Code : 021305

B.Tech 3rd Semester Exam., 2017

MATERIAL SCIENCE

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer (any *seven*) : 2×7=14

(a) Which of the following is strong and ductile materials?

(i) Polymers

(ii) Ceramics

(iii) Metals

(iv) Semiconductors

(b) Which of the following statements is false?

(i) Line defects are thermodynamically stable

(ii) Dislocation can end inside a crystal without forming loop

(iii) ABC ABC ABC ... is stacking sequence for HCP crystal

(iv) All of the above

(Turn Over)

(c) Time-dependent permanent deformation is called

(i) plastic deformation

(ii) elastic deformation

(iii) creep

(iv) Anelastic deformation

(d) The most influencing factor of diffusivity is

(i) diffusing species

(ii) temperature

(iii) lattice structure

(iv) presence of defects

(e) Which of the following is not a Hume-Ruthery condition?

(i) Crystal structure of each element of solid solution must be the same

(ii) Size of atoms of each two elements must not differ by more than 15%

(iii) Elements should form compounds with each other

(iv) Elements should have the same valence

(f) Phase formed of diffusionless reaction is

(i) pearlite

(ii) lower bainite

(iii) upper bainite

(iv) martensite

(g) Eutectoid product in Fe-C system is called

(i) pearlite

(ii) bainite

(iii) ledeburite

(iv) spheroidite

(h) Failure due to excessive deformation is controlled by

(i) material properties

(ii) design and dimensions

(iii) Both (i) and (ii)

(iv) None of the above

(i) Most often machine components are failed by

(i) buckling

(ii) creep

(iii) fatigue

(iv) All of the above

(Turn Over)

(j) Last constituent to fail in fiber reinforced composites is

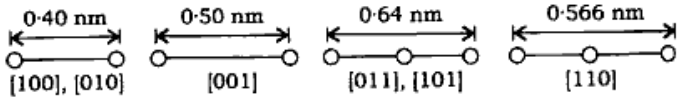
(i) matrix

(ii) fiber

(iii) Both fails at same time

(iv) Can't define

2. (a) The accompanying figure shows the atomic packing schemes for several different crystallographic directions for a hypothetical metal. For each direction, the circles represent only the atoms contained within a unit cell, the circles are reduced from their actual size. Draw the unit cell and identify the crystal structure : 7



(b) Show that a line of dislocation contains edge, screw or mixed dislocations. 7

3. (a) For aluminium (atomic radius 0·1431 nm), compute the inter-planer spacing for (110) set of planes. 7

(b) Calculate the atomic packing fraction for diamond cubic crystal and find its density (atomic radius $r = 0 \cdot 77$ Å). 7

(Continued)

4. Construct and label different regions of Ag-Cu phase diagram using the following data :

Melting point of Ag = 960 °C

Melting point of Cu = 1085 °C

At eutectic point = 780 °C, eutectic composition = 28 wt% Cu, maximum solubility of Ag in Cu = 8 wt%, maximum solubility of Cu in Ag = 6 wt%

At room temperature, maximum solubility of Ag in Cu = 3 wt% and maximum solubility of Cu in Ag = 2 wt%

Assume the liquids, solidus and solvus line are straight. Calculate the amount of proeutectic phase in 60 wt% Cu alloy at 779 °C and draw the change in micro-structures when cooled slowly from liquid state to room temperature. 6+2+6=14

5. Construct isothermal transformation diagram for eutectoid steel, determine and draw the final microstructure of a small specimen that has been subjected to the following time-temperature treatment. In each case, assume that the specimen begins at 800 °C, and that it has been held

at this temperature long enough to have achieved a complete and homogeneous austenite structure : 6+(2×4)=14

(a) Rapidly cool to 250 °C, hold for 10^5 s, then quench to room temperature

(b) Rapidly cool to 400 °C, hold for 10 s, then quench to room temperature

(c) Rapidly cool to 700 °C, hold for 10^5 s, then quench to room temperature

(d) Rapidly cool to 650 °C, hold at this temperature for 6 s, rapidly cool to 400 °C, hold for 10 s, then quench to room temperature

6. For a polymer-matrix fiber-reinforced composite—

(a) list three functions of the matrix phase; 6

(b) compare the desired mechanical characteristics of matrix and fiber phases; 4

(c) cite two reasons why there must be a strong bond between fiber and matrix at their interface. 4

7. A continuous and aligned glass fiber-reinforced composite consists of 30 vol% of glass fibers having a modulus of elasticity of 69 GPa and 70 vol% of a polyester resin that, when hardened, displays a modulus of 3·4 GPa.

(a) Compute the modulus of elasticity of this composite in the longitudinal direction. 2

(b) If the cross-sectional area is 250 mm^2 and a stress of 40 MPa is applied in this longitudinal direction, compute the magnitude of the load carried by each of the fiber and matrix phases. 6

(c) Determine the strain that is sustained by each phase when the stress in part (b) is applied. 6

8. (a) What is cast iron? How does it differ from pig iron? 5

(b) Compare ductile (nodular) cast iron with other cast iron on the basis of mechanical properties, composition and microstructure. 9

(Turn Over)

9. Write short notes on the following : 14

(a) Composite and alloys

(b) Annealing and normalizing

(c) Cross-slip and jog

(d) Frank-Read source

★★★