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SARDAR PATEL UNIVERSITY

M.Sc. (Physics)(IVth Semester) Examination

Date : 27/04/2015, Day :Monday , Time : 2:30 p.m. to 5:30 p.m.

Subject : Crystal growth and imperfections in Solids, Paper No. PS04EPHY02

CBCS(choice based credit system)

Important Note : Q.1 : Multiple choice questions (MCQ) carries one mark each.
Q.2 : Short questions carries two marks each (attempt any seven out of nine)
Q.3 to Q.6 : Long questions carries 12 marks .

Total Marks : 70

Choose the appropriate options from the following in Q.1

Q.1 (8)

i) For two component system which is completely insoluble in both states, the number of degree of freedom above melting point is:
(a) 2 (b) 3 (c) 1 (d) 0

ii) If the misoriented single crystal sections are identical but are joined together in such a way that the boundary acts as reflecting plane is termed as
(a)twin (b) tilt (c) stacking fault (d) twist

iii) A plot of temperature corresponding to upper points on the curve against suitable alloy compositions gives the line called
(a) Peritectic (b) Eutectic (c) Liquidus (d) Solidus

iv) The Burger's vector of edge dislocation is --------- to the dislocation line.
(a) perpendicular (b) parallel (c) diagonal
(d) undefined

v) The failure that occurs in structures subjected to dynamic and fluctuating stresses is termed as
(a) Creep (b) Fatigue (c) Fracture (d) dislocation

vi) In most metal alloys, which type of diffusion occurs much more rapidly
(a)Interstitial (b) Dissociative (c)Vacancy (d) Ring

vii) Surface method is limited to crystals with a dislocation density in the range of (in cm^{-2})
(a) 10^{7} to 10^{10} (b) 10^{1} to 10^{6} (c) 10^{10} to 10^{20} (d) 10^{20} to 10^{30}

viii) Three adjacent F centers forms :
(a) M-Center (b) R- center (c) V-center (d) F_A- center

Q.2 ***Answer any seven questions out of nine in Q.2*** (14)

i) State important characteristics of choosing a solvent in solution growth technique.

ii) What is Gibb's phase rule? Calculate the number of degree of freedom for binary system using this rule for a condensed system.

iii) Define carburizing and decarburizing process in steel.

iv) Define slip planes and slip directions.

v) A single crystal of copper (fcc) contains a low angle tilt boundary on a (010) plane and the tilt axis parallel to the [001] direction. Calculate the tilt angle, if the spacing of the dislocations in the boundary is 1.5×10^{-6} m. (Given : $a = 3.61 A^0$).

vi) Show diagrammatic representation of the dislocation movement in the Frank-Read source.

vii) What is cross slip ? Draw a plot of stress dependence of the velocity of edge and screw dislocations in a crystal.

viii) What is hardness ? State different techniques known to you for determining the hardness of a material.

ix) What is Kirkendall effect ?

Q.3(a) Draw phase equilibrium diagram of two component system which is mutually soluble in liquid state and insoluble in solid state and discuss it in detail. (6)

Q.3(b) Explain in detail Vernueil flame fusion and float zone technique used for the growth of crystals. (6)

OR

Q.3(b) Discuss growth of crystals by gel and flux techniques and also state their advantages and disadvantages. (6)

Q.4(a) By considering the plastic deformation due to slip obtain the equation for critical resolved shear stress for plastic deformation to start. (6)

Q.4(b) Derive the necessary expression for concentration of Frenkel imperfection. (6)

OR

Q.4(b) What are stacking faults ? Discuss how stacking faults may be produced in fcc and hcp crystals. (6)

Q.5(a) What are colour centres ? Explain how F, R, M and V centres are produced with diagrams. **(6)**

Q.5(b) Derive the expression for elastic strain energy of edge, screw and mixed dislocations. Also show that whether or not a dislocation reaction will occur using the simple Frank rule. **(6)**

OR

Q.5(b) Explain X-ray topography and field ion microscopy methods used for observing dislocations in crystals. **(6)**

Q.6(a) Differentiate between ductile and brittle fracture. **(6)**

Q.6(b) Discuss different types of cyclic stresses and explain how experimentally S-N curves can be obtained. Also explain two distinct types of S-N behavior observed for ferrous and non-ferrous alloys. **(6)**

OR

Q.6(b) Obtain the necessary expression for non-steady state diffusion and solve the given problem. **(6)**

The diffusion coefficient of Li in Ge at 500^0C is of the order of $10^{-10}m^2/s$. How much time it should take to penetrate a distance of 2mm ?

********** THE END **********