

國立成功大學
110學年度碩士班招生考試試題

編 號：154

系 所：生物醫學工程學系

科 目：材料科學

日 期：0202

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。

Multiple choice: (50 points, 1 point each)

- Which of the following defect type is not likely happen in ceramic (A) anion interstitial (B) anion vacancy (C) cation interstitial (D) cation vacancy
- Which of the following property usually will NOT increase with bonding energy of (A) melting point (B) conductivity (C) boiling point (D) tensile strength
- Which of the following are the most common coordination numbers for ceramic materials? (A) 2 and 3 (B) 6 and 12 (C) 6, 8, and 12 (D) 4, 6, and 8
- What is the atomic packing factor for HCP structure (A) 0.50 (B) 0.63 (C) 0.68 (D) 0.74
- Which of the following bonding is directional? (A) ionic (B) metallic (C) covalent (D) geometric
- 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
- What's the resolution of regular optical microscopy (A) 0.2 nm (B) 2 nm (C) 0.2 μm (D) 2 μm (E) 0.2 mm
- Atoms of which of the following elements diffuse most rapidly in iron? (A) Mo (B) C (C) Cr (D) W
- What property is strongly influenced by the vibration of atoms (A) melting point (B) conductivity (C) reflective index (D) friction coefficient
- What kind of instrument is used to get the image of this bug (Fig.1) (A) Optical microscopy (B) X-ray (C)

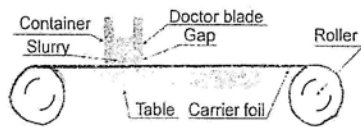


SEM (D) TEM (E) AFM (Fig.1) (Fig.2)

- In Fig.2, the darker color on the surface of gear is processed by (A) forged (B) case hardened (C) extrusion (D) injection molding
- 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
- Which of the following tests is not "hardness test" method? (A) Vickers (B) Brinell (C) Charpy (D) Knoop
- 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
- A steel rod is pulled in tension with a stress that is less than the yield strength. The modulus of elasticity may be calculated as: (A) Axial stress divided by axial strain (B) Axial stress divided by change in length (C) Axial stress times axial strain (D) Axial load divided by change in length
- What mechanical property directly correlate to "Critical resolve shear stress? (A) Tensile strength (B) Young's modulus (C) ductility (D) Yielding strength
- 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
- The atoms surrounding a screw dislocation experience which kind of strains (A) Tensile (B) shear (C) compressive (D) bending strains

19. For Nitinol shape-memory alloy, it involves which transformation (A) martensite-to-perlite (B) austenite-to-perlite (C) austenite-to-bainite (D) martensite-to-austenite transformation
20. Which of the following is the slip system for the face center cubic crystal structure? (A) $\{100\} \langle 110 \rangle$ (B) $\{110\} \langle 110 \rangle$ (C) $\{111\} \langle 110 \rangle$ (D) $\{110\} \langle 111 \rangle$ (E) $\{111\} \langle 100 \rangle$
21. Why some metals (e.g., lead and tin) do not strain harden when deformed at room temperature. (A) their recrystallization temperatures lie below room temperature (B) their glass transformation temperatures lie above room temperature (C) number of slip system is small (D) melting temperature is high (E) density of dislocation is low
22. Which of the following parameters is usually NOT involved in the study of "fracture mechanism" (A) materials properties (B) dislocation density (C) initiation of crack (D) propagation of crack (E) stress level
23. Hardness test is usually directly correlated to what property of some metals (steel, copper) (A) Young's modulus (B) yield strength (C) tensile strength (D) fatigue strength (E) fracture toughness
24. 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
25. 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
26. What's the composition of cementite (A) Pure carbon (B) Fe_3C (C) 0.76 wt% C in Fe_3C (D) Fe_2O_3 (E) β iron
27. Which property can increase with increasing tempering temperature (A) reduction in area (B) tensile strength (C) yielding strength (D) hardness (E) Young's modulus
28. Which crystal system has the most slip system (A) SC (B) BCC (C) FCC (D) HCP
29. Amorphous thermoplastics are formed above their (A) glass transition temperatures (B) softening points (C) melting temperatures (D) none of the above
30. What is the reason caused the concentration gradient in new phase formation? (A) high heating rate (B) high strain rate (C) high cooling rate (D) high flow rate
31. Which of the following may occur during an annealing heat treatment? (A) Yielding stress may increase (B) Ductility may decrease. (C) Toughness may increase. (D) Fatigue strength may increase.
32. What's the crystal structure of martensite (A) FCC (B) BCC (C) BCT (D) HCP (E) SC
33. What's the structure with alternating layers of α -ferrite and Fe_3C (A) Austenite (B) Bainite (C) Cementite (D) Martensite (E) Pearlite
34. In most case, the plastic deformation often involves (A) the existence (B) the growth (C) the motion (D) the disappearance (E) the length of dislocation
35. Which type of materials usually has the largest variation in strength based on their nature property (A) Metals (B) Ceramics (C) Polymers (D) Composites
36. The approximate distance between two adjacent atoms: (A) 0.1 nm (B) 0.3 nm (C) 1 nm (D) 3nm
37. Which property increase with increasing temperature (A) electrical conductivity of metal (B) electron concentration of semiconductor (C) saturation magnetization (D) thermal conductivity

38. The appearance of corrosion is in small holes (A) stress (B) selective leaching (C) Galvanic (D) pitting corrosion
39. What is the symbol used in electrical property for "Permittivity" (A) D (B) ϵ (C) σ (D) μ
40. Forming operations are those in which the shape of a metal piece is changed by (A) elastic deformation (B) plastic deformation (C) Heat treatment (D) Cold treatment
41. Low carbon steel: These generally contain less than about (A) 0.1 wt% (B) 0.25 wt% (C) 0.6 wt% (D) 1.4 wt% (E) 2.14wt% of C
42. 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%
43. What is the casting method in the Fig.3 (A) slip (B) tape (C) sand (D) investment casting



(Fig. 3)



(Fig.4)

44. What kind of corrosion cause this Fig.4 (A) crevice (B) pitting (C) selective leaching (D) stress corrosion (E) erosion corrosion
45. The pure titanium metal has a relatively low density (4.5 g/cm³), and an elastic modulus of (A) 45 (B) 69 (C) 107 (D) 207 (E) 320 GPa.
46. For reinforcement efficiency, when fiber randomly and uniformly distributed within a specific plane and stress direction in the plane of the fiber (A) 1/5 (B) 1/3 (C) 3/8 (D) 1/2 (E) 1
47. 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
48. Which of the following heat treatment is treated at the highest temperature (A) Stress relief (B) Spheroidize (C) Full annealing (D) Normalize
49. What phase(s) is the composition of Ti-6Al-4V alloy (A) α (B) near α (C) β (D) $\alpha+\beta$
50. The mechanical properties of steel are sensitive to the content of (A) Oxygen (B) Carbon, (C) Nitrogen (D) Hydrogen (E) Zinc which is normally less than 1.0 wt%.

II. Define the following terms: (1.5 pts each)

1. Amorphous
2. Anisotropic
3. Non-stoichiometry
4. Mixed dislocation
5. Crystal vs glass

6. Frenkel and Schottky defects
7. Interdiffusion vs. Interstitial diffusion
8. Ductile-to-brittle transition
9. Fatigue strength and fatigue limit:
10. Plane strain fracture toughness (K_{Ic})
11. Poisson's ratio
12. Strain hardening
13. Stress raiser
14. Viscoelasticity
15. Hardenability
16. Investment Casting
17. Specific modulus (specific stiffness)
18. Pultrusion
19. Sacrificial anode
20. Critical fiber length

III. Calculation and essay questions:

1. Make a schematic plot showing the **simulated tensile engineering stress-strain behavior** for a typical ductile metal alloy of copper with dimension 100mm in length and 40mm² in cross sectional area to the point of fracture. Please **define** and **point out** the following terms with **unit** in the **figure**: (a) stress (b) strain (c) yielding strength (d) ultimate tensile strength (e) Young's modulus (f) percentage of elongation (10%)
2. (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 30 MPa, compute the resolved shear stress in the $[\bar{1}11]$ 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?

$$(6\%) \quad \lambda = \cos^{-1} \left[\frac{u_1 v_2 + v_1 v_2 + w_1 w_2}{\sqrt{(u_1^2 + v_1^2 + w_1^2)(u_2^2 + v_2^2 + w_2^2)}} \right]$$

3. Sketch within a cubic unit cell the following planes: (4%)

(a) $(0\bar{1}\bar{1})$, (b) $(1\bar{2}\bar{2})$,