國立成功大學 109 學年度碩士班招生考試試題

系　　所：生物醫學工程學系

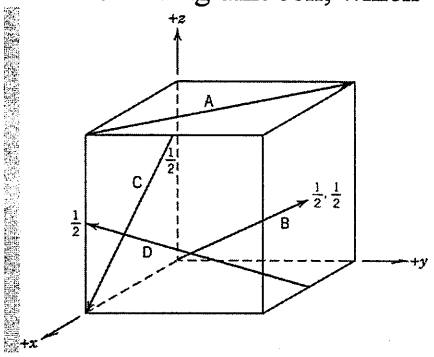
考試科目：材料科學

考試日期：0210，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。

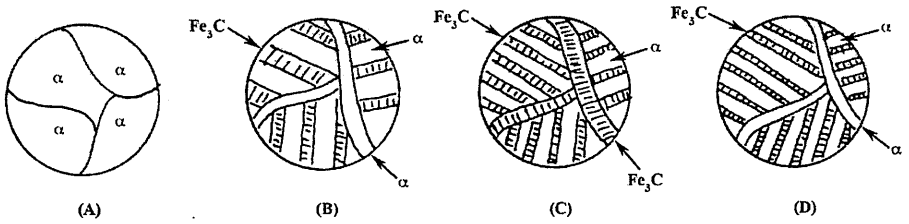
I. Multiple choice: (40 points, 1 point each)

1. In the following unit cell, which vector represents the [121] direction?



2. Which of the following property usually will NOT increase with bonding energy of (A) melting point (B) conductivity (C) boiling point (D) tensile strength
3. Do noncrystalline materials have grain boundaries? Do noncrystalline materials display the phenomenon of allotropy (or polymorphism)? (A) Yes; Yes (B) Yes; No (C) No; Yes (D) No; No
4. 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
5. Which dislocation is perpendicular to Burgers vector (A) round (B) screw (C) edge (D) mixed dislocation.
6. 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
7. What's the resolution of regular optical microscopy (A) 0.2 nm (B) 2 nm (C) 0.2 um (D) 2 um (E) 0.2 mm
8. Which of the following bonding is the primary bonding (A) van der Waals (B) Internal (C) Ionic (D) Hydrogen bonding
9. 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
10. What property is strongly influenced by the vibration of atoms (A) melting point (B) conductivity (C) reflective index (D) friction coefficient
11. The number of vacancies inside a metal is mostly depend on (A) crystal structure (B) atomic number (C) valence electron (D) temperature
12. Which of the following test is not "hardness test" method? (A) Vickers (B) Brinell (C) Charpy (D) Knoop
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 is 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. 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
15. 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
16. The atoms surrounding a screw dislocation experience which kind of strains (A) Tensile (B) shear (C) compressive (D) bending strains
17. 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 $\beta+\alpha$
18. Which of the following parameter 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
19. 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
20. 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
21. Schematic room-temperature microstructures for four iron-carbon alloys are as follows. Rank these microstructures (by letter) from the hardest to the softest.



(A) $A > B > C > D$ (B) $C>B>D>A$ (C) $A > B > D > C$ (D) $D>C>B>A$ (E) $C > D > B > A$

22. Which property can increase with increasing tempering temperature (A) reduction in area (B) tensile strength (C) yielding strength (D) hardiness (E) Young's modulus
23. K_c in fracture mechanics represent (A) stress intensity factor (B) Yielding strength (C) facture toughness (D) plain strain facture toughness
24. What's the crystal structure of austenite (A) FCC (B) BCC (C) BCT (D) HCP (E) SC
25. Which metal is the most inert in corrosion (A) 316 stainless steel (passive) (B) Titanium (C) Silver (D) Copper
26. What is the typical electrical conductivity value/range for semiconducting materials? (A)10^7 $(\Omega\text{-m})^{-1}$ (B) 10^{-20} to 10^{-7} $(\Omega\text{-m})^{-1}$ (C) 10^{-6} to 10^4 $(\Omega\text{-m})^{-1}$ (D) 10^{-20} to 10^{-10} $(\Omega\text{-m})^{-1}$
27. 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

28. Which of the following heat treatment is treated at the highest temperature (A) Stress relief (B) Spheroidize (C) Full annealing (D) Normalize
29. Which corrosion cause by dissimilar metal (EMF value) (A)Pitting (B) Crevice (C) Galvanic (D)Selective leaching
30. What phase(s) is the composition of Ti-6Al-4V alloy (A) α(B) near α(C) β (D)α+β
31. 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%.
32. 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
33. Which steel is relatively soft and weak but have outstanding ductility and toughness; in addition, they are machinable, weldable, (A) low-carbon (B) medium-carbon (C) high-carbon (D) white iron (E) Malleable iron
34. The steel used for tool and die (A) low-carbon (B) medium-carbon (C) high-carbon (D) white iron (E) Malleable iron
35. What kind of cast iron metallurgical image in this figure (1) (A) gray, (B) nodular, (C) white, (D) malleable (E) compacted graphite.
36. What kind of cast iron metallurgical image in this figure (2) (A) gray, (B) nodular, (C) white, (C) malleable (E) compacted graphite.

figure (1)

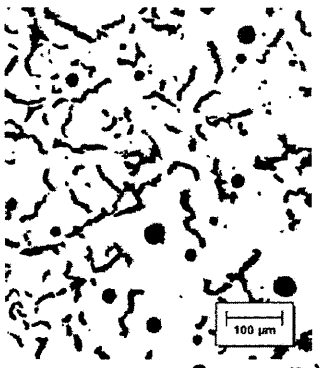
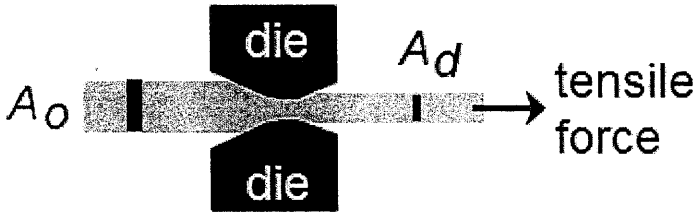


figure (2)

37. What is the forming method in the figure (A) forging (B) extrusion (C) rolling (D) drawing



38. 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.
39. What's the symbol we usually use for electric conductivity (A) ρ (B) μ (C) σ (D) ε(E) ν
40. Which one has the highest specific modulus and specific strength of all reinforcing fiber materials. (A) Glass fiber (B) Aramid fiber (C) carbon fiber (D) ceramic

國立成功大學 109 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：0210，節次：2

II. Define the following terms: (2 pts each)

1. Steroisomerism
2. Self-interstitial
3. Mixed dislocation
4. Electronegativity
5. Crystal vs glass
6. FCC vs BCC for structure of material
7. Annealing
8. Stress Intensity factor, Fracture toughness, Plane strain facture toughness
9. ASTM stands for
10. Fine vs coarse pearlite
11. Hypereutectoid alloy
12. Isothermal transformation diagram
13. Hydrogen embrittlement
14. Gary cast iron
15. Resilience vs toughness

III. Calculation and essay questions:

1. What point defects are possible for MgO as an impurity in Al_2O_3? How many Mg^{2+} ions must be added to form each of these defects? (5 points)
2. 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.** (6 points)
3. 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: **CPR=KW/ρAt**, where adjust constant uses 87.6 (7 pts)
4. 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, rank them from least to greatest weight in accordance with these criteria. (6 Points)

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

5. Suppose that a wing component on an aircraft is fabricated from an aluminum alloy that has a plane strain fracture toughness of $40\ MPa\sqrt{m}$. It has been determined that fracture results at a stress of 365 MPa when the maximum internal crack length is 2.5 mm. For this same component and alloy, compute the stress level at which fracture will occur for a critical internal crack length of 4.0 mm. (Use: $K_{IC} < Y\sigma_C(\pi a)^{1/2}$) (6 Points)