

國立聯合大學 110 學年度碩士班考試招生

材料科學工程學系

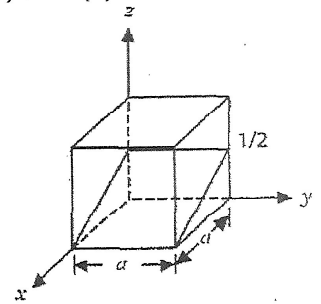
入學考試試題

科目：材料科學導論

第 1 頁共 4 頁

A. Crystal structure: (24%)

- (4%) The most closed-packed crystal structure for a single-element material is (a) BCC (b) FCC (c) orthorhombic (d) diamond (e) zinc blend
- (4%) Which of the following crystal structure exhibits better ductility than the others? (a) FCC (b) HCP (c) diamond (d) triclinic (e) rock salt
- (4%) What is the Millar index of the plane in the right figure? (a) (201) (b) (102) (c) (012) (d) (120) (e) (210)
- (4%) Which of the following usually has the densest atomic packing? (a) metal (b) ceramic (c) polymer (d) semiconductor (e) liquid
- (4%) In the sodium chloride lattice, the coordination number is (a) 4 (b) 6 (c) 8 (d) 12 (e) 3
- (4%) Which of the following shows anisotropic characteristics? (a) glass (b) Fe-4%Si alloys after sheet rolling (c) polycrystalline solids (d) polymer (e) amorphous solids



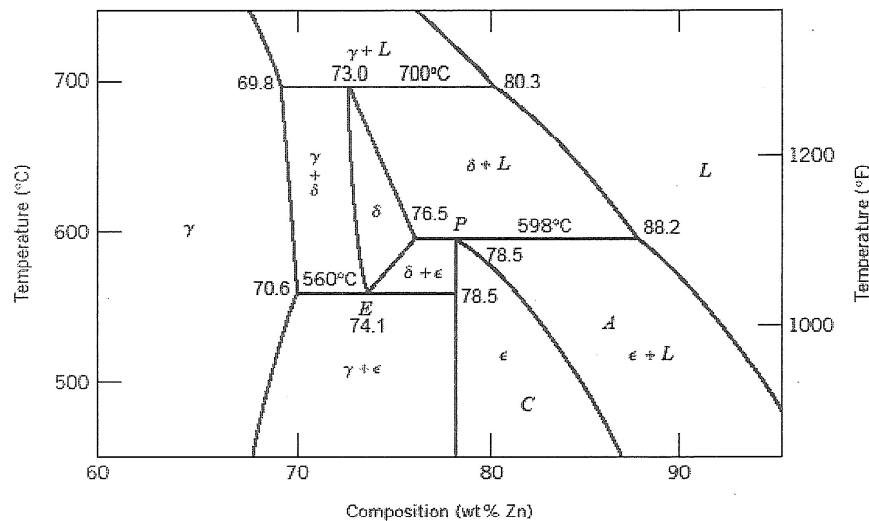
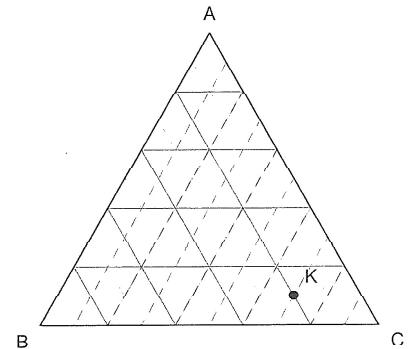
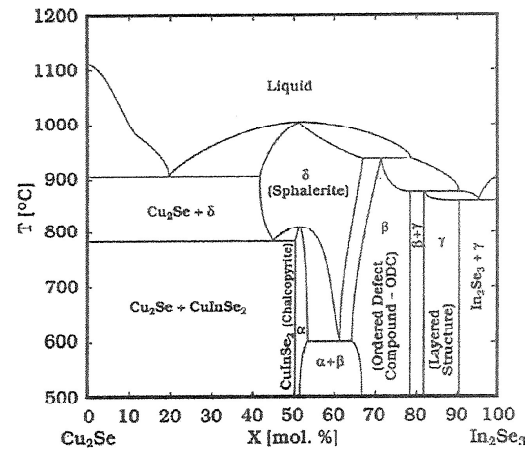
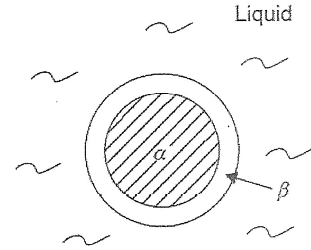
B. Mechanical properties: (38%)

- (4%) Hall-Petch equation indicates that (a) dislocation density (b) grain size (c) vacancy concentration (d) surface energy (e) stacking fault plays a key role in determining the strength of metals.
- (4%) Which of the following method cannot increase the strength of metals? (a) increase the dislocation density (b) incorporate foreign atoms into the matrix (c) induce well-dispersed precipitates (d) increase the grain boundary area (e) anneals at elevated temperature and then cools slowly
- (4%) Which of the following has no obvious effect on strengthening a material? (a) metal -> cold work (b) ceramic -> high powder condensation (c) glass -> ion exchange (d) semiconductor -> doping (e) polymer -> add fibers
- (4%) In the right table, which material is the strongest? (a) material A (b) material B (c) material C (d) material D (e) material E
- (4%) In the right table, which material is the stiffest? (a) material A (b) material B (c) material C (d) material D (e) material E
- (4%) In the right table, which material experiences the greatest percent of reduction in area? (a) material A (b) material B (c) material C (d) material D (e) material E
- (4%) Why some metals (e.g., lead, tin, and zinc) cannot be strain-hardened by cold working at room temperature? (a) crystal structure (b) soft (c) recrystallization temperature (d) slip system (e) atomic size
- (10%) The tensile stress required to cause yielding single-crystalline aluminum is 3 MPa if the tensile axis is [100]. What is the critical resolved shear stress for yielding in aluminum?

| Materials | Yielding strength (MPa) | Tensile strength (MPa) | Strain at fracture | Fracture strength (MPa) | Modulus of elasticity (GPa) |
|-----------|--------------------------|------------------------|--------------------|-------------------------|-----------------------------|
| A | 310 | 340 | 0.23 | 265 | 210 |
| B | 100 | 120 | 0.4 | 105 | 150 |
| C | 415 | 550 | 0.15 | 500 | 310 |
| D | 700 | 850 | 0.14 | 720 | 210 |
| E | Fracture before yielding | | | 650 | 350 |

C. Phase diagram (36%)

- 15.(4%) The reaction in the right figure is $L + \alpha \rightleftharpoons \beta$, which is called (a) eutectic (b) eutectoid (c) monotectic (d) peritectic (e) peritectoid reaction
- 16.(4%) Which of the following is not an all solid phase reaction? (a) order-disorder transformation (b) eutectoid transformation (c) congruent transformation (d) peritectoid transformation (e) allotropic transformation
- 17.(4%) CuInSe_2 is a ceramic material for solar cell applications. How many eutectic points are there in the $\text{Cu}_2\text{Se}-\text{In}_2\text{Se}_3$ phase diagram shown on the right? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5.
- 18.(4%) Same as the above. How many eutectoid points are there in the $\text{Cu}_2\text{Se}-\text{In}_2\text{Se}_3$ phase diagram shown on the right? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5.
- 19.(4%) Same as the above. How many peritectic points are there in the $\text{Cu}_2\text{Se}-\text{In}_2\text{Se}_3$ phase diagram shown on the right? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5.
- 20.(4%) Same as the above. Which phase do you think is constructed from chalcopyrite by using Cu-In antisites Cu_{In} and Cu interstitials Cu_{i} (a) Cu_{2+y}Se phase (b) α phase (c) β phase (d) γ phase (e) none of the above
- 21.(4%) What is the composition at point K in the ternary phase diagram in the right figure? (a) A:10%, B:20%, C:70% (b) A:70%, B:20%, C:10% (c) A:10%, B:20%, C:70% (d) A:20%, B:70%, C:10% (e) A:20%, B:10%, C:70%



22.(8%) The Cu-Zn phase diagram is shown in the figure below. Show the weight percentage of each phase of the 25%Cu-75%Zn alloy just above 560°C.

國立聯合大學 110 學年度碩士班考試招生

材料科學工程學系

入學考試試題

科目： 材料科學導論 第 3 頁共 4 頁

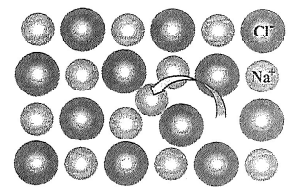
D. Equilibrium (26%)

If a system is not at equilibrium, it will move spontaneously towards equilibrium, because this allows it to reach a lower-energy, more stable state. Therefore, try to answer the following questions.

- 23.(4%) A reaction is spontaneous if (a) $\Delta G < 0$ (b) $\Delta G = 0$ (c) $\Delta G > 0$ (d) $\Delta S < 0$ (e) $\Delta S > 0$.
- 24.(4%) Based on free energy, the stable phase at low temperature is (a) simple cubic (b) body-centered cubic (c) face-centered cubic (d) orthorhombic (e) monoclinic
- 25.(4%) Which of the following phase is not shown in the equilibrium phase diagram of the iron-carbon system because it is not an equilibrium phase? (a) ferrite (b) cementite (c) pearlite (d) austenite (e) martensite
26. (4%) It has been well known that the steels containing small quantities of sulphur may suffer "hot shortness" at high-working temperatures. This is because the Fe-Fe grain boundary energy ($\gamma_{\text{Fe-Fe}}$) and Fe-FeS interface energy ($\gamma_{\text{Fe-FeS}}$) meet the following criterion: (a) $\gamma_{\text{Fe-Fe}} \geq \gamma_{\text{Fe-FeS}}$ (b) $\gamma_{\text{Fe-Fe}} \leq \gamma_{\text{Fe-FeS}}$ (c) $\gamma_{\text{Fe-Fe}} \geq 2\gamma_{\text{Fe-FeS}}$ (d) $\gamma_{\text{Fe-Fe}} \leq 2\gamma_{\text{Fe-FeS}}$ (e) $\gamma_{\text{Fe-Fe}} \geq \frac{1}{2}\gamma_{\text{Fe-FeS}}$
- 27.(10%) The driving force is a measure of how far away from equilibrium a state is. It makes the system move towards equilibrium. What is the driving force for the following phenomenon? (i) recovery (ii) recrystallization (iii) grain growth (iv) secondary recrystallization (v) strain-induced boundary migration.

E. Ceramics (28%)

- 28.(4%) What is the maximum cation-anion radius ratio for coordination number 6? (a) 1.0 (b) 0.732 (c) 0.414 (d) 0.225 (e) 0.155
- 29.(4%) The general formula for a material with spinel structure is (a) ABO (b) ABO₂ (c) ABO₃ (d) ABO₄ (e) AB₂O₄
- 30.(4%) In spinel structure, the anion has a (a) simple cubic (b) BCC (c) FCC (d) diamond (e) HCP packing
- 31.(4%) In the right figure, the defect is called (a) Schottky defect (b) Frenkel defect (c) interstitial (d) vacancy (e) divacancy
- 32.(4%) Which of the following is not commonly used in ceramic processing (a) tape casting (b) slip casting (c) injection molding (d) sintering (e) melt casting
- 33.(4%) The color of a glass is mainly determined by (a) The network forming ions in the glass (b) The network modifying ions in the glass (c) Multivalent ions in the glass, which have specific absorption bands in the visible spectrum. The glass has the same color as the absorbed light (d) Multivalent ions in the glass, which have specific absorption bands in the visible spectrum. The glass color corresponds to the complementary wavelengths, not absorbed by the glass (e) none of the above
- 34.(4%) Considering the MgO crystal, which of the following Kröger-Vink notation is incorrect? (a) A vacancy on the Mg site: V_{Mg}'' (b) A vacancy on the O site: V_{O}^{\bullet} (c) An Al interstitial: Al_i^+ (d) An Al on a Mg site: Al'_{Mg} (e) An Li on a Mg site: Li'_{Mg}



國立聯合大學 110 學年度碩士班考試招生

材料科學工程學系

入學考試試題

科目：材料科學導論

第 4 頁共 4 頁

F. Semiconductor (24%)

- 35.(4%) The primary reason for the wide spread use of silicon in semiconductor device technology is (a) abundance of silicon on the surface of the Earth. (b) larger bandgap of silicon in comparison to germanium. (c) favorable properties of silicon dioxide (SiO_2) (d) lower melting point (e) indirect bandgap.
- 36.(4%) Which of the following elements act as an acceptor when added to pure silicon? Assume that the impurity elements are substitutional. (a) gallium (b) phosphorous (c) arsenic (d) antimony (e) germanium
- 37.(4%) When a pure semiconductor is heated, its resistivity (a) goes up (b) goes down (c) remains the same (d) goes up then down (e) can't say
- 38.(4%) As the doping to a pure semiconductor increases, the bulk resistivity of the semiconductor (a) remains the same (b) increases (c) decreases (d) increase then decrease (e) none of the above
- 39.(4%) What is an energy gap? (a) the energy equal to the energy acquired by an electron passing a 1 V electric field (b) the energy band in which electrons can move freely (c) an energy level at which an electron can exist (d) an energy range in a solid where no electron states can exist (e) the minimum energy difference between the top of the conduction band and the bottom of valence band
- 40.(4%) Which of the following device does not have p-n junctions in it? (a) light emitting diode (b) solar cell (c) field effect transistor (d) bipolar junction transistor (e) fuel cell

G. Polymer (24%)

- 41.(4%) Regarding thermoplastic polymers, which of the following is not true? (a) Behave in ductile, plastic manner (b) Chains have weak van der Waals bonds (c) Decompose on heating instead of melting (d) Upon heating, soften and melt (e) Easily recycled
- 42.(4%) Poly(ethylene oxide) can be used as a water-soluble binder for injection molding. Which of the following molecular weight do you think have the highest melting temperature? (a) 1,330 (b) 9,250 (c) 100,000 (d) 500,000 (e) 5,000,000
- 43.(4%) Replacing the hydrogen atoms in polymer chains with others (e.g. Cl, F) will (a) decrease polarity (b) lead to inter-chain hydrogen bonding (c) lead to lower strengths (d) lead to lower stiffness (e) lead to lower melting temperatures
- 44.(4%) Regarding glassy polymers, which of the following is not true? (a) good ductility (b) poor formability (c) good strength (d) good stiffness (e) good creep resistance
- 45.(4%) During the winter months, the temperature in some parts of Alaska may go as low as -55°C (-65°F). Which would be suitable for automobile tires under these conditions? (a) Elastomer natural isoprene (b) styrene-butadiene (c) acrylonitrile-butadiene (d) chloroprene (e) polysiloxane
- 46.(4%) Which of the following is a conductive polymer? (a) Polypropylene (b) Polystyrene (c) Polyvinyl chloride (d) PEDOT:PSS (e) Polyethylene