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SARDAR PATEL UNIVERSITY

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

Date :12/04/2016 , Day :Tuesday , Time : 2:30p.m. to 5:30p.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) Point defects can be studied by which of the following method :
(a) surface method (b) decoration method (c) field ion microscopy
(d) X-ray diffraction
- ii) The Burger's vector of edge dislocation is ----- to the dislocation line.
(a) perpendicular (b) parallel (c) diagonal
(d) undefined
- iii) A plot of temperature corresponding to upper points on the curve against suitable alloy compositions gives the line called
(a) Peritectic line (b) Eutectic line (c) Liquidus line (d) Solidus line
- iv) Two adjacent F centres are called
(a) M centre (b) F_A centre (c) R centre
(d) V centre
- v) Diffusion has a very strong dependence on which of the following parameter
(a) time (b) temperature (c) pressure (d) atmosphere
- vi) The process in which carbon is lost in the form of CO or CO₂ from surface layers of the steel due to an oxidizing atmosphere is called as
(a) Carburizing (b) Nitriding (c) Decarburizing (d) Surface hammering
- vii) Which of the following technique is best suited for growth of ruby crystals ?
(a) flame fusion (b) floating zone (c) Vernueil's flame fusion (d) Czochralski .
- viii) If the misoriented single crystal sections are identical but are joined together in such a way that the boundary acts as a reflecting plane and is called as
(a) Grain boundary (b) twin boundary (c) tilt boundary (d) twist boundary

Q.2

Answer any seven questions out of nine in Q.2

(14)

- i) Explain tilt and twist boundary in short.
- ii) How stacking faults are produced in hcp crystals ?
- iii) Explain how cross slip process takes place in fcc crystal.
- iv) Give difference between ductile and brittle fracture.
- v) What is Gibb's phase rule? Calculate the number of degree of freedom for binary system using this rule for a condensed system.
- vi) Discuss in short ampoule cleaning process used for the growth of crystals by vapour phase technique.
- vii) What are stress raisers ?
- viii) What are colour centers and how they are produced in ionic crystals ?
- ix) State Fick's first and second law of diffusion.

Q.3(a) What is nucleation? Derive an expression for critical radius of nucleus for the case of homogeneous nucleation. (6)

Q.3(b) Draw and explain Peritectic phase equilibrium diagram for two component system in detail and calculate amount of phase present using lever rule. (6)

OR

Q.3(b) Explain crystal pulling and Vernueil's flame fusion method used for growing crystals in detail. (6)

Q.4(a) Differentiate between edge and screw dislocation. Also explain what are slip planes and slip directions. (6)

Q.4(b) Explain what is Burger's vector and Burger's circuit. Also solve the following problem : The concentration of Schottky defects in an ionic crystal is 1 in 10^{10} at a temperature of 300°K . Calculate the value of energy formation of Schottky defects at this temperature. (6)

OR

Q.4(b) Using necessary expressions explain dislocation motion. Also discuss whether dislocation motion depends on width and temperature. (6)

Q.5(a) Explain electron microscopy and field ion microscopy to observe dislocations in crystals. (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 multiplication of dislocations by Frank-Read sources and multiple cross glide process. (6)

Q.6(a) Discuss different techniques used for measuring hardness of soft and hard materials. (6)

Q.6(b) A gear made of 1020 steel(0.20wt%) is to be gas carburized at 927°C. Calculate the carbon content at 0.060 inch below the surface of the gear after a 10 hour carburizing time. Assume the carbon content at the surface is 1.20wt%. (6)

$$D(\text{at } 927^{\circ}\text{C}) = 1.28 \times 10^{-11} \text{m}^2/\text{s}.$$

| | |
|---------------------------|---------------|
| Given : erf $\frac{Z}{X}$ | $\frac{Z}{X}$ |
| 0.8802 | 1.1 |
| X | 1.1125 |
| 0.9103 | 1.2 |

OR

Q.6(b) What are cyclic stresses ? Discuss S-N curves with appropriate diagrams in detail. (6)

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