

國立臺北科技大學 112 學年度碩士班招生考試

系所組別：3301 材料科學與工程研究所

第二節 材料科學與工程導論 試題 (選考)

第 1 頁 共 2 頁

注意事項：

1. 本試題第一部分計算，共 4 題，每題 10 分；第二部分選擇題，共 10 題，每題 3 分；第三部分填空，共 15 題，每題 2 分；總分共計 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

Part 1. Calculation questions. (40%)

1. What are the indices for the three planes drawn in the following sketch? (10%)

Plane 3 needs to be presented with three-axis Miller scheme and four-axis Miller-Bravais scheme. (plane 1: 3%; plane 2: 3%; plane 3: 4%)

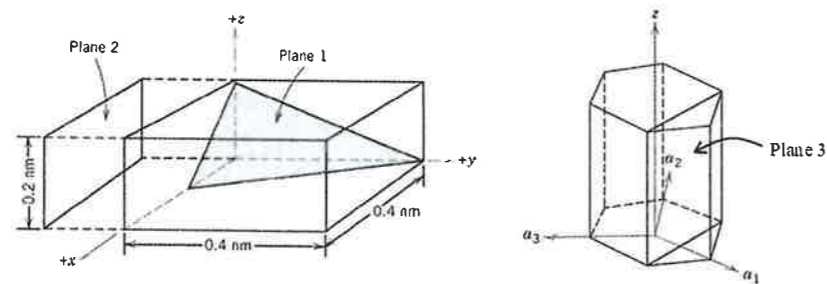


Figure 1.

2. Refer to iron-iron carbide phase diagram (Fig.2) below.

(a) Explain what are eutectic, eutectoid, and peritectic reactions? Also, select the corresponding point (A-E) for each reaction in the iron-iron carbide diagram. (5%)

(b) Austenite with the carbon content of 0.76 wt% can completely transform into pearlite during the cooling process. Please calculate the ratio of ferrite and cementite based on this composition, at the temperature just below the transformation temperature. (solubility limit of carbon in the ferrite phase is 0.022 wt%) (5%)

3. Figure 3 shows the stress-strain curves of 2 materials (A and B) when a tensile force is applied until fracture. Please answer the following questions.:

- (a) Beyond which point that plastic deformation occurs? (3%)
- (b) Necking occurs at which point? (3%)

(c) For A and B materials, determine which one is metal and which one is ceramic. (4%)

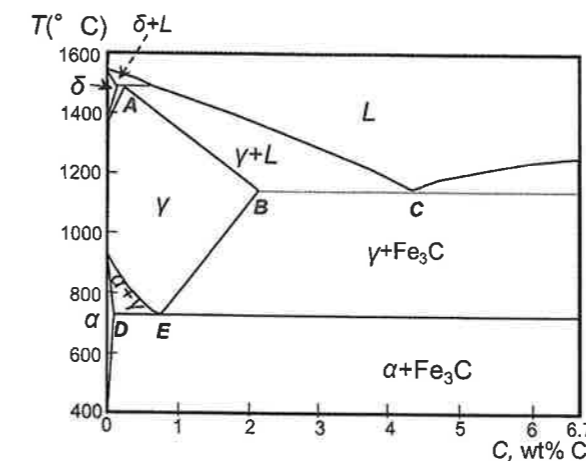


Figure 2.

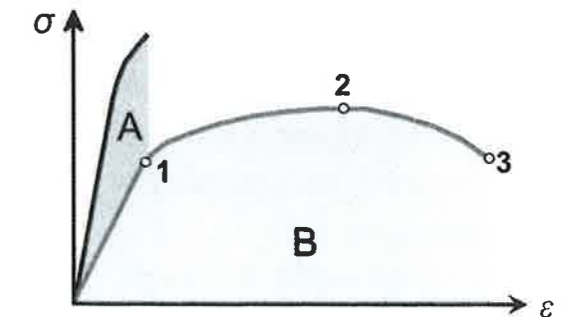


Figure 3.

4. Germanium, to which 10^{24} m^{-3} As atoms have been added, is an extrinsic semiconductor at room temperature, and virtually all the As atoms may be thought of as being ionized (i.e., one charge carrier exists for each As atom).

(a) Is this material n-type or p-type? (5%)

(b) Calculate the electrical conductivity of this material, assuming electron and hole mobilities of 0.1 and $0.05 \text{ m}^2/\text{V}\cdot\text{s}$, respectively. (5%)

Part 2. Selection questions. (30%, each for 3%)

5. Choose the wrong statement

- a. shear stress is the driving force for slip to occur of edge dislocations.
- b. materials with more slip systems are more easily to be deformed.
- c. dislocation motion in metals is relatively easy because metallic bonding is non-directional.
- d. plastic deformation is easier in a perfect single crystal.

6. Which of the statements about nucleation mechanism are NOT true: (multiple selections)

- a. impurities or heterointerface could reduce the supercooling when materials solidify.
- b. homogeneous nucleation is energetically favored to occur than heterogeneous nucleation.
- c. critical radius for heterogeneous nucleation is smaller than for homogeneous nucleation.
- d. growth step begins once nucleus size is over the critical radius.

7. Choose the correct statement.

- a. Ferrite, austenite, cementite and martensite are equilibrium phases of Fe-C alloy.
- b. Mechanical properties of Cementite could be modified by changing Fe-C composition.
- c. Property difference of pearlite malleable iron, pearlite grey iron and pearlite ductile iron comes from the difference in graphite composition.

注意：背面尚有試題

d. Pearlite, bainite, and martensite could be obtained by controlling the cooling rate of austenite. They could have the same composition.

8. Choose the correct statement.

- Energy of electrons in an atom is continuously distributed, and electron tend to occupy from the lowest energy state.
- When atoms are at equilibrium distance, the net force is zero and net energy is at minimum values.
- Anisotropy means the property value does not depend on the measurement direction.
- electron position in an atom can be precisely determined.

9. Silicon has an energy bandgap of 1.12eV; which of light or photon in the following statements could be absorbed by Si? (multiple selections)

- photons with the energy of 1eV;
- photons with the energy of 1.5eV;
- Light with a wavelength of 532nm;
- Light with a wavelength of 1 μ m.

10. What is the principle for the strengthening of metals?

- reducing dislocation density;
- reducing dislocation mobility;
- increasing dislocation mobility;
- reducing grain boundary.

11. Following the previous question, what process can strengthen metals? (multiple selections)

- reducing grain size;
- recovery;
- cold working;
- hot working;
- solid solution process;
- recrystallization.

12. Choose the wrong statement.

- diamagnetic and paramagnetic materials are considered non-magnetic.
- ferromagnetism is permanent magnetization.
- antiferromagnetic materials have incomplete cancellation of spin moments.
- paramagnetic materials have permanent atomic dipoles.

13. Select the properties with the same temperature dependence from the following. (multiple selections)

- vacancy concentration;
- diffusion coefficient;
- critical radius for nucleation;
- intrinsic carrier concentration.

14. Choose the wrong statement about semiconductors. (multiple selections)

- Hall effect determines the majority carrier type, concentration, and mobility.
- The energy corresponding to the highest filled state at 0K is Fermi energy.
- An p-n junction diode turns on at forward bias and turns off at reverse bias.
- Recombination of electrons from the conduction band to the valence band always results in photon generation.
- At high temperature, extrinsic carrier concentration dominates.

Part 3. Filling the blanks with appropriate answer in English or Chinese (30%, each for 2%)

15. _____ is produced by rapidly quenching austenite to a sufficiently low temperature to prevent carbon diffusion and the formation of pearlite and bainite.

16. A system at _____ is in its most stable state; that is, its phase properties do not change with time.

17. The primary crystal bonding types are metallic, ionic, and _____ bonding.

18. The vacancy concentration is related to the point defect activation process, and it exponentially decays with the inverse of Boltzmann's constant and _____.

19. _____ means the ratio of cation and anion of a compound is not exactly the same as predicted by the chemical formula.

20. The electrical properties of intrinsic semiconductors are inherent in the pure material, and electron and hole concentrations are equal. The electrical properties of _____ semiconductors are dominated by impurities. It could be n- or p-type.

21. The transport of thermal energy from high- to low-temperature region of a material is termed _____.

22. Light amplification by stimulated emission radiation is _____.

23. Precipitation hardening is accomplished by two different heat treatments: _____ heat treatment and then precipitation heat treatment.

24. Solid solution strengthening results from _____ interactions between impurity atoms and dislocations.

25. For non-equilibrium cooling, the transformation of materials is shifted to a lower temperature than indicated by the phase diagram. This phenomenon is termed _____.

26. Metallic corrosion is typically electrochemical, involving both _____ reactions.

27. The time-dependent plastic deformation of metals subjected to constant stress and at a temperature greater than 0.4 T_m is termed _____.

28. Burger's vector is parallel to the _____ dislocation line.

29. Pearlite is the alternating α ferrite and _____ layers.