[104]   SEAT No. _____

SARDAR PATEL UNIVERSITY
M.Sc. (Physics) (IV–Semester) Examination (CBCS)
Tuesday, Date: 26/03/2019
Time: 10.00 a.m. to 01.00 p.m.
Title: CRYSTAL GROWTH AND IMPERFECTIONS IN SOLIDS (CMP)
Subject Code : PS04EPHY22 (NEW)

Instructions:
(a) Figures to the right indicate marks.
(b) Answer of all the questions (including MCQs) should be written in the provided answer book only.

Total Marks : 70

Q.1   Write answer of all questions by showing your choice against the question [8] number in main answer book.

(1)   _____ method is called crucibleless technique for crystal growth.
   (a) Bridgman   (b) crystal pulling   (c) floating zone   (d) flux growth

(2)   In Gel growth, density of gel should be in between _____ gm/cm^3.
   (a) 0.01035 to 0.01400   (b) 0.1035 to 0.1400   (c) 1.035 to 1.040   (d) 10.35 to 14.00

(3)   A foreign atom that replace a parent atom in crystalline lattice is called

   _____ .
   (a) substitutional impurity atom   (b) self interstitial atom
   (c) interstitial impurity atom   (d) None

(4)   Number of dislocation lines that intersect a unit area in the crystal is called :
   (a) Stress field of dislocation   (b) dislocation density
   (c) dislocation multiplication   (d) (b) and (c) both

(5)   Which type of defect is responsible for cross slip process to occur in single crystals?
   (a) edge dislocation (b) screw dislocation (c) point defects (d) stacking faults

(6)   The total elastic energy of dislocation when two parallel edge dislocations lying in the same slip plane of same sign or opposite sign separated by a larger distance is always_____ than when they are separated by smaller distance.
   (a) reduced   (b) increased   (c) same   (d) none of these.

(7)   Dynamic and fluctuating stresses leads to the failure of material is termed as
   (a) creep   (b) fatigue   (c) fracture   (d) dislocation

(8)   Any jog with more than one atomic plane spacing high is referred to as
   (a) interstitial jog (b) composite jog   (c) vacancy jog   (d) line tension jog

①

Q.2   Attempt any Seven of the following questions: [14]

(1)   Describe the ampoule cleaning procedure for the growth of crystals using vapour transport technique.

(2)   Explain the growth procedure to grow calcium tartrate crystal from gel.

(3)   How stacking fault is produced in hcp crystal by removing close packed plane and then shear.

(4)   What is diffusion? Explain self diffusion in metal.

(5)   If 2 eV is the energy required to move an atom from the crystal's interior to the surface. What is the proportion of vacancies present in the crystal at 500K and at 1500K?

(6)   By considering the forces acting on a dislocation line, obtain the expression for stress required to bend a dislocation to a radius R.

(7)   The diffusion coefficient for Li in Ge at 500^0C is of the order of $10^{-10}m^2$/s. What is its approximate distance of penetration in 1 hour?

(8)   Discuss different types of cyclic stresses.

(9)   Differentiate between carburizing and decarburizing process.

Q.3(a) Using necessary suitable schematic diagram describe Verneuil flame fusion   [6] technique for the growth of crystals from melt.

Q.3(b) Draw a necessary diagram for growth of crystals using high temperature   [6] solution method by slow cooling process and explain its crystal growth procedure in detail. Also mention the characteristics of the solvent.

OR

Q.3(b) What is nucleation? With help of suitable diagram describe homogeneous   [6] nucleation in detail.
Consider the freezing of Barium at atmospheric pressure for each degree of undercooling when $\Delta T=1$ ^{0}K. Calculate: Critical nucleus size, number of spherical cluster with radius r^*, free energy changes between liquid and solid per unit volume and free energy changes at critical nucleus size.
Given data: -melting point of Barium = 725 ^{0}C, heat of fusion per unit volume = 3.20 x 10^9 J/m^3, Solid – liquid interfacial free energy =81.0 mJ/m^2 and Atomic volume =2.52 x 10^{-29} m^3.

Q.4(a) What is colour center? Describe different types of colour centers are formed   [6] in crystalline material giving suitable example.

Q.4(b) What is dislocation? Describe edge and screw dislocation in a crystal using   [6] necessary diagram.

OR

Q.4(b) With the help of neat diagram explain formation of grain and tilt boundary   [6] in crystalline material.
Calculate the spacing between dislocations in a tilt boundary in fcc nickel, when the angle of tilt is 2^0 (where, a = 3.52 A^0).

②

Q.5(a)   Draw and explain the diagram showing the intersection of edge-edge, edge - [6] screw dislocation and screw – screw dislocation resulting in the formation of Jogs.

Q.5(b)   Describe surface and X-ray topography techniques which are used for [6] observing the defects in crystals.

OR

Q.5(b)   At 927^{0}C, a 1.2% carbon steel is getting decarburized for a duration of 5 [6] hours in an atmosphere equivalent to 0% at the surface of the steel. Determine the minimum depth upto which post machining is to be done, if the carbon content at the surface after machining should not be below 0.8%.
D(C in iron) = 1.28 x 10^{-11}m^2/s at 927^{0}C .
Given : erf Z,   Z
          0.6420   0.65
          0.6666   X
          0.6778   0.70

Q.6(a)   Define hardness and explain different techniques by which hardness of a [6] material can be determined.

Q.6(b)   Explain different factors that affect the fatigue life of a material.   [6]

OR

Q.6(b)   Which techniques are used to measure the impact energy? Describe them [6] and also show that how these tests can be used to determine whether or not a material experiences a ductile-to-brittle transition with decreasing temperature.

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