Module 2 – Microstructure

Sample Questions

1. Name any one strong bond and explain how it occurs. Is it a directional bond? Why or why not?
2. Name any one weak bond and explain how it occurs. Is it a directional bond? Why or why not?
3. Why are bonds classified as strong and weak?
4. The melting point depends on the strength of the bond. True or false? Explain.
5. Why is it that only some covalent bonds lead to chains or sheets?
6. Why is it that covalently bonded materials are generally weak though the covalent bond itself is strong?
7. What are two strong covalently bonded materials? What gives them the high strength?
8. Why are carbon nanotubes very strong while graphite is soft and weak?
9. Explain the metallic bond and how the type of bonding affects the thermal and electrical conductivity, malleability and ductility, and light reflecting ability of metals.
10. Van de Waals bond can be easily broken by heat. True or false. Why?
11. Why is the hydrogen bond stronger than other Van der Waals bonds?
12. Draw the Condon-Morse diagram for a strong bond and a weak bond. Mark and explain the differences.
13. Explain how the force-separation curve can be obtained from the energy-separation curve.
14. Explain using the Condon-Morse diagram why there is an elastic regime and inelastic regime in most materials.
15. Why is the Young's modulus or the modulus of elasticity the same in compression and tension?
16. What do the shape and the peak of the tension side of the force-separation curve indicate?
17. Can materials fail under compression alone? Why or why not?
18. Explain, with the help of the Condon-Morse diagram, why materials expand when heated. Does the type of bond affect this behaviour?
19. Why does the strength of the bond affect the thermal expansion coefficient?
20. The tensile strength of a material generally decreases as the temperature increases. Why?
21. How can solid structures be classified? Briefly explain each of the classes.
22. The crystalline structure of metals is such that it is closely packed and dense. Why?
23. Explain the three types of crystalline lattice arrangements common in metals.
24. Why do different lattice arrangements occur? Can the same metal have different lattice structures?
25. Under what conditions are ionic lattice structures stable?
26. Explain the microstructure of kaolinite. Is it expansive?
27. What are the roles of ionic and van der Waals bonds on the structure and behaviour of clays?
28. Give the different classes of clay. Why does expansion occur only in one of them?
29. Explain the stages of formation of a polycrystalline metal.
30. What are different types of defects that can occur in a crystalline material? Give examples of each of them.
31. What is the difference between interstitial and substitutional solid solutions?

32. Explain how point defects lead to strengthening in metal alloys.
33. Why are there limits for the composition of alloys?
34. What are the two types of line defects? Explain each of them.
35. How does an edge dislocation affect the stresses around it?
36. How does an edge dislocation move under shear stress?
37. What is a screw dislocation? How does it move under stress?
38. How does a grain boundary occur? Why is it called a surface defect?
39. Explain the difference between deformation of the lattice by twinning and by slipping.
40. What are two types of volume defects? Give examples for both.
41. Can a material occur both in crystalline and amorphous forms?
42. A melt when cooled can either become a crystalline or amorphous solid. What controls this? What is needed to ensure the formation of an amorphous structure?
43. Soda glass glass has a lower melting point than fused silica. Why?
44. How are metallic glasses made?
45. What are the merits of metallic glasses?
46. What are amorphous precipitates? Why do they have gelling?
47. Why is C-S-H called a gel?
48. How does the carbon bonding in polymer chains favour their rotation?
49. What leads to the entanglement of polymer chains and what are its effects?
50. Why is the crystallinity of a polymer solid affected by the entanglement of the chains?
51. Why is the viscosity of a polymer affected by the entanglement of the chains?
52. What are the different basic types of polymer structures? Give examples.
53. Why do linear polymers have a better possibility to have a crystalline structure?
54. Discuss the differences between thermoplast and thermoset polymers.
55. What are the mechanisms of atom movement that can lead to plastic deformations?
56. Metals having crystal structures with more slip planes will deform more easily under stress. Why?
57. Why is copper more malleable and ductile than zinc?
58. Why is dislocation movement not common in covalent and ionic solids?
59. Why are grain boundaries barriers to slip?
60. How do smaller grain sizes increase the yield strength of metals?
61. How is diffusion affected by temperature?
62. How is diffusion affected by point defects?
63. Diffusion at grain boundaries is higher than within the lattice. Why?
64. Interstitial diffusion requires less energy than vacancy diffusion. Why?
65. Write and explain Fick’s law of diffusion.
66. Explain what a phase is? How does a multi-phase material differ from a sold solution?
67. Why is concrete considered as a multi-phase material?
68. What is Gibb’s phase rule? Explain the different terms and changes using the phase diagram of ice.
69. Explain the phenomenon of dry ice using the phase diagram of CO_2.
70. Melting of an alloy does not occur at a fixed temperature. Explain using a binary phase diagram.

71. In the case of the Al_2O_3-Cr_2O_3 system (phase diagram given), find the liquid and solid compositions, and % liquid in the material for the overall compositions with (a) Cr_2O_3 = 30% at 2100 °C, and (b) Cr_2O_3 = 70% at 2200 °C.
72. In the case of the copper-nickel system (phase diagram given), find the liquid and solid compositions, and % liquid in the material for the overall compositions with (a) Ni = 50% at 1300 °C, and (b) Ni = 20% at 1200 °C.
73. In the case of the copper-nickel system (phase diagram given), explain how the microstructure forms for an alloy with 40% Ni.
74. In the case of the copper-silver system (phase diagram given), find the liquid and solid compositions, and % liquid in the material for the overall compositions with (a) Ag = 15% at 1000 °C, and (b) Ag = 90% at 800 °C.
75. In the case of the lead-tin system (phase diagram given), find the liquid and solid compositions, and % liquid in the material for the overall compositions with (a) Sn = 20% at 250 °C, and (b) Sn = 90% at 200 °C.
76. In the case of the copper-silver system (phase diagram given), find the compositions of the α and β phases, and % α phase in the material for the overall compositions with (a) Ag = 15% at 700 °C, (b) Ag = 90% at 500 °C, and (c) Ag = 50% at 600 °C.
77. In the case of the lead-tin system (phase diagram given), find the compositions of the α and β phases, and % α phase in the material for the overall compositions with (a) Sn = 20% at 150 °C, (b) Sn = 90% at 100 °C, and (c) Sn = 50% at 183 °C.
78. In the case of the copper-silver system (phase diagram given), describe how the microstructure forms, as the melt is cooled to room temperature, for the compositions of (a) Ag = 1%, (b) Ag = 7%, (c) Ag = 40%, (d) Ag = 71.9%, (e) Ag = 85%, (f) Ag = 95%, and (g) Ag = 99%.
79. The composition of the lamellar structure in a eutectic system changes as the temperature drops. Explain.
80. In the ternary diagram of CaO-Al_2O_3-SiO_2 (given), give the approximate compositions of (a) Anorthite, and (b) Gehlenite.
81. In the ternary diagram of Fe-Cr-Ni (given), give the approximate compositions of (a) 18-8 Stainless steel, and (b) σ.
82. Explain the process of sintering. How does it change the void structure and grain sizes?
83. What is diffusion bonding?