MARIA COLLEGE OF ENGINEERING AND TECHNOLOGY, MARTHANDAM

DEPARTMENT OF MECHANICAL ENGG. | ME 2253 - ENGINEERING MATERIALS AND METALLURGY
IIYEAR (4th SEMESTER)

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1. Define Solid solution.
   Two metals combined together to form a single structure

2. Name the two kinds of Solid Solutions
   Substitutional
   Interstitial

3. How the substitutional Solutions are formed.
   When the Solute atoms replace Solvent atoms

4. How the Interstitial Solutions are formed.
   When the Solute atoms are small enough to occupy the holes between the Solvent atoms

5. What are the factors governing Solid solubility?
   Crystal structure
   Relative atomic
   size Chemical
   affinity Valency

6. What is Phase diagram?
   The phase diagram indicates the temperature at which the solid alloy will start melting and finish melting.

7. What are the types of phase diagrams?
   Unary
   Binary
   Ternary

8. What are the Coordinates of phase diagram?
   Temperature and Time

9. What is Isomorphous Reactions?
   Two metals that is completely soluble in Liquid state and solid state.

10. Give some examples of Isomorphous alloy systems.
    Copper and
    nickel Gold
    and silver Iron
    and vanadium

11. What is Eutectic Reactions?

Two metals that are completely soluble in Liquid state and partly or insoluble in the solid state

12. Give the Reaction happening in Eutectic?

Liquid à Solid 1 + Solid 2

13. What is Peritectic Reactions?

Liquid + Solid 1 à Solid 2

14. What is Eutectoid Reactions?

This reaction is due to the transformation in solid state

15. Give the Reaction taking place in Eutectoid?

Solid 1 à Solid 2 + Solid 3

16. Write an example of the eutectoid reaction occurs in the Iron Carbon System

Austenite à Ferrite + Cementite

17. What is Peritectoid Reactions?

This reactions is due to the transformation of two Solids in to third solid state

18. Give the Reaction taking place in Peritectoid ?

Solid 1 + Solid 2 à Solid 3

19. Why Iron-Iron Carbide diagram is important/

It is the most important binary alloy system in engineering alloys because we get important alloys Cast Iron and steel.

20. What is the content of steel?

It contains 0.008% to 2.14 wt% C in Fe.

21. What is the content of Cast Iron?

It contains 2.14% to 6.7 wt% C in Fe.

22. What are the two-phase diagrams of Iron-carbon system?

Fe – Fe_3C

Fe - C

Here Fe – Fe_3C is the portion of Fe – C phase diagram.

23. What are the four solid phases in the iron- iron carbide diagram?
    1. d -Ferrite
    2. Austenite (g)
    3. Cementite
    4. a – Ferrite

24. What are the reactions taking place in the Iron-Carbide diagram?
    Peritectic
    Eutectic
    Eutectoid

25. What is the Peritectic reaction in Iron-Carbide diagram?

    d -Ferrite + Liquid à Austenite (g)

26. What is the Eutectic reaction in Iron-Carbide diagram?

    Liquid à Austenite (g) + Cementite

27. What is the name of this combination Austenite (g) + Cementite?
    Ledubrite

28. What is the Eutectoid reaction in Iron-Carbide diagram?

Austenite (g) à a – Ferrite + Cementite

29. What is the name of this combination a – Ferrite + Cementite?

Pearlite

30. What is Hypoeutectoid and Hypereutectoid steeel?

A composition Left to the Eutectoid Composition is Hypoeutectoid
A composition Right to the Eutectoid Composition is Hypereutectoid

31. Write the classification of steel ?

Low carbon
Medium carbon
High Carbon
Tool steel

31. How the steel classified?

According to the carbon content in Fe.

32. What are the types of Cast iron?

Gray
Nodular
White
Malleable

33. What is Heat treatment of metal?

Combination of heating, holding and cooling

34. Write some objectives of Heat treatment?

1. To Relieve internal stresses
2. To improve Machinability
3. To improve the properties

35.What are the types of heat Treatment?

Annealing
Normalising
Hardening
Tempering

36. What are the types of Annealing?

Full
Stress-relief
Recrystallization
Spheroidizing
Process

37. What is the process in Full Annealing?

Heating the steel 15^0 to 40^0 C above A_3 temperature
Now the steel is Austenized
Cooling very slowly in the furnance itself

38. What is the process in Stress relief annealing?

Heating the steel up to 600
degree C Now the steel is
Austenized
Cooling very slowly in the room temp in air

39. What is the process in Recrystallization or process annealing?

Heating the steel 600 to 650
degree C Now the steel is
Austenized
Cooling very slowly in the room temp in air

40. What is the Spheroidizing?

The cementite is hard to machine because of its needle like structure
So heated to about 700 degree C. Now the Cementite becomes globular structure
Called Spheroids which will be easy to machine.

41. What is Normalising?

Annealing Heat tretment process called normalizing.
Heating the steel 55^0 to 85^0 C above A3 temperature
Hold for 15 minutes. Now the steel is Austenized
Cool down in still air

42. What is the purpose of normalizing?

To refine the grain size
To produce more uniform and desirable size distribution.

43. what is the abbrevation of TTT-diagram?

Time,Temperature and Transformation of Austenite.

44.what are the other names of TTT diagram?

Isothermal Transformation(IT-diagram) curves and S-curve,C-curve due to their shapes

45. How to obtain IT – diagram?

Normally upon cooling austenite transforms to Pearlite(ferrite + cementite)

46.what are the co-ordinates of IT-diagram?

Amount of Austenite transformed in vertical axis(Y-axis)

Time(Logirathamic scale,so we can use for days,weeks,months) in X-axis

47. What are the products you came to know from IT-diagram?

AT 700 ^{0} C Coarse Pearlite
AT 600 ^{0} C upper Bainite (Sorbite)
AT 500 to 550 ^{0} C Fine Pearlite(Troosite)
AT 550 to 300 ^{0} C Lower Bainite (acicular troosite)

48. What is Hardness?

Resistance to plastic deformation

49. What is Hardening?

Hardening is process in which the metal is heated to the austenizing temp and suddenly cooled in cold water.

50. What is the reason for Hardening?

Martensite is formed from Austenite directly .This is a complex structure formed due to sudden cooling.

51. What is Tempering?

In Hardening the metal becomes too brittle and with lot of internal stresses which would affect the property of metal. To remove this and to get desired property we reheat the hardened metal.this process is called Tempering.

52. What is Martempering?

If we reheat the after Martensite formation

53. What is Austempering?

Transformation directly to Bainite formation

54. What are the three types of Tempering?

Low temperature
High temperature
Medium
Temperature

55. What are the types of hardening process?
Work
Hardening Age
Hardening Air
Hardening
Hardening by heating and quenching

56. What is Hardenability?
Penetration of Hardness in the metal

57. What is the test to find Hardenabilty?
Jominy Quench Test

58. What is case hardening?
The surface of the steel is more hard and wear resistant whereas the core remains soft and tough.
Example: in gears, ball bearings

59. What are the various types of case Hardening?
Carburizing, Cyaniding, Nitriding, Flame and Induction Hardening

60. What is alloy steel?
Steel in which other elements are added other than carbon.

61. What are the effects of alloying additions on steel?
To increase Strength, Hardness, Toughness, Properties

62.How stainless steel divided?
Martensitic, Ferritic, Austenitic63. What are the various types of Tool steels?
Plain carbon
Low alloy
High speed
High Chromium High Carbon steels

64. What is HSLA steels?
High Strength low alloy steels, which have, better mechanical properties.

65.What are Maraging steels?
Martensite aging. Steels with greater Tensile strength (ultra high strength steels)

66. How copper alloys classified?
Copper-Zinc
Copper-Tin

67.what are the types of bronze?
Phosphorous
Silicon
Beryillium
Manganese
Aluminium

68. What are the three main steps in precipitation Strengthening treatment?
Solution Treatment
Quenching
Aging

69. Define the term polymer.
Poly- many
Mer-single unit
Polymer – many units joined together

70. What are the naturally occurring polymers?
Wood,rubber,leather etc.

71.What are the synthetic polmers?
Nylon,Terlyene,Poly ethylene ….

72. What is polymerization?
Small molecules combine to form large molecule.

73. What are the types of polymerization?
1. Addition
2. Condensation

74. What is the difference between Addition and condensation polymerization?
Addition – no by product formed
Condensation –by product formed

75.How are polymers classified?
Thermoplasts, Thermosets

76. What is the difference between Thermoplasts and Thermosets?
Thermosets cannot be remoulded
Thermosets can be remoulded

77. Define ceramics?
Ceramics are compounds of metallic and non- metallic elements. Ex: stone,brick,clay,glass

78.What does new ceramic material include?
Oxcides,carbides ,borides and other similar compounds

79. Name two refractory materials.
Magnesia
Alumina

80. What is composite material?
Two or more materials with superior properties combined together to form new product.

81. Write an example for composite material?
Cement concrete, glass reinforced plastic polywood

82. What are the different types of composites?
Particle
reinforced Fibre
reinfoeced
Structural

83.What is matrix and reinforcement?
The Major element molten metal is matrix.The material which is added to improve the properties is reinforcement.

84. How the metals are classified?
Ferrous (Iron-based)
Non-Ferrous (non Iron-based)

85. What are the two types of Deformation in metals?
Plastic Deformation
Elastic Deformation

86. What is plastic deformation?

When a body is subjected to a force, it will tend to deform. When the deformation exceeds the elastic limit it will not regain to its original form

87. What is Elastic deformation?

When a body is subjected to a force, it will tend to deform. When the deformation with in the elastic limit it will regain to its original form

88. In what ways plastic deformation takes place?

Two methods
1.Slipping
2.Twinning

89.Define slipping.

It is defined as the shear transformation, which moves the atoms over a number of interatomic distances relative to their initial position.

90.Define Twinning.

It is the two plastic deformations which takes place along two planes due to set of forces acting on a given metal.

91.Define fracture.

Seperation of Solids in to two Parts.

92. What are the two components of the p[rocess of fracture?
Crack initiation
Crack propagation

93. What are the different types of fracture/
Brittle
Ductile
Fatigue
Creep

94. What is the use of izod test?
To determine the impact strength of the material

95.What is the yield strength?
The material yield with out a change in the load

96.What are the tests conducted in the material?
Impact test,hardness test,shear test,tensile test,fatigue test,creep test

97. What is fatigue fracture?
It is the fracture that occurs under repeatedly applied fatigue stresses

98. What is Brittle fracture?
It takes place with minimum of plastic deformation and very rapid crack propagation.

99. What is creep fracture?
It is the fracture that takes place due to excessive creeping of metals under steady loading and high temperature.

100. What is the need of mechanical test?
Inorder to determine which material is best by knowing the properties such as hardness,ductility,Strength.

1. Discuss the similarities and differences between substitutional and interstitial solid solutions.(Refer Page No:1.5 -1.8 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

2.Explain the following invariant reactions with reference to a phase diagram:
(a) Eutectic reaction, (b) Eutectoid reaction,
(c) Peritectic reaction, and (d) Peritectoid reaction.(Refer Page No 1.34-1.39 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

3.What are the micro-constituents of iron- carbon alloys? Explain the general characteristic of each. (Refer Page No 1.47-1.51 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

4. Draw iron- iron carbide equilibrium diagram and mark on it all salient temperatures and composition fields.(Refer Page No 1.52-1.56 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

5.Explain the primary crystallisation of eutectoid steels, hypoeutectoid steels, and hypereutectoid stells.(Refer Page No 1.57-1.62 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

6.Compare and contrast the process of full annealing, process annealing, stress relief annealing, recrystallisation annealing, and spheroidise annealing.(Refer Page No 2.4-2.11 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

7. (a) Describe the normalising process of heat treatment (Refer Page No 2.11-2.12 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

(b) Differentiate between normalising and full annealing(Refer Page No 2.12-2.13 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

8.Explain the process of martempering compare and contrast it with austempering process (Refer Page No 2.21- 2.25 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

9. (a)What do you understand by isothermal transformation?
(b) What are TTT diagrams?
(c) How a TTT diagram is drawn?
(d) Draw a neat sketch of the TTT diagram for a eutectoid steel and label the regions,.
Mark the different products formed on this diagram.(Refer Page No 2.27-2.33 in

V.Jayakumar) and Intro to physical metallurgy ,SYDNEY AVNER)

10.What is meant by carburising of steel? Briefly explain the various types of carburising(Refer Page No 2.50-2.56 in V.Jayakumar) and Intro to physical metallurgy ,SYDNEY AVNER)

11.(a)Give the classifications of steels.(Refer Page No 3.8 in V.Jayakumar)
(b) Describe the properties and typical applications of low medium, and high- carbon steels;(Refer Page No 3.3-3.11 in V.Jayakumar)
(c)What is an alloy steel? how are alloy steels classified? Explain them.(Refer Page No 3.13-3.15 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

12.(a)What are the main classifications of stainless steels?
(b) Discuss the different types of stainless steel, making reference to approximate compositions, structures, heat treatments.
(c)Give typical applications for each of the main catetgories of stainless steel.(Refer Page No 3.22-3.28 in V.Jayakumar and Intro to physical metallurgy ,SYDNEY AVNER)

13.(a)Explain the principle characteristics pf cast iron and explain the factors which affect the structrure of cast iron.(Refer Page No 3.37-3.40 in V.Jayakumar)
(b)Describe the structures of the main types of cast irons and account for their continued use as engineering materials.(Refer Page No 3.41-3.48 in V.Jayakumar)
c) Compare grey and malleable cast irons with respect to
(i) composition and heat treatment,(ii)microstructure, and
(iii) mechanical characteristics.(Refer Page No 3.48-3.51 in V.Jayakumar)
(d) Compare white and nodular cast irons with respect to
(i) composition and heat treatment,(ii) microstructure, and
(iii) mechanical characteristics.(Refer Page No 3.51-3.56 in V.Jayakumar)

14. Discuss the composition,Properties, and typical applications of any four copper alloys.(Refer Page No 3.59-3.69 in V.Jayakumar)

15.Explain the composition, properties, and typical applications of some aluminium alloys.(Refer Page No 3.68-3.70 in V.Jayakumar)

16.What do you understand by polymerisation? with th help of suitable examples, compare and condensation polymerisation.(Refer Page No 4.10-4.14 in V.Jayakumar/Engineering Materials by Kenneth G. Budinski/Sydney H Avener)

17.(a)Describe the difference between thermoplastics and thermosetting plastics.(Refer Page No 4.20-4.21 in V.Jayakumar/Engineering Materials by Kenneth G. Budinski/Sydney H Avener)
(b) Explain the difference between commodity plastics and engineering plastics.(Refer Page No 4.21-4.22 in V.Jayakumar/Engineering Materials by Kenneth G. Budinski/Sydney H Avener)

18.What are Ceramics? List and briefly explain five important properties of Ceramics that make them useful engineering materials.(Refer Page No 4.52-4.55 in V.Jayakumar/Engineering Materials by Kenneth G. Budinski/Sydney H Avener)

19.Discuss the properties and typical applications of the following engineering Ceramics:
(a)Alumina (b)SiC (c)silicon nitride (d)PSZ and (e)Sialons(Refer Page No 4.56-4.65 in V.Jayakumar/Engineering Materials by Kenneth G. Budinski/Sydney H Avener)

20(a).what is the Distintion between matrix and dispersed phases in a Composite material?(Refer Page No 4.66-4.68 in V.Jayakumar/Engineering Materials by Kenneth G. Budinski/Sydney H Avener)
(b)Contrast the mechanical characteristics of Matrix and dispersed phases for fibre-reinforced composites.(4.75 in V.Jayakumar/Sydney H Avener)

21.Explain the two modes of plastic deformation in metals with neat sketches.(Refer Page No 5.7-5.9 in V.Jayakumar/Sydney H Avener)
(a) Critically compare the deformation by slip and twinning (Refer Page No 5.16 in V.Jayakumar/Sydney H Avener)
(b) Derive an empression for critical resolved shear stress in material subjected to uni-axial tensile loading. Also distinguish between shear strees and critical resolved shear stress.(Refer Page No 5.12-5.14 in V.Jayakumar/Sydney H Avener)

22. What is brittle fracture? Explain the Griffith's theory on brittle fracture and deduce and expression for the critical stress required to propagate a crack simultaneously in a brittle material.(Refer Page No 5.17-5.20 in V.Jayakumar/Sydney H Avener)

23.What ia meant by ductile fracture?Explain the mechanism of it. (Refer Page No

5.21-5.23 in V.Jayakumar/Sydney H Avener)

24.(a)Explain the mechanism of fatigue fracture(Refer Page No5.25 in V.Jayakumar/Sydney H Avener) (b)Discuss any two mechanisms of creep fracture(Refer Page No5.27-5.31 in V.Jayakumar)
(c)How can you prevent: (i) fatigue fracture, and (ii)creep fracture.(Refer Page No
5.27-5.31)

25.(a) Describe a tensile test to determine various tensile properties.(ReferPage No5.33-5.38) (b) Explain the testing procedure of (i) a compression test, and (ii) a shear test.(Refer Page No
5.43 in V.Jayakumar/Sydney H Avener)