逢甲大學100學年度碩士班招生考試試題 編號：047 科目代碼：324

科目	材料科學導論	適用系所	材料科學與工程學系	時間	120分鐘

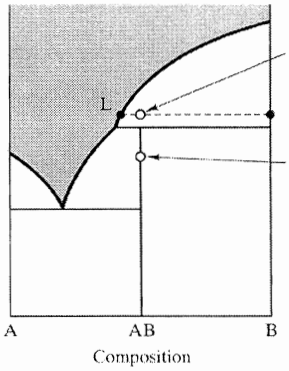
※請務必在答案卷作答區內作答。 共 2 頁第 1 頁

1. (a) Apart from composite, what are the another four fundamental categories of engineering materials? Give a specific material for each category. (b) Plot a tetrahedron showing the relative contribution of different bond types for the five fundamental categories of engineering materials. (20%)

2. Steel surface can be hardened by carburization. During one such treatment at 1000℃, there is a drop in carbon concentration from 5.6 to 4.2 at% carbon between 1 and 2 mm from the surface of the steel. Calculate the flux of carbon atoms into the steel in this near-surface region. 已知以下常數：the density of the iron = 7.63 g/cm^3; atomic mass = 55.85 amu; $D_0 = 2 \times 10^{-5}$ m^2/s; activation energy = 142,000 J/mole; R = 8.314 J/(mole · K) (20%)

3. (a) What are the three alternate diffusion paths for a polycrystalline solid? (b) Which path has the slowest diffusivity (擴散係數) and which path has the highest diffusivity? (c) Which path has the smallest diffusion activation energy? (b)-(c)必須解釋原因 (20%)

4. The phase diagram of A-B alloy system is shown on the right (Y axis is temperature). (a) Where is the location of the melting point of pure A? (b) AB compound will be melted when heated to a given temperature. Which metling behavior is AB? congruent or incongruent. (必須解釋作答原因) (c) Point out the location of the eutectic points in the phase diagram. (20%)



5. Silicon has diamond-cubic structure. (a) Plot the unit cell of this material and the location of Si atoms. (b)What is the coordination number of each Si atom? (20%)

6. The first three diffraction peaks of a metal powder are $2\theta = 40.6^\circ$, 58.4°, 73.4° using Cu K_α-radiation (λ = 0.1542 nm). (a) Is this a body centered cubic or face centered cubic metal? (b) What is the lattice constant of the unit cell? (c) If the atomic mass of this pure metal is 183.8 amu, what is the density of the metal? (20%)

7. Iron has a body centered cubic (bcc) structure. (a) Draw a cubic cell and then indicate one of the slip planes and the slip directions within this slip plane. (b) Calculate the number of slip systems of the bcc iron. (10%)

8. A single-crystal iron wire is situated so that a tensile load is oriented along the [1 1 0] crystal direction. If the applied stress is 50 MPa, what will be the resolved shear stress along the [1 1 $\bar{1}$] direction within the (1 0 1) plane? (10%)

9. A composite material contains 67 wt% nylon polymer and 33wt% glass fiber. (a) Calculate the density of this composite material. (The density of nylon polymer = 1.14 g/cm^3, and the density of the reinforcing glass fiber = 2.54 g/cm^3.) (b) Calculate the elastic modulus of this composite under isostrain condition. Assume the elastic moduli of nylon polymer and glass fiber are 6.9×10^3 and 72.4×10^3 MPa, respectively. (20%)

10. A phosphorus-doped silicon has a conductivity of 2.00×10^{-2} Ω^{-1}m^{-1} at room temperature. (a) What is the predominant charge carrier in this material? (b) What is the density of the predominant charge carrier? (c) What is the drift velocity of electrons and holes under an electrical field strength of 200 V/m? Assume the electrical mobilities μ_e (for electron) and μ_h (for hole) are 0.140 and 0.038 m^2/(V · s), respectively. (20%)

Physical constants:
Charge of electron $e = 1.6\times10^{-19}$ coulomb, Mass of electron $m_e = 9.11\times10^{-31}$ kg, Planck's constant $h = 6.63\times10^{-34}$ J · s, Boltzmann constant $k = 1.38\times10^{-23}$ J/K. Avogadro's constant $N = 6.02\times10^{-23}$, Gas constant R = 8.314 J/(mole · K)

11. Refer to the *TTT* diagram for eutectoid steel shown below. (20%)

(a) Calculate the microstructure of eutectoid steel that completes the following steps of heat treatment: instantly quenched from region to 500℃→held for 3 seconds→quenched instantly to 250℃.

(b) What will happen if the resulting microstructure from part (a) is held for 1 day at 250℃ and then cooled to room temperature?

(c) What will happen if the resulting microstructure from part (a) is quenched directly to room temperature?

(d) Sketch the above three kinds of thermal histories.