BITS PILANI DUBAI CAMPUS

Second Semester 2004-05

Course No: ES UC242 Course Name: Structure and Properties of Materials

COMPREHENSIVE EXAMINATION - Regular (Closed Book)

Time: 3 hrs MAX MARKS: 80 Date: 29.05.05

Note: All questions carry equal marks.

Q1a. Show that the atomic packing factor for HCP is 0.74.

Q1b. Derive the planar density expression FCC (111) plane in terms of atomic radius R.

Q2a. Calculate the minimum cation to anion radius ratio for the coordination number of 6.

Q2b. Describe the unit cell for Cesium chloride crystal structure.

Q3a. List the factors that influence the degree of crystallinity of polymeric materials.

Q3b. Cite the differences in thermoplastic and thermosetting polymers.

Q4a. Using a sketch, explain edge dislocation.

Q4b. Briefly describe tilt and twin boundary.

Q5a. Write Fick's first and second laws in equation form, and define all parameters.

Q5b. The diffusion coefficients for iron in nickel are given below at two temperatures. Determine the values of D_o and the activation energy Q_d. (R=8.31 J/mol-K)

T (K)	D (m^2/s)
1273	9.4×10^{-16}
1473	2.4×10^{-14}

Q6a. Explain how grain boundaries impede dislocation motion.

Q6b. Describe solid solution strengthening for substitutional impurity atoms.

Q7a. Briefly explain eutectoid and peritectic reactions.

Q7b. Show the schematic representations of the microstructures for an iron-carbon alloy of hypoeutectoid composition C_o as it is cooled from within the austenite phase region to below the eutectoid temperature.

Q8a. Briefly cite the differences between pearlite and bainite structures.

Q8b. Briefly explain the differences between isothermal and continuous cooling transformation diagrams for a eutectoid iron-carbon alloy.

Q9a. Discuss the influence of the following factors on polymer tensile modulus or strength: (i) molecular weight, (ii) degree of crystallinity, (iii) predeformation, (iv) heat treating of undeformed materials.

Q9b. List the factors that influence glass transition temperature.

Q10a. Describe crevice corrosion.

Q10b. Briefly explain one technique used for galvanic protection.

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Second Semester 2004-05
Course No: ES UC242 Course Name: Structure and Properties of Materials
Test 2 - Regular (Open Book)
Time: 50 MIN **MAX MARKS: 40** **Date: 10.04.05**

Q1. When making hardness measurements why an indentation very close to the preexisting indentation is not made?

[4]

Q2. Consider a single crystal of BCC iron oriented such that a tensile stress is applied along a [1 0 0] direction. (a) compute the resolved shear stress along a (1 1 0) plane and in a [1 $\bar{1}$ 1] direction when a tensile stress of 50 MPa is applied. (b) if slip occurs on a (1 1 0) plane and in a [1 $\bar{1}$ 1] direction and the critical resolved shear stress is 30 MPa, calculate the magnitude of the applied tensile stress necessary to initiate yielding.

[8]

Q3. Compute the tensile strength and the radius before deformation of cold worked cylindrical copper rod that has ductility (%EL) of 20% and the cold worked radius is 10 mm. Refer to Figs. Q3(a) and Q3(b)

[6]

Q4. A Pb-Sn alloy of composition 20 wt% Sn-80wt% Pb is slowly heated from a temperature of 100 °C. (a) At what temperature does the first liquid phase form? (b) What is the composition of liquid phase? (c) At what temperature does the complete melting of alloy occurs? (d) What is the composition of the last solid remaining prior to complete melting? Refer to Fig. Q4.

[8]

Q5. A hypothetical A-B alloy of composition 70 wt% B- 30 wt%A at some temperature is found to consist of mass fractions of 0.5 for both α and β phases. If the composition of β phase is 80 wt% B – 20 wt% A, what is the composition of α phase?

[6]

Q6. Compute the mass fractions of proeutectoid ferrite and pearlite that form in an iron-carbon alloy containing 0.05 wt% C.

[4]

Q7. Explain the difference between eutectoid and proeutectoid ferrite in a hypoeutectoid steel.

[4]

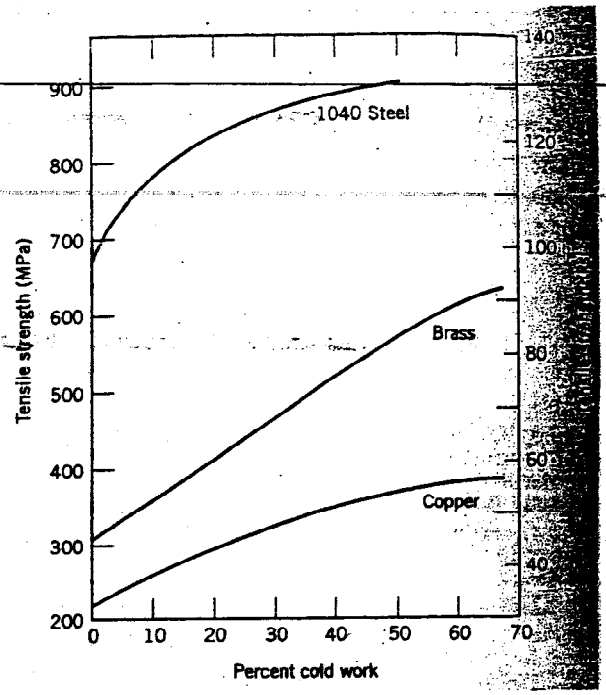

Fig Q 3(a)

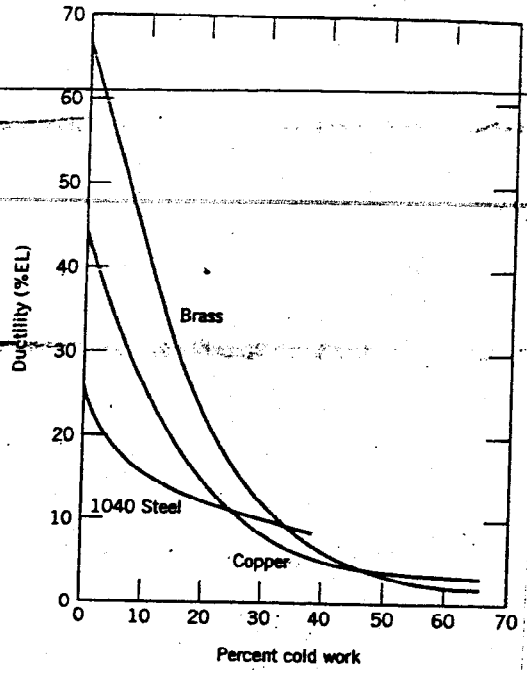

Fig. Q 3.(b)

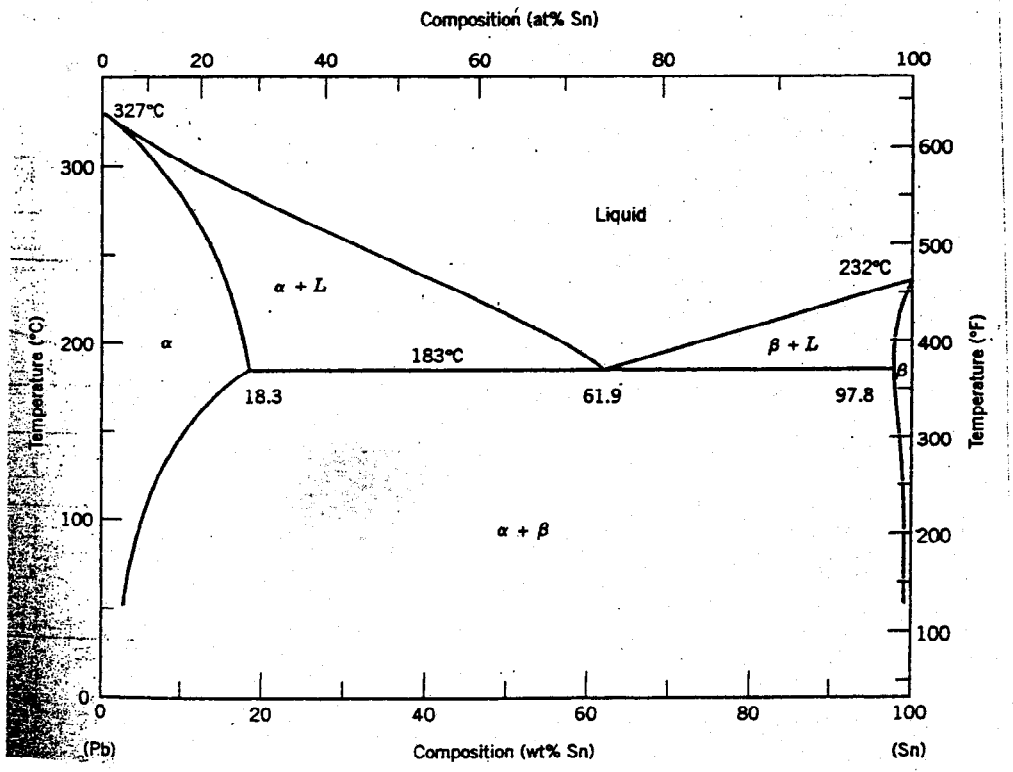

Fig. Q4

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Second Semester 2004-05

Course No: ES UC242 Course Name: Structure and Properties of Materials

Test 1 - Regular (Closed Book)

Time: 50 MIN MAX MARKS: 40 Date: 23.02.05

Q1.

a) State the main difference between ionic, covalent and metallic bonding. [3]

b) Plot the variation of net potential energy on interatomic separation for two isolated atoms a show the bonding energy for these two atoms on this plot. [2+2]

Q2.

a) Draw the plane ($\bar{1}$ 0 1 0) for the hexagonal crystal system. [4]

b) Cite the indices of the direction that results from the intersection of pair of planes (1 1 0) a (1 1 1) within a cubic crystal. [6]

c) Derive the planar density expression for BCC (1 1 0) plane in terms of atomic radius R. [3]

d) Fig. Q2d shows three different crystallographic planes for a unit cell of a hypothetical met The circles represent atoms. To what crystal system does the unit cell belong? [2] and why?. [2]

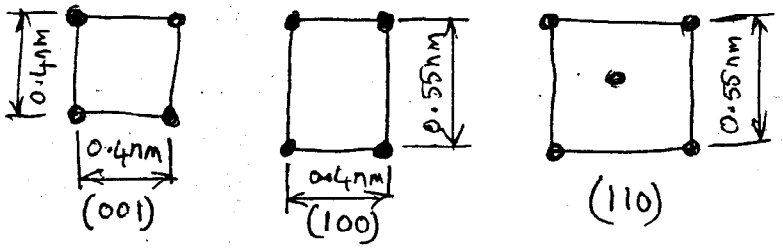

Fig. Q2d

Q3.

a) Compute the atomic packing factor for Cesium Chloride structure. The ionic radii of Cesiu and Chlorine ions are 0.17 nm and 0.181 nm respectively. [5]

b) List the point coordinates of all Chlorine ions situated at the face centered positions for a un cell of Sodium Chloride structure. [3]

Q4.

a) Sketch the mer structure for polytetrafluoroethylene. [4]

b) Compute the mer molecular weight for polyethylene. A_C=12.01 g/mol, A_H=1.008 g/mol where A_C and A_H represent the atomic weights of Carbon and Hydrogen respectively. [4]

BIRLA INSTITUTE OF TECHNOLOGYAND SCIENCE PILANI
DUBAI CAMPUS
Second Semester 2004-05

Set A

ES UC242 — Structure & Properties of Materials — 09.03.0
Max Marks: 20x1=20 — Quiz- Regular — Time: 30 Min

Name: ID No.: Section:

Q1. In ceramic crystal structures the stacking of close packed anion layers for FCC arrangement correspond to _____
a) AAA.....
b) ABABAB....
c) ABCABC.....
d) none of these

Q2. The coordination number of FeO is 6. The predicted crystal structure is _____
a) rock salt
b) cesium chloride
c) sphalerite
d) none of these

Q3. _____ is known as perovskite crystal structure.
a) Sodium chloride
b) Fluorite
c) Barium titanate
d) none of the above

Q4. If the cation-anion radius ratio is between 0.155 and 0.225, then the coordination number for cation is _____
a) 2
b) 3
c) 4
d) 6

Q5. Hydrocarbons has relatively low melting and boiling points as _____
a) weak hydrogen and van der Waals bonds bonds exist in each molecule, and weak hydrogen and van der Waals bonds exist between molecules
b) covalent bonds exists in each molecule, and weak hydrogen and van der Waals bonds exist between molecules
c) covalent bonds exists in each molecule, and covalent bonds exists between molecules
d) none of the above

Q14. The relative orientations of Burgers vector and dislocation line are perpendicular for _____
a) edge dislocation
b) screw dislocation
c) mixed dislocation
d) none of the above

Q15. The driving force for steady state diffusion is _____
a) diffusion flux
b) diffusion coefficient
c) concentration gradient
d) none of the above

Q16. Which of the following is true for interstitial diffusion? [ ]
a) In most metal alloys, interstitial diffusion occurs much more rapidly than diffusion by vacancy mode
b) In most metal alloys, interstitial atoms are smaller and thus are more mobile
c) In most metal alloys, there are more empty interstitial positions than vacancies
d) all of the above

Q17. Purification of hydrogen gas is an example of _____
a) steady state diffusion
b) unsteady state diffusion
c) both steady and unsteady state diffusion
d) none of the above

Q18. A plate of iron is exposed to a carbon rich atmosphere on one side and carbon deficient atmosphere on other side at 700 °C. If a condition of steady state is achieved, the concentration gradient is _____ if the concentrations of carbon at positions 5 mm and 10 mm beneath carburizing surface are 1.2 kg/m^3 and 0.8 kg/m^3, respectively.

Q19. Carbon diffusion in Iron occurs by _____
a) vacancy diffusion
b) interstitial diffusion
c) both vacancy and interstitial diffusion
d) none of the above

Q20. The diffusion coefficient increases with _____
a) increase in temperature and increase in activation energy
b) decrease in temperature and increase in activation energy
c) increase in temperature and decrease in activation energy
d) none of the above

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DUBAI CAMPUS
Second Semester 2004-05

Set A

ES UC242 — Structure & Properties of Materials — 09.03.05

Max Marks: 20x1=20 — Quiz- Regular — Time: 30 Min

Name: ID No.: Section:

SOLUTIONS

Q1. [c]
Q2. [a]
Q3. [c]
Q4. [b]
Q5. [b]
Q6. [c]
Q7. [b]
Q8. [c]
Q9. [a]
Q10. [b]
Q11. [a]
Q12. 98.7 at%
Q13. [c]
Q14. [a]
Q15. [c]
Q16. [d]
Q17. [a]
Q18. – 80 kg/m^4
Q19. [b]
Q20. [c]

BIRLA INSTITUTE OF TECHNOLOGYAND SCIENCE PILANI
DUBAI CAMPUS
Second Semester 2004-05

Set B

ES UC242 | Structure & Properties of Materials | 09.03.05
Max Marks: 20x1=20 | Quiz- Regular | Time: 30 Min

Name: ID No.: Section:

Q1. Copper and nickel is an example of _____
a) substitutional solid solution
b) interstitial solid solution
c) both substitutional and interstitial solid solution
d) none of these

Q2. The composition in atom percent of aluminum, for an alloy that consists of 97 wt% aluminum and 3 wt% copper is _____. (A_{Cu}=63.55 g/mol, A_{Al}=26.98 g/mol)

Q3. _____ is a special type of grain boundary across which there is specific mirror lattice symmetry
a) tilt boundary
b) twist boundary
c) twin boundary
d) none of these

Q4. The relative orientations of Burgers vector and dislocation line are perpendicular for _____
a) edge dislocation
b) screw dislocation
c) mixed dislocation
d) none of the above

Q5. The driving force for steady state diffusion is _____
a) diffusion flux
b) diffusion coefficient
c) concentration gradient
d) none of the above

Q6. Which of the following is true for interstitial diffusion? [ ]
a) In most metal alloys, interstitial diffusion occurs much more rapidly than diffusion by vacancy mod
b) In most metal alloys, interstitial atoms are smaller and thus are more mobile
c) In most metal alloys, there are more empty interstitial positions than vacancies
d) all of the above

Q14. If the cation-anion radius ratio is between 0.155 and 0.225, then the coordination number for cation is_____
a) 2
b) 3
c) 4
d) 6

Q15. Hydrocarbons has relatively low melting and boiling points as _____
a) weak hydrogen and van der Waals bonds bonds exist in each molecule, and weak hydrogen and van der Waals bonds exist between molecules
b) covalent bonds exists in each molecule, and weak hydrogen and van der Waals bonds exist between molecules
c) covalent bonds exists in each molecule, and covalent bonds exists between molecules
d) none of the above

Q16. Single chain bonds of backbone atoms of polymer chain molecules are _____
a) rotationally rigid
b) rigid in bending and twisting
c) capable of rotation and bending in three dimensions
d) none of these

Q17. Styrene – butadiene rubber (SBR) is a _____ from which automobile tyres are made.
a) alternating copolymer
b) random copolymer
c) block copolymer
c) none of these

Q18. For a stereoisomer where all the R groups are situated on the same side of the chain are known as _____ (R represents an atom or side group other than hydrogen, eg. Cl, CH_3)
a) atactic
b) syndiotactic
c) isotactic
d) none of these

Q19. Crystallization is easily accomplished for _____
a) linear polymers
b) branched polymers
c) cross linked polymers
d) network polymers

Q20. The burgers vector representation for the BCC crystal structure is _____
a) a/2 [0 1 1]
b) a/2 [1 1 1]
c) a/2 [1 0 1]
d) none of these