

II B.Tech II Semester Supplementary Examinations, Apr/May 2008
MATERIAL SCIENCE FOR CHEMICAL ENGINEERING
(Chemical Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. Sketch a (110) plane in a unit cell of cubic crystal. Show all the (111) directions that lie on this plane, giving Miller indices of each one of them. [16]
2. Write about :
 - (a) Ionic structures.
 - (b) Covalent structures. [8+8]
3. (a) What is meant by the term 'solid phase'?
 - (b) Give some examples of single phase and multiphase materials and state why they are so called? [6+10]
4. (a) How the stability of a dislocation loop can be determined?
 - (b) Give a brief note on the origin of dislocations? [8+8]
5. (a) By taking logarithm on both sides of the equation $\dot{\epsilon}^* + A [\sinh(\alpha\sigma)]^n e^{-Q/RT}$, show that the condition for plotting data involving $\dot{\epsilon}^*$ and σ to obtain a straight line
(b) Explain why a decrease in temperature should cause the line to shift to the right. [10+6]
6. Distinguish between the term "recovery" and "recrystallization" involved in the process of heating cold-worked metals? [16]
7. What is meant by ductile-brittle transition temperature? Name a few materials which are susceptible to brittle transition? State some of the factors responsible for brittle transition? [16]
8. Draw the free energy curves versus composition for the solid and liquid phases in a protective system at
 - (a) A temperature above protective temperature T_p , where a solid phase is present.
 - (b) T_p
 - (c) A temperature below T_p where a liquid phase is present. [16]

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1. How many atoms are there per square millimeter on:
(a) (100) Plane of copper
(b) (110) Plane
(c) (111) Plane? [5+5+6]
2. State the usual methods used in determining the structure of a crystal. State also how to determine lattice parameters of a cubic crystal by the diffraction method. [16]
3. (a) What is meant by the term 'solid phase'?
(b) Give some examples of single phase and multiphase materials and state why they are so called? [6+10]
4. Derive an expression for the energy per unit length of an edge dislocation? [16]
5. What is engineering stress and strain? What is meant by true stress and true strain? State where each of them are particularly used and suitable? In mathematical terms, which of these is the independent variable? [16]
6. If a bar of metal is quenched from a high temperature, the surface layers are found to contain compressive stresses and the center portion tensile stresses. Explain the phenomena? [16]
7. Explain the mechanism of
(a) fatigue failure
(b) Creep failure. [8+8]
8. Define grain boundary and account for its character. [16]

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1. (a) Sketch the five, two dimensional (plane) lattices.
(b) Explain why each is a distinct distribution of points in two dimension.
(c) Why is “entered square” not a separate plane lattice. [10+3+3]
2. Calculate the atomic density (number of atoms for unit area) in (111),(110),(100) planes of copper (F.C.C.) with the lattice parameter of $3.61 \text{ \AA}$. Can you pack atoms more closely than in (111) plane? [16]
3. Why is inter solubility possible in a substitutional solid solution but not in an interstitial solid solution? [16]
4. Discuss :
 - (a) How solute atoms affect dislocation motion?
 - (b) How precipitate particles affect dislocation motion? [8+8]
5. (a) By taking logarithm on both sides of the equation $\dot{\epsilon}^* + A [\sinh(\alpha\sigma)]^n e^{-Q/RT}$, show that the condition for plotting data involving $\dot{\epsilon}^*$ and σ to obtain a straight line
(b) Explain why a decrease in temperature should cause the line to shift to the right. [10+6]
6. A pure iron sheet 0.10 inch thick is annealed before cold-rolling it to 0.08 inch (negligible change in width).
 - (a) What would be the ductility of the iron after cold-rolling?
 - (b) Estimate the approximate temperature of recrystallization for this iron?
 - (c) Give two reasons why the recrystallization temperature of any metal is not fixed? [16]
7. The fracture strength of a sample of glass is 40 MN/m^2 . Estimate the Griffith's crack length in this sample assuming $E=60,000 \text{ MN/m}^2$ and $\gamma = 0.2 \text{ J/m}^2$. [16]
8. Explain why the rate of transformation of austenite to pearlite goes through a maximum (the nose of the TTT as the reaction temperature is lowered below A1) (Supply TTT diagram in the examination). [16]

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1. (a) A sodium chloride crystal is used to measure the wave length of some X rays. The diffraction angle is 5.2° for d111 spacing of chloride ions. What is the wavelength? (The lattice constant is $5.63 \text{ \AA}$) d111.
(b) Write tin is bct with equivalent points at 0,0,0 and $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$ and lattice constants of a $5.820 \text{ \AA}$ and c $=3.175 \text{ \AA}$. The unit cell however has four atoms (at 0,0,0; $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$; $0, \frac{1}{4}, \frac{1}{4}$ and $0, \frac{1}{2}, \frac{3}{4}$)
(c) What is the linear density of equivalent points in
 - i. (111) and
 - ii. (201) directions? [5+5+6]
2. Give detailed explanation for powder method. [16]
3. Explain the difference between edge and screw dislocation. [16]
4. Explain clearly the role of dislocations in crystal growth? [16]
5. (a) What is the difference between slip in single crystals and slip in polycrystalline metals?
(b) Explain with neat sketches the mechanism for dislocation in plastic deformation. [6+10]
6. Cite five engineering applications where metal is cold-worked to increase the tensile strength? [16]
7. What is fracture? State the causes of fracture in a material? [16]
8. (a) What is meant by eutectoid, hypo eutectoid, hypereutectoid steels?
(b) What is the relationship between them? [12+4]
