

國立成功大學
110學年度碩士班招生考試試題

編 號： 95

系 所： 材料科學及工程學系(綠色應用
材料碩士班)

科 目： 基礎材料科學

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節 次： 第 3 節

備 註： 可使用計算機

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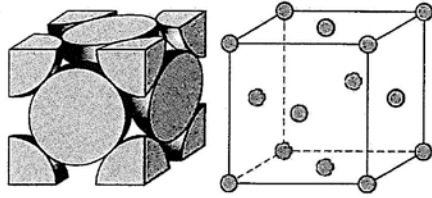
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※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。基礎材料科學共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

- For most metals, the fraction of vacancies just below the melting temperature is on the order
(a) 10^{-1} (b) 10^{-2} (c) 10^{-3} (d) 10^{-4} (e) 10^{-5} .
- Diffusion mechanism is the result of which of the following:
(a) Concentration gradient (b) Internal mechanical stress
(c) Random motion of particles (d) Thermally activated kinetic energy.
- A 50 mm long rod of Si_3N_4 has a rectangular cross section with width and height dimensions of 6 mm and 3 mm, respectively. If the rod was tested in three-point bending, the rod fails at the applied load of 670 N. Calculate the rupture stress MPa.
(a) 310 (b) 465 (c) 520 (d) 630 (e) 930.
- Which of them involves a cation–vacancy and a cation–interstitial pair in ceramics?
(a) dislocation (b) impurity (c) Schottky defect (d) Frenkel defect (e) none of them.
- Which of the following statement is support about PFZ
(a) precipitation free zone (b) precipitation focus zone
(c) prestrain free zone (d) penetration free zone.
- “Kirkendall effect” is a well-known phenomenon occurs in many metallic materials systems, which of the following statements is correct?
(a) Kirkendall effect confirms that alloy element with lower melting temperature usually diffused slower.
(b) Kirkendall effect shows that porosity will occurs due to the interstitial element diffusion.
(c) Kirkendall effect is useful to explain the formation of void on the solder interface related to the joint reliability of electric circuit.
(d) Kirkendall effect is useful to explain the phenomenon for surface coating application, e.g. carburization process.
- Generally, the ingot structure appears rarely:
(a) peritectic (b) dendritic (c) equiaxed (d) columnar.
- For a 99.65 wt% Fe-0.35 wt% C alloy at a temperature just below the eutectoid, determine the fraction of eutectoid ferrite?
(a) 0.95 (b) 0.44 (c) 0.56 (d) 0.39 (e) 0.60.

9. Assume A is a constant. For two isolated ions, the attractive energy E is a function of the interatomic distance r, according to
(a) $E=-A/r$ (b) $E=-A/r^2$ (c) $E=-A/r^4$ (d) $E=-A/r^6$ (e) $E=-A/r^8$.
10. Thus atoms of some elements have two or more different atomic masses, which are called
(a) diatomic molecules (b) isotopes (c) crystals (d) Ionics (e) none of them.
11. Grain boundary strengthening is an important mechanism to enhance the mechanical properties of metallic alloys. Which of the following statement is correct related to the grain boundary strengthening?
(a) The larger the grain size the less defect density and better mechanical property.
(b) The grain boundaries act as pinning points that will impede the propagation of dislocations and result in lower mechanical properties.
(c) Grain boundary strengthening is also known as the Hall-Petch strengthening.
(d) The grain size of metallic alloys can be changed by aging treatment.
12. For the process of a ceramic material, during firing the formed piece shrinks and experiences a reduction of porosity and improvement in mechanical integrity; the process is termed ?
(a) drying (b) vitrification (c) sintering (d) quench (e) age hardening.
13. Annealing twins are typically found in metals with
(a) FCC (b) BCC (c) HCP (d) diamond (e) SC structure.
14. Which of the following statement about microsegregation is correct ?
(a) dendritic spacing (b) ingot center (c) rolling structure (d) recrystallization.
15. For a specimen of gold with elastic modulus of 130 GPa and Poisson ratio of 0.34, what is the theoretical shear stress in GPa?
(a) 20.7 (b) 7.70 (c) 14.7 (d) 18.4 (e) 24.3
16. Which of the following statements about martensite is incorrect?
(a) The martensite grains nucleate and grow at a very rapid rate—the velocity of sound within the austenite matrix.
(b) The martensitic transformation rate is time dependent.
(c) Martensite may be thought of as a transformation product that is competitive with pearlite and bainite.
(d) Plate like martensite may occur in low carbon steel which is caused by dislocation stacking inside.
(e) The martensitic transformation is termed an athermal transformation.

17. Characteristics of diffusionless transformation for metals:
(a) coherent structure (b) 2D surface relief (c) bamboo leaf structure (d) amorphous material.
18. Which of the following statement is support about the diffusionless transformation
(a) cementite (b) pearlite (c) bainite (d) martensite.
19. Which one of the following polymers characteristic has linear and branched structure; they soften when heated and harden when cooled?
(a) thermoplastic (b) thermosetting (c) random copolymer (d) graft copolymer.
20. Which of the following heat treatments can make steels have a maximum softness and ductility?
(a) Normalizing (b) Full annealing (c) Spheroidizing (d) Austenitizing (e) Process annealing.
21. For a metal under a stress state with $\sigma_x=350$ MPa, $\sigma_y=70$ MPa and $\tau_{xy}=210$ MPa, calculate the maximal shear stress in MPa.
(a) 180 (b) 200 (c) 280 (d) 380 (e) 480.
22. Which of following compound belongs to Zinc Blende structure?
(a) SiC (b) silica (c) NaCl (d) ThO₂ (e) none of them.
23. What is the characteristic of peritectoid?
(a) $L \rightarrow \alpha + \beta$ (b) $\alpha \rightarrow \beta + \gamma$ (c) $\alpha + L \rightarrow \beta$ (d) $\alpha + \beta \rightarrow \gamma$ (e) $L_1 \rightarrow \alpha + L_2$.
24. Atomic Packing Factor (APF) of FCC:
(a) 0.52 (b) 0.68 (c) 0.72 (d) 0.74.
25. Which of the following statement about GP zone could be caused ?
(a) casting (b) forging (c) rolling (d) heat-treatment.
26. The figure shows a hard sphere model for FACE-CENTERED CUBIC (FCC) unit cell. The atom centers are represented by small circles to provide a better perspective of atom positions. Assume that the spheres have the same diameter. Which one of the following is a WRONG characteristic?



- (a) Each corner atom is shared among eight unit cell
 - (b) Each face-centered atom is shared by two unit cell
 - (c) Each corner atom has a coordination number of 8
 - (d) Each face-centered atom has a coordination number of 12
 - (e) The atomic packing factor is 0.74.
27. The ideal c/a ratio in HCP crystal structure is?
 (a) 2 (b) 1.633 (c) 1.5 (d) 1 (e) none of them.
28. Which one is correct?
 (a) A typical engineering stress-strain curve is concave under tension.
 (b) The engineering stress is larger than the true stress for a compression testing at the same strain.
 (c) A typical engineering stress-strain curve is convex under compression.
 (d) The engineering stress is larger than the true stress for a tension testing at the same strain.
 (e) Barreling happens in a tension testing.
29. Which one of following is a WRONG statement about graphite?
 (a) Graphite is more stable than diamond at ambient temperature and pressure
 (b) Graphite is one of the most widely adopted as the anode material for lithium ion battery
 (c) The graphite structure is composed of layers of hexagonally arranged carbon atoms
 (d) The electron participates in weak van der Waals type of bond between the layers in graphite
 (e) Each carbon bonds to four other carbons (sp^3 hybridization), and these bonds are totally covalent.
30. Which of the following statement is not support about the diffusionless transformation ?
 (a) strain induced transformation (b) martensite (c) stress induced transformation (d) GP zone.
31. A 6061-T4 aluminum alloy occurs to yield at the following stress state of $\sigma_x=70$ MPa, $\sigma_y=120$ MPa and $\tau_{xy}=60$ MPa, determine the yield stress in MPa according to the Tresca criteria.
 (a) 120 (b) 70 (c) 60 (d) 150 (e) 160.

32. What does dominate Up-hill diffusion for the phase transformation of metals:
(a) kirkendall effect (b) interstitial diffusion (c) composition (d) free energy.
33. For ceramics, how to introduce an impurity ion having a charge different from the host ions?
(a) formation of twin boundary (b) removal of twin boundary
(c) formation of lattice defects (d) None of them.
34. One type of the defect in ionic crystal involves a cation-vacancy and anion-vacancy is called:
(a) Frenkel defect (b) Schottky defect (c) Interstitial defect (d) Substitutional defect.
35. For the metal after cold working, which of the following statements about the phenomenon of grain growth is incorrect?
(a) growing by the movement of grain boundary
(b) atoms get through grain boundary by diffusion
(c) the smaller grains are consumed by the bigger grains
(d) the driving force is strain energy
(e) grain growth is related to the initial grain size.
36. Which of the following statement is support about minimizing the free energy barrier for nucleation ?
(a) grain refinement (b) alloying (c) preheating (d) undercooling.
37. Which of the following iron-carbon alloys and associated microstructures is of the highest tensile strength?
(a) 0.25 wt% C with spheroidite (b) 0.25 wt% C with coarse pearlite (c) 0.6 wt% C with fine pearlite
(d) 0.6 wt% C with coarse pearlite (e) 0.6 wt% C with spheroidite.
38. What is the most critical factor for explosion nucleation in uniform nucleation and solidification:
(a) chemical composition (b) undercooling (c) interface energy (d) direction of heat transfer.
39. Mechanical twins (Deformation twins) generally occur in?
(a) Ni (b) Cu (c) Al (d) Mg.
40. A hydrogen gas container with an internal pressure of 20 kg/m^3 , the thickness of the container is 5 mm, and the steady-state diffusion coefficients is $10^{-10} \text{ m}^2/\text{s}$. Please estimate the hydrogen leakage rate of this container.
(a) $4 \times 10^{-10} \text{ kg/m}^2\text{sec}$ (b) $1 \times 10^{-8} \text{ kg/sec}$ (c) $4 \times 10^{-7} \text{ kg/m}^2\text{sec}$ (d) $2 \times 10^{-9} \text{ kg/m sec}$.

41. Which one of the following chainlike paraffin molecules has the lowest boiling point ($^{\circ}\text{C}$)?
(a) CH_4 (b) C_2H_6 (c) C_3H_8 (d) C_4H_{10} (e) C_5H_{12} .
42. For two edge dislocations of opposite signs lying on the same slip plane, which of the following interactions is not likely to happen?
(a) Annihilation of each other (b) Creation of another extra half plane of atoms
(c) Creation of rows of vacancies (d) Creation of rows of interstitials.
43. Aluminum has a FCC crystal structure and an atomic radius of 1.431 \AA . The lattice constant of aluminum is 4.048 \AA . What is the interplanar spacing for the (200) set of planes?
(a) 1.431 \AA (b) 2.024 \AA (c) 2.337 \AA (d) 2.862 \AA (e) 4.048 \AA .
44. For an isomorphous system, which one of the following is wrong?
(a) same crystal structure (b) nearly atomic radii (c) similar electroconductivity (d) identical valences.
45. Why does add the Inoculant (inoculum) during solidification?
(a) increase cooling rate (b) decrease intersurface energy
(c) increase concentration (d) form grain boundary.
46. The driving forces for interface control in diffusion are:
(a) chemical energy (b) lattice strain (c) concentration difference (d) time.
47. The typical dislocation density of alloy after heat treatment is about:
(a) 10^{8-9} mm^{-3} (b) 10^{5-6} mm^{-3} (c) 10^{2-3} mm^{-3} (d) 10^{0-1} mm^{-2} .
48. What is the atomic packing factor of BCC?
(a) 0.68 (b) 0.74 (c) 0.82 (d) 0.56 (e) none of them.
49. What kind of structure with the atomic coordinates of (0, 0, 0) and (1/2, 1/2, 1/2)?
(a) BCC (b) FCC (c) HCP (d) SC (e) none of them.
50. After elastic deformation "easy glide" which is a linear region of low strain-hardening is observed at which direction is parallel to the tension axis for tension deformation of a FCC single crystal.
(a) $\langle 100 \rangle$ (b) $\langle 110 \rangle$ (c) $\langle 111 \rangle$ (d) $\langle 112 \rangle$ (e) $\langle 145 \rangle$.