編號： 155

國立成功大學 108 學年度碩士班招生考試試題

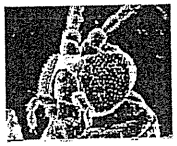
系　　所：生物醫學工程學系

考試科目：材料科學

考試日期：0224，節次：2

※ 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: (19 points, 1 point each)

1. Which of the following defect type is not likely happen in ceramic (A) anion interstitial (B) anion vacancy (C) cation interstitial (D) anion vacancy
2. What is the atomic packing factor for HCP structure (A) 0.50 (B) 0.63 (C) 0.68 (D) 0.74
3. The approximate distance between two adjacent atoms: (A) 0.1 nm (B) 0.3 nm (C) 1 nm (D) 3nm
4. What kind of instrument is used to get the image of this bug (A) Optical microscopy (B) X-ray (C) SEM (D) TEM (E) AFM 
5.  The darker color on the surface of gear is processed by (A) forged (B) case hardened (C) extrusion (D) injection molding
6. Atoms of which of the following elements diffuse most rapidly in iron? (A) Mo (B) C (C) Cr (D) W
7. What mechanical property directly correlate to "Critical resolve shear stress? (A) Tensile strength (B) Young's modulus (C) ductility (D) Yielding strength
8. 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
9. 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
10. 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
11. What's the structure with alternating layers of α-ferrite and Fe_3C (A) Austenite (B) Bainite (C) Cementite (D) Martensite (E) Pearlite
12. 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>
13. Creep is one way to characterize material's property. Usually, the creep test is materials under a step load then describe its time dependent mechanical behavior. When material is under step loading, which kind of curve is used to describe its "creep' behavior (A) force vs time (B) stress vs strain (C) stress vs time (D) strain vs time
14. Which property can increase with increasing Carbon composition in Iron (A) reduction in area (B) tensile strength (C) ductility (D) elongation (E) fracture toughness
15. Which of the following wavelength is in visible range (A) $5X10^{-10}$ (B) $5X10^{-7}$ (C) $5X10^{-4}$ (D) $5X10^{-1}$ (E) $5X10^{2}$ m
16. 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.

17. 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%
18. For reinforcement efficiency, when fiber randomlay 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
19. 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

II. Definition of the following term (29 Points): (1-10: 1.5 points; 11-17: 2 points)

1. Non-stoichiometry
2. Ansiotropic
3. Burgers vector
4. Critical fiber length:
5. Steady-state diffusion
6. Specific modulus (specific stiffness).
7. Ductile-to-brittle transition
8. Plane strain fracture toughness
9. Supercooling
10. Poisson's ratio

11. Interstitial diffusion vs. interdiffusion
12. Frenkel and Schottky defects
13. Investment Casting vs tape casting
14. Fatigue life vs fatigue strength
15. Crevice corrosion vs pitting corrosion
16. Eutectic reaction vs eutectoid reaction
17. Define "engineering stress" vs "true stress"

III. Calculation (52 points)

1. Calculate the density of an element aluminum metal, given that Al has an **FCC crystal** structure, **a radius of 0.1431 nm**, and an atomic weight of **27 g/mol.** (5 Points)

2. (a) Suppose that Li_2O is added as an impurity to CaO. If the Li^+ substitutes for Ca^{2+}, what kind of vacancies would you expect to form? How many of these vacancies are created for every Li^+ added?
   (b) Suppose that $CaCl_2$ is added as an impurity to CaO. If the Cl^- substitutes for O^{2-}, what kind of vacancies would you expect to form? How many of the vacancies are created for every Cl^- added? (6 Points)

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3. A structural member 150 mm long must be able to support a load of 60,000 N without **experiencing any plastic deformation.** Given the following data for brass, steel, aluminum, and titanium, (A) calculate the required weight and (B) rank them from least to greatest **weight** in accordance with these criteria. (use the relationship between force, stress, area, volume, area and density) (10 points)

Alloy	Yield Strength (MPa)	Tensile Strength (MPa)	Density (g/cm^3)
Brass	415	520	8.5
Ductile Iron	276	310	7.1
Aluminum	310	389	2.7
Titanium	550	689	4.5

4. It is desired to produce a continuous and oriented carbon fiber-reinforced epoxy having a modulus of elasticity of at least 83 GPa (12×10^6 psi) in the direction of fiber alignment. The maximum permissible specific gravity is 1.40. Given the following data, is such a composite possible? Why or why not? Assume that composite specific gravity may be determined using a relationship similar to $\rho_c = \rho_m(1 - V_f) + \rho_f V_f$. (6 points) $E_{cl} = E_m(1 - V_f) + E_f V_f$

	SpecificGravity	Modulus of Elasticity [GPa (psi)]
Carbon fiber	1.80	260 (37×10^6)
Epoxy	1.25	2.4 (3.5×10^5)

5. (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 $[\bar{1}11]$ 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?

Use $\lambda = \cos^{-1}\left[\dfrac{u_1u_2 + v_1v_2 + w_1w_2}{\sqrt{\left(u_1^2 + v_1^2 + w_1^2\right)\left(u_2^2 + v_2^2 + w_2^2\right)}}\right]$ (8 points)

6. Make a schematic plot showing the tensile engineering stress–strain behavior for a typical metal alloy to the point of fracture. Please **define 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)

7. A three-point transverse bending test is conducted on a cylindrical specimen of aluminum oxide having a reported flexural strength of 400 MPa. (a) If the specimen radius is 2.5 mm and the support point separation distance is 25 mm, would you expect the specimen to fracture when a load of 625 N is applied? Justify your answer.

(b) Would you be 100% certain of the answer in part (a)? Why or why not? $\sigma = \dfrac{My}{I}$ (7 points)