

國立成功大學

111學年度碩士班招生考試試題

編 號： 155

系 所： 生物醫學工程學系

科 目： 材料科學

日 期： 0219

節 次： 第 2 節

備 註： 可使用計算機

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

I. Multiple choice: (60 points, 1 point each)

1. Which of the following defect is linear defect? (A) Interstitial atoms (B) Dislocation (C) Stacking Fault (D) Grain boundary
2. For a long carbon-carbon chain, what's the most possible angle between each bond (degree)? (A) 180 (B) 120 (C) 109 (D) 90
3. Which one is NOT the polymorphic form of carbon? (A) Fullerenes (B) Diamond (C) Graphite (D) Perovskite
4. What's the coordination number for the atom in HCP? (A) 4 (B) 6 (C) 8 (D) 12
5. What's atomic packing factor for FCC? (A) 58% (B) 68% (C) 74% (D) 76%
6. What type of material has the lowest stiffness? (A) Polymers (B) Ceramics (C) Metals (D) Composites
7. What's type of bonding is not chemical bonding? (A) Metallic (B) Hydrogen (C) Ionic (D) Covalent
8. What's device in this figure (Fig 1)? (A) Tubing (B) Vascular graft (C) Draining tube (D) Artificial tendon
9. What's device in this figure (Fig 2)? (A) Heart valve (B) Vascular graft (C) Draining tube (D) Artificial tendon



Fig 1



Fig. 2



Fig3

10. What kind of diffusion in this figure (Fig 3) (A) Interdiffusion (B) Interstitial diffusion (C) self-diffusion (D) vacancy diffusion
11. Which imaging "procedure" is similar to "SEM" except the source of imaging? (A) Optical microscopy (B) X-ray (C) FTIR (D) TEM (E) AFM
12. In the following unit cell (Fig.4), which vector represents the [121] direction?

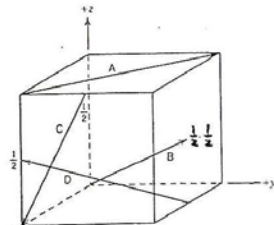


Fig.4

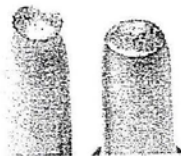


Fig.5

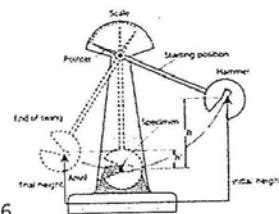


Fig.6

13. What kind of fracture in this picture? (Fig.5) (A) Brittle (B) Ductile (C) Shear (D) Compression
14. What kind of test in this figure? (Fig.6) (A) energy (B) Gravity (C) Impact (D) Hardness
15. Which factor will not affect the equilibrium number of vacancies N_v for a given material (A) total number of atomic sites (B) grain size (C) temperature (D) energy required to form a vacancy
16. The approximate distance between two adjacent atoms: (A) 0.1 nm (B) 0.3 nm (C) 1 nm (D) 3nm

17. Atoms of which of the following elements diffuse most rapidly in iron? (A) Mo (B) C (C) Cr (D) W
18. The arrangement information of crystal in a solid is usually elucidated from which instrument (A) Optical microscopy (B) X-ray (C) SEM (D) TEM (E) IR
19. The number of vacancies inside a metal is mostly depend on (A) crystal structure (B) atomic number (C) valence electron (D) temperature
20. What phase transformation of Shape memory occur at elevated temperature? (A) Martensite-to-pearlite transformation (B) Martensite-to-austenite transformation (C) Austenite -to-Pearlite transformation (D) Austenite-to-martensite transformation
21. Which structure formed at highest temperature? (A) Spheroidite (B) Coarse Peralite (C) Fine Pearlite (D) Bainite
22. Why grain boundary can hinder the motion of dislocation by adjacent grains? (A) Atomic order (B) Grain size different (C) Dislocation increase (D) Different crystallographic direction
23. What's the meaning of anelasticity (A) Reversible (B) Plastic (C) Temperature dependent (D) Loading rate dependent
24. What's moment of inertia (I) of rectangular shape materials (b: width, h: height) (A)bh (B)bh²/3 (C)bh³/12 (D)b²h²/8
25. The machine used to conduct testing for mechanical property of materials? (A) ASTM (B)MTS (C)X-ray (D) AFM
26. Which crystal system has the most slip system (A) BCC (B)BCT (C)FCC (D)HCP
27. Which of the following test is not "hardness test" method? (A) Vickers (B) Brinell (C) Charpy (D) Knoop
28. The fatigue test is usually presented in S/N curve, S and N stand for (A) cycle/force (B) stress/strain (C) stress/cycles (D) force/time
29. What mechanical property directly correlate to "Critical resolve shear stress? (A) Tensile strength (B) Young's modulus (C) ductility (D) Yielding strength
30. Which of the following factor is used to test material's facture toughness (A) Tensile strength (B) elongation (C) energy absorbed (D) Young's modulus
31. A binary composition-temperature phase diagram for an "isomorphous system" will be composed regions of the following phase (A) L, α and β (B) L, L+ α , α (C) L, L+ α , L+ β and β (D) L, L+ α , L+ β and β + α
32. Which of the following is the slip system for the face center cubic crystal structure? (A) {100} <110> (B) {110} <110> (C) {111} <110> (D) {110} <111> (E) {111} <100>
33. What test is used to test ceramic material's tensile strength (A) tensile test (B) torsion test (C) impact test (D) flexural test (E) fatigue test
34. Which of the following method is usual way to strengthen the metal (A) by grain size increase (B) solid solution (C) hot working (D) dislocation removal
35. What's the composition of cementite (A) Pure carbon (B) Fe₃C (C) 0.76 wt% C in Fe₃C (D) Fe₂O₃ (E) β iron
36. What's the crystal structure of martensite (A) FCC (B) BCC (C) BCT (D) HCP (E) SC
37. What's the structure with alternating layers of α -ferrite and Fe₃C (A) Austenite (B) Bainite (C) Cementite (D) Martensite (E) Pearlite
38. Which of the following is not the advantage of Mg degradable biomaterial? (A) biodegradation (B) anti-inflammatory (C) high strength (D) antibacterial
39. Which medical device is not suitable for degradable metal? (A) joint replacement (B) wound clip (C) Bone plate for fracture (D) coronary artery stent

40. What problem is most challenge as implant material for Mg and its alloy? (A) Stiffness (B) Corrosion resistance (C) Biocompatibility (D) osteogenic inductivity
41. What's the common upper limit of carbon content for low-carbon steel? (A) 0.1% (B) 0.25% (C) 0.6% (D) 1.4%
42. What is the main phase formed in cast iron different from steel? (A) Pearlite (B) Ferrite (C) Cementite (D) Graphite
43. What kind of cast iron in this Fig.7? (A) Gray (B) White (C) Malleable (D) Ductile
44. What kind of cast iron in this Fig.8? (A) Gray (B) White (C) Malleable (D) Ductile



Fig.7

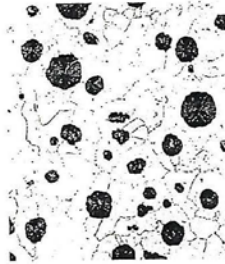


Fig.8

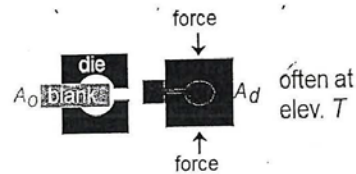


Fig.9

45. What method in this Fig.9? (A) Rolling (B) Die casting (C) Forging (D) Investment casting
46. Which of the following method is not "forming" operation? (A) Forging (B) Rolling (C) Extrusion (D) Welding
47. Which casting mold is the most expensive? (A) Lost form (B) Die (C) Sand (D) Investment
48. Hardenability: which phase is formed by its ability? (A) Austenite (B) Martensite (C) Cementite (D) Pearlite
49. Which ceramic fabrication is in this Fig.10? (A) Slip casting (B) Blowing (C) Tape casting (D) Pressing
50. Which SFF method shown in this Fig.11? (A) Selected laser sintering (B) Stereolithography (C) Fused deposition medolling (D) Wax printing



Fig.10 hollow component

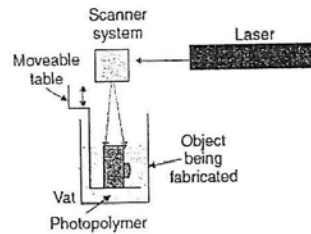


Fig.11

51. What's the symbol of "Conductivity"? (A) ϵ (B) ρ (C) σ (D) μ
52. Which property will change with geometry and size? (A) Resistance (B) Conductivity (C) Band gap (D) Resistivity
53. Which parameter does not involve in "Critical fiber length for effective stiffening & strengthening" (A) fiber diameter (B) modulus of elasticity of fiber (C) fiber ultimate tensile strength (D) shear strength of fiber-matrix interface
54. What is the main phase formed in cast iron different from steel? (A) Pearlite (B) Ferrite (C) Cementite (D) Graphite

55. What's strengthening mechanism is used for ultrahigh-strength stainless steel (17-7PH)? (A) Solid solution (B) Cold working (C) Precipitation hardening (D) Grain Size reduction
56. What material has the highest superconducting temperature (A) Tungsten (B) Nb-Ti alloy (C) $\text{YBa}_2\text{Cu}_3\text{O}_7$ (D) $\text{HgBa}_2\text{Ca}_2\text{Cu}_2\text{O}_8$
57. Which of the follow steel has the highest ductility (A) 1010 (B) 1020 (C) 1040 (D) 1085
58. Which of the following iron was treated by the fastest cooling rate (A) ferritic gray cast iron (B) Pearlitic gray cast iron (C) White cast iron (D) Pearlitic ductile cast iron
59. The steel used for tool and die (A) low-carbon (B) medium-carbon (C) high-carbon (D) white iron (E) Malleable iron
60. Generically, cast irons are a class of ferrous alloys with carbon contents (A) below 1.4 wt% (B) below 2.14 wt% (C) above 2.14 wt%; (D) above 4.5 wt% (E) above 6.7 wt%

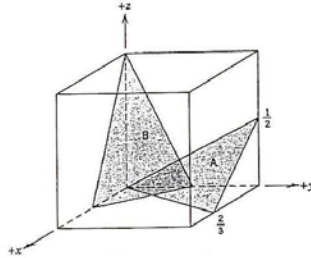
II. Define the following terms: (1.5 pts each, 18 points total)

1. Bragg's law
2. Burgers vector
3. Non-stoichiometry
4. Frenkel and Schottky defects
5. FCC vs BCC for structure of material
6. Viscoelasticity:
7. Tempered martensite:
8. Hypereutectoid alloy:
9. Ductile-to-brittle transition
10. Sacrificial anode
11. Pultrusion
12. Hardenability

III. Essay and calculation (22 points total)

1. Calculate the radius of a vanadium atom, given that V has a BCC crystal structure, a density of 5.96 g/cm^3 , and an atomic weight of 50.9 g/mol . (4 point)
2. A three-point transverse bending test is conducted on a cylindrical specimen of aluminum oxide having a reported flexural strength of 400 MPa. If the specimen radius is 2.4 mm and the support point separation distance is 30 mm, would you expect the specimen to fracture when a load of 600 N is applied? (4%) where $\sigma = My/I$; $M = FL/4$; $I = \pi R^4/4$
3. (a) A single crystal of a metal that has the BCC crystal structure is oriented such that a tensile stress is applied in the [010] direction. If the magnitude of this stress is 2.75 MPa, compute the resolved shear stress in the direction on each of the (110) and (101) planes.
(b) On the basis of these resolved shear stress values, which slip system(s) is (are) most favorably oriented? (6%)

4. Determine the Miller indices for the planes shown in the following unit cell: **show step by step procedure (4 points)**



5. A piece of corroded steel plate was found in a submerged ocean vessel. It was estimated that the original area of the plate was 100 cm^2 and that approximately 2.4 kg had corroded away during the submersion. Assuming a corrosion penetration rate of 12 mm/yr for this alloy in seawater, estimate the time of submersion in years. The density of steel is 7.9 g/cm^3 . Use: $\text{CPR} = KW/\rho At$, where adjust constant uses 87.6 (4 pts)