$$

(50 marks)

      [b]   A reinforced plastic sheet is to be made from a matrix with a tensile strength of 60 MN/m^2 and continuous glass fibres with a modulus of 76 GN/m^2. If the resin ratio by volume is 70% and the modulus ratio of the composites is 25, estimate the tensile strength and modulus of the composites.

(50 marks)

2.   [a]   Discuss briefly the classification of various polymer composites.

(30 marks)

      [b]   For effective strengthening and stiffening of the polymer composites, the use of critical fibre length, l_c, fibre orientation and concentration of fibre are very important. Give your comments.

(40 marks)

      [c]   Discuss the results obtained in Table 1.

Table 1: Mechanical and thermal properties of nylon-6-clay composites

Composite Type	Wt (%) nanoclay	Tensile strength (MPa)	Tensile modulus (GPa)	Impact (kJ/m^2)	HDT (^{o}C) at 18.5 kg/cm^2
Nanoscopic (Exfoliated)	4.2	107	2.1	2.8	145
Micro (tactoid)	5.0	61	1.0	2.2	89
Pristine Polymer	0	69	1.1	2.3	65

(30 marks)

3. [a]   Explain the advantages and disadvantages of SiC whickers compared to SiC particulate as reinforcement in metal matrix composite.

(30 marks)

    [b]   List out FOUR bonding types between reinforcement and matrix in composite materials that are possible. Describe mechanism of TWO bonding that are significant in metal matrix composite.

(30 marks)

    [c]   Explain the cause and the consequence of particle agglomeration and inhomogeneous reinforcement particles during fabrication of metal matrix composite using solid state processing. Propose few solutions that can overcome these problems.

(40 marks)

4. [a]   Plot graphs to explain the effect of size, volume fraction and shape of reinforcement on the Young's Modulus of metal matrix composite. Discuss trend of the graphs and provide the causes for such trend.

(50 marks)

    [b]   Even though metal matrix composite offers many advantages compared to polymer matrix composite and ceramic matrix composite, its application in industry is still limited due to its processing difficulties and high cost. Discuss TWO applications that metal matrix composite are the most suitable candidate.

(50 marks)

5.   Design a Fibre Reinforced Ceramic Matrix Composite System using Slurry Infiltration Technique. List any advantages, disadvantages of the materials and technique used in your system and also describe on the problems appear due to chosen materials and technique and gives their solution.

(100 marks)

6.   [a]   A ceramic material does not have a unique strength in the same way that a metal does. Therefore, one of the approaches to improve its toughness strength and stiffness is via Ceramic Matrix Composite (CMC). Using a typical stress-strain curve, explain the advantages of ceramic composite compared to monolithic ceramic.

(40 marks)

        [b]   One of the method to fabricate Ceramic Matrix Composite is via Sol Gel Method. Explain its advantages and disadvantages of this method. You may use an example of composite system to support your answer.

(40 marks)

        [c]   What is wettability? Describe the condition where the spreading will occur.

(20 marks)

7.   [a]   Discuss briefly the 4 type of biodegradable polymers.

(40 marks)

[b]   A new development in metal-matrix composite is made for the National Aerospace plane with a matrix of the intermetallic compound titanium aluminide (Ti3Al) and continuous silicon carbide fibers. A unidirectional composite is made with the SiC continuous fibers all in one direction. If the modulus of the composite is 210 GPa and assuming isostrain conditions, what must the volume percent of SiC fibers in the composite be if E_{SiC} = 390 GPa and $E_{(Ti3Al)}$ = 145 GPa?

(30 marks)

[c]   Discuss how interfacial bonding affects the fracture behavior of the CMCs.

(30 marks)

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