國立成功大學

113學年度碩士班招生考試試題

編　號：149

系　所：生物醫學工程學系

科　目：材料科學

日　期：0201

節　次：第 2 節

備　註：可使用計算機

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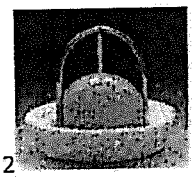
※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

I. Multiple choice: (45 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. What phenomenon is properties of materials varying with crystallographic orientation? (A)Anisotropic (B)Polymorphism (C) Crystallinity (D)Amorphous
3. What's medical device in this figure (Fig 1)? (A) Tubing (B) Vascular graft (C)　Draining tube　(D) Artificial tendon
4. What's medical device in this figure (Fig 2)? (A) Heart valve (B) Vascular graft (C)　Draining tube　(D) Artificial tendon

Fig 1 

Fig. 2 

5. Which instrument requires high vacuum? (A) Optical microscopy (B) X-ray (C) FTIR (D) TEM (E) AFM
6. Which imaging "procedure" is similar to "SEM" except the source of imaging? (A) Optical microscopy (B) X-ray (C) FTIR (D) TEM (E) AFM
7. In the following unit cell, which vector represents the [121] direction (Fig.3)?

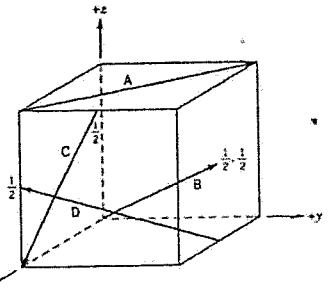


Fig.3

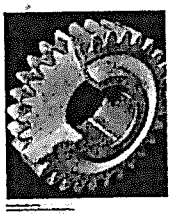
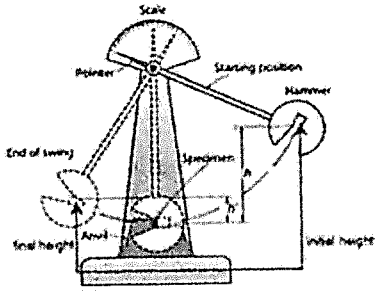
Fig.4 

Fig.5 

8. The darker color (Fig.4) on the surface of gear is processed by (A) forged (B) case hardened (C) extrusion (D) injection molding
9. What kind of test in this figure? (Fig.5) (A) energy (B) Gravity(C) Impact (D) Hardness
10. The number of vacancies inside a metal is mostly depend on (A) crystal structure (B) atomic number (C) valence electron (D) temperature
11. Which of the following property usually will NOT increase with bonding energy of (A) melting point (B) conductivity (C) boiling point (D) tensile strength
12. Atoms of which of the following elements diffuse most rapidly in iron? (A) Mo (B) C (C) Cr (D) W
13. Secondary bonding forces arise from atomic or molecular (A) spin (B) rotation (C) displacements (D) dipoles
14. Which material has the **lowest stiffness**?　(A)Metals (B)Ceramics (C)Polymers (D)Composites
15. Which one is NOT the polymorphic form of carbon? (A)Fullerenes (B)Diamond (C) Graphite (D)Perovskite
16. 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

17. What' s the driving force for phase transformation in eutectoid transformation? (A)Diffusion (B) Supercooling (C) Superheating (D)Dislocation motion
18. Which structure formed at highest temperature? (A) Spheroidite (B) Coarse Peralite (C) Fine Pearlite (D) Bainite
19. Which structure is strongest? (A)Temper Martensite (B)Bainite (C) Course pearlite (D)Sphoridite
20. In this Cu-Ag phase diagram (Fig.6), how many components and phases respectively? (A) 2 comp, 1 phase (B) 2 comp, 2 phase (C) 2 comp, 3phase (D) 1 comp, 2 phase
21. Name of this structure (Fig.7) (A)Ferrite (B) Peralite (C) Cementite (D) Bainite
22. In this phase diagram (Fig.8), which point represent "peritectic" reaction? (A)A (B) C (C) D (D) E

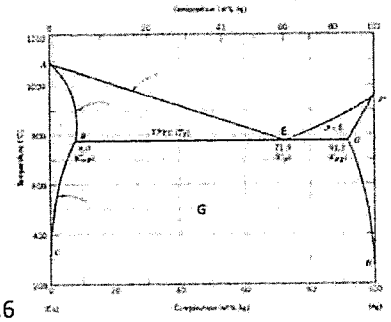


Fig.6

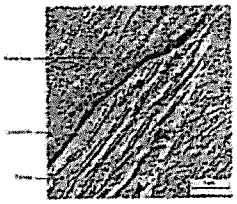


Fig.7

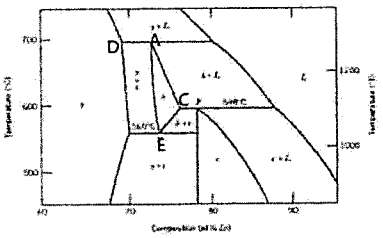


Fig.8

23. Which method can increase fatigue life? (A)Applied tension on material (B) Surface roughness (C) Shot peening (D) Increase mean stress
24. What's unit of density of dislocation? (A) mm (B)unitless (C)mm^{-1} (D)mm^{-2}
25. What's the unit of modulus of elasticity? (A)N (B) Pa (C) N/m (D) N-s/M^2
26. The instrument used to conduct testing for mechanical property of materials? (A) ASTM (B)MTS (C)X-ray (D) AFM
27. Which crystal system has the most slip system (A) BCC (B)BCT (C)FCC (D)HCP
28. Which of the following method can NOT increase strength of materials? (A) Quench (B) Grain size increase (C) Plastic deformation (D) Solid solution
29. Which of the following test is not "hardness test" method? (A) Vickers (B) Brinell (C) Charpy (D) Knoop
30. What mechanical property directly correlate to "Critical resolve shear stress? (A) Tensile strength (B) Young's modulus (C) Ductility (D) Yielding strength
31. What's behavior causing the elasticity of metal? (A) Bond stretch (B) Dislocation movement (C) Slip (D)Solid solution?
32. 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
33. What's the crystal structure of martensite iron (A) FCC (B) BCC (C) BCT (D) HCP (E) SC
34. What's the structure with alternating layers of α-ferrite and Fe_3C (A) Austenite (B) Bainite (C) Cementite (D) Martensite (E) Pearlite
35. Which property can <u>increase</u> with <u>increasing tempering temperature</u> (A) reduction in area (B) tensile strength (C) yielding strength (D) hardiness (E) Young's modulus
36. Which property increase with annealing? (A)Ductility (B) Strength (C) Modulus of elasticity (D) Grain size

37. Bone plate, the max receiving stress is 100 MPa, the yielding strength of material is 200 MPa, what is the safety factor? (A) 0.5 (B) 1 (C) 2 (D) 4
38. For metal, why the "fracture stress" is usually lower than "tensile strength"? (A) Necking (B)Crack (C)Dislocation ((D) Loading rate
39. What character is used to describe the "ductility" of materials at fracture? (A)% elongation (B) % of energy absorption (C) Stress to cause failure (D)Force to cause failure
40. 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
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.9? (A)Gray (B) White (C)Malleable (D)Ductile

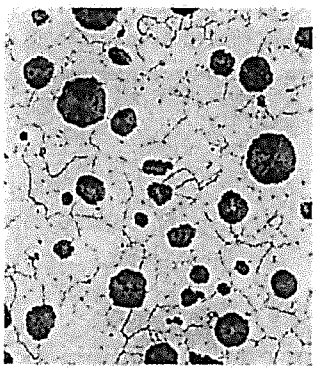


Fig. 9

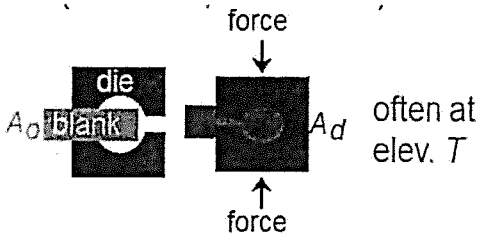


Fig.10

44. What method in this Fig. 10? (A)Rolling (B)Die casting (C)Forging (D)Investment casting
45. Which property will change with geometry and size? (A) Resistance (B) Conductivity (C) Band gap (D) Resistivity

II. Define the following terms: (1.5 pts each, 24 points total)

1. Burgers vector
2. Crevice corrosion
3. Crystal system
4. Electronegativity
5. Frenkel and Schottky defects
6. FCC vs BCC for structure of material
7. Hardenability
8. Investment Casting
9. Hypereutectoid alloy
10. LED Light-emitting diode (LED)
11. Mixed dislocation
12. Poisson's ratio

13. Pultrusion
14. Stain hardening
15. Tempered martensite
16. Viscoelasticity

III. Essay and calculation (31 points)

1. **Make a schematic plot (畫出應力應變曲線)** showing the tensile engineering stress–strain behavior for a typical metal alloy to the point of fracture. Please define (with unit) and point in the figure (a) stress (b) stain (c) yielding strength (d) ultimate tensile strength (e) Young's modulus; now superimpose on this plot a schematic compressive engineering stress-strain curve for the same alloy. Explain any differences between the two curves. (10 Points)
2. Determine the **Miller indices** for the planes shown in the following unit cell (Fig.10): **show step by step procedure (6 points)**

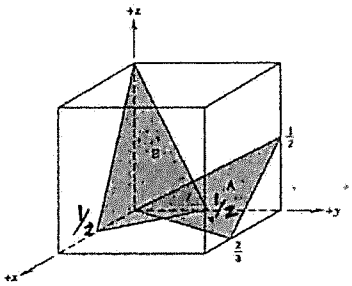


Fig.10

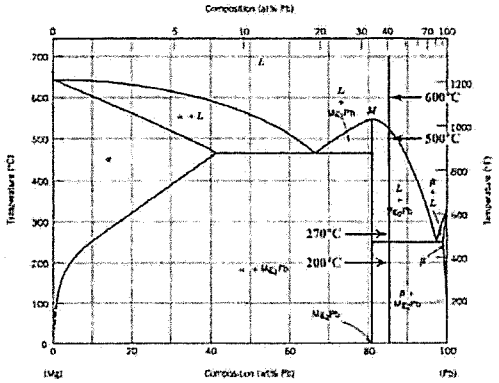


Fig.11

3. For an 85 wt% Pb-15 wt% Mg alloy (Fig.11), **make schematic sketches of the microstructure (畫出微結構)** that would be observed for conditions of very slow cooling at the following temperatures: 600°C, 500°C, 270°C, and 200°C. Label all phases and indicate their approximate compositions and their ratio. (5 %)
4. (a) If a rod of 1025 steel 1.0 m long is heated from 20°C to 100°C while its ends are maintained rigid, **determine the type and magnitude of stress that develops.** Assume that at 20°C the rod is stress free. (b) What will be the stress magnitude if a rod 2 m long is used? (c) If the rod in part (a) is cooled from 20°C to -20°C, what type and magnitude of stress will result? using a value of 200 GPa for the modulus of elasticity of steel, and a value of 12.0×10^{-6} $(^{0}C)^{-1}$ for α_l *(thermal expansion coefficient) (5 points)*
5. A single crystal of a metal that has the FCC crystal structure is oriented such that a tensile stress is applied parallel to the [110] direction. If the critical resolved shear stress for this material is 1.75 MPa, **calculate the magnitude(s) of applied stress(es)** necessary to cause slip to occur on the (111) plane in each of the $[1\bar{1}0]$, $[10\bar{1}]$, and $[01\bar{1}]$ directions. Use

$$\phi = \cos^{-1}\left[\frac{u_1u_2 + v_1v_2 + w_1w_2}{\sqrt{\left(u_1^2 + v_1^2 + w_1^2\right)\left(u_2^2 + v_2^2 + w_2^2\right)}}\right]$$ (5 points)