

College of Engineering, Pune
(An Autonomous Institute of Government of Maharashtra)
End Semester Examination
PCC/MT 09004 Polymers and Composites
Semester I

Year: T.Y.B.Tech

Academic Year: 2013 – 14

Duration: 3 Hours

Branch: Metallurgical Engineering

November 2013

Max. Marks: 60

Instructions to the candidates

- 1) All questions are compulsory.
 - 2) Figures given to the right side indicate full marks.
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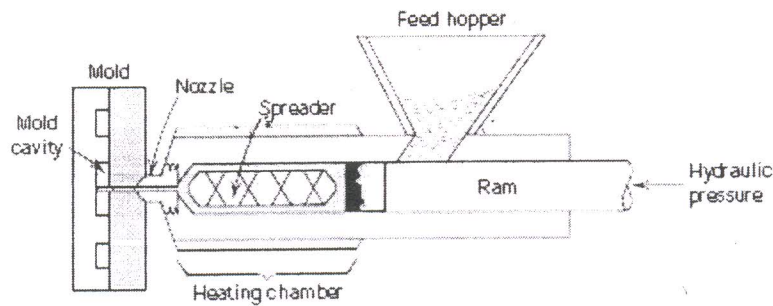
Q.1 Each of the sentences from (i) to (v) consists of an assertion followed by a reason.

1x5 = 5

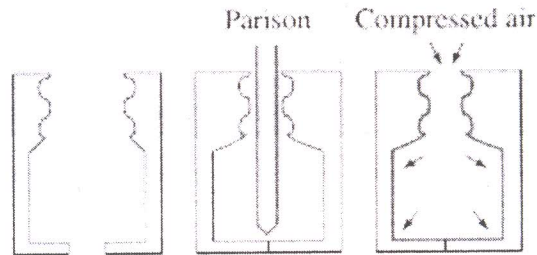
Answer:

- (A) if both assertion and reason are true statements and the reason is a correct explanation of the assertion.
 - (B) if both assertion and reason are true but reason is not a true explanation of the assertion.
 - (C) if the assertion is true but the reason is a false statement.
 - (D) if the assertion is false but the reason is a true statement.
 - (E) if the both assertion and reason are false statements.
- (i) Metal matrix composites usually retain their strength to higher temperatures than the matrix alloy *because* the reinforcement is normally a ceramic material which has good mechanical properties at elevated temperatures.
 - (ii) The properties of continuous fibre composites are anisotropic *because* the arrangement of the fibres is often unidirectional.
 - (iii) Polymer matrix composites have high values for specific modulus *because* polymers are high strength materials.
 - (iv) The coefficient of thermal expansion of metal matrix composite with a ceramic reinforcement is less than that of matrix *because* the coefficient of thermal expansion of a ceramic is usually less than that of metal.
 - (v) Many thermoplastics are partially crystalline *because* thermoplastics cross – link to form a rigid network.

Q.2 The following figures (a) and (b) show schematic sketches of manufacturing techniques employed for polymeric articles. Identify and describe each process. **2x3 = 6**



(a)



(b)

- Q.3 How do glass transition temperatures of polyethylene, polypropylene and polymethyl methacrylate compare? Explain their differences based on the structure of monomer. 3
- Q.4 What do properties of composite materials depend upon? 3
- Q.5 What is a coupling agent? What is "sizing" related to the production of glass fibres? 2
- Q.6 Several epoxy matrix composites were prepared using different lengths of $3 \mu\text{m}$ – diameter ZrO_2 fibres. It was found that strength of the composite increased with increasing fibre length up to 5 mm. For long fibres, the strength is virtually unchanged. Estimate the strength of the bond between the fibres and the matrix. 3
- Q.7 We would like to produce lightweight epoxy part to provide thermal insulation. We have hollow glass beads for which the outside diameter is $1/6$ inch and the wall thickness is 0.001 inch. Determine the weight and number of beads that must be added to the epoxy to produce a composite with mass of 500 gm with a density of 0.65 g/cc. the density of the glass is 2.5 g/cc and that of epoxy are 1.25 g/cc. 5
- Q.8 An electrical contact material is produced by infiltrating copper (Cu ; $\rho_{\text{Cu}} = 8.9 \text{ g/cc}$) into a porous tungsten carbide (WC ; $\rho_{\text{WC}} = 15.77 \text{ g/cc}$) compact. The density of final composite is 12.3 g/cc. Assuming that all of the pores are filled with copper, calculate
- the volume fraction of copper in the composite.
 - the volume fraction of pores in tungsten carbide compact prior to infiltration
 - the original density of tungsten carbide compact before infiltration.
- 4

- Q.9 Explain briefly how the volume of fibre, fibre orientation, fibre strength and modulus affect the properties of fibre reinforced composite. 4
- Q.10 What are the advantages of using ceramic matrix composites? 2
- Q.11 Explain briefly in what sporting equipments composite materials are used. What is the main reason why composites are used in these applications? 2
- Q.12 Cite the general difference in strengthening mechanism between large particle and dispersion strengthened composites. 2
- Q.13 List four reasons why glass fibres are extensively used. 2
- Q.14 Which are the toughening mechanisms of composite materials. Explain any of the mechanisms with a suitable diagram. 5
- Q.15 How will crystal size, crystallinity, density and Young's modulus of alumina fibres produced by solution spinning change after heat treatment? 2
- Q.16 What are the controlling parameters in production of metal matrix composites in squeeze casting and liquid metal infiltration? 2
- Q.17 Draw the schematic sketches for the following. **1x3 = 3**
- (i) Coefficient of thermal expansion of pure metals and that reinforced with ceramic materials like Al_2O_3 as a function of temperature
 - (ii) Young's modulus of a composite material as a function of vol% reinforcement in longitudinal and transverse direction
 - (iii) Young's modulus of pure metals and that reinforced with ceramic materials like Al_2O_3 as a function of temperature
- Q.18 What are the general steps involved in sol – gel processing and vapour deposition technique in manufacturing of ceramic matrix composites? 5