114MM02

國立臺北科技大學 114 學年度碩士班招生考試

系所組別：3300 材料科學與工程研究所

第二節　材料科學與工程導論　試題

注意事項：

1.本試題第一部分計算及問答，共 5 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 10 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. Answering the following questions. (50%)

1. Please sketch or determine the miller plane

(a) cubic unit cell $(01\bar{1})$ (2%)

(b) cubic unit cell $(1\bar{1}2)$ (2%)

(c) Determine the four-index Miller-Bravais scheme of the below planes in Fig. 1. (6%)

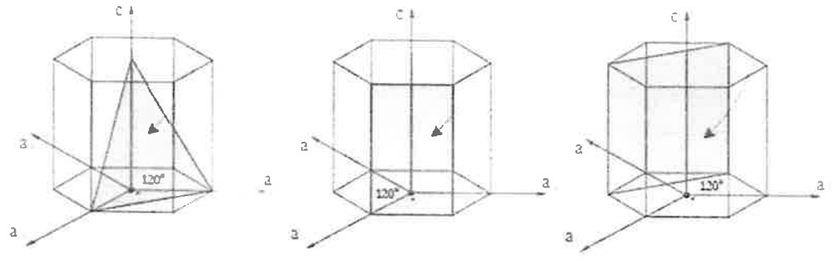

Figure 1.

2. $CH_3NH_3SnI_3$ is a material with perovskite structure (ABX3) where $CH_3NH_3^+$ represents an ionized organic molecule. The degradation or decomposition of $CH_3NH_3SnI_3$ occurs due to oxidation of Sn^{2+} to Sn^{4+}.

(a) if degradation occurs, what crystalline defect (or defects) would be expected to form in order to maintain charge neutrality? (5%)

(b) how many defects would be created for each Sn^{4+} ion? (5%)

3. For the nucleation process of solidifying from liquid, free energy changes as a function of nucleus radius. Sketch this free energy plot accordingly,

(a) at two different temperatures T1 and T2, where T1>T2. (5%)

(b) for homogeneous and heterogeneous nucleation process. (5%)

4. Please draw the corresponding band diagram of a p-n junction at the following conditions. **(a)** at equilibrium condition, (2%) **(b)** and **(c)** with applied bias as shown in the Fig 2.(each for 2%). And **(d)** p-n^{++} at equilibrium (4%)

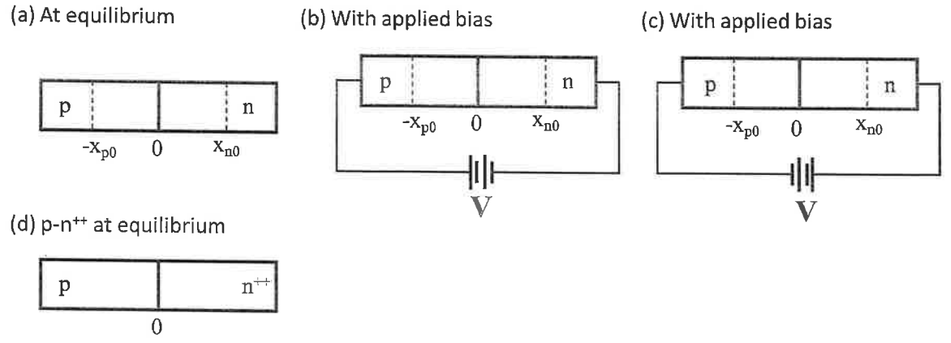

Figure 2.

5. Select true and correct false statements. (each statement for 2 %)

(a) carbon atoms in unsaturated hydrocarbons are singly bonded to other atoms.

(b) free radical polymerization can be accomplished by using saturated hydrocarbon molecules.

(c) size of polymers is determined by measuring the chain length.

(d) bond breaking is not required to obtain different polymer configurations.

(e) isomerism of polymer means they are two compounds with the same structure but having different chemical formulas.

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

6. Why are noble gases chemically inert?

a.Their outermost electron shell is full

b.They have high electronegativity

c.They have low electronegativity

d.They are in gaseous state

e.They have high ionization energy

7. Choose the correct statement.

a. Energy of electrons in an atom is continuously distributed, and electron tend to occupy from the lowest energy state.

b. atoms with large different electronegativity values tend to form ionic bonding.

c. atomic bonding forms when attractive energy and repulse energy cancel each other.

d. electron position in an atom can be precisely determined.

注意：背面尚有試題

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

9. Which is the valid slip systems for FCC, BCC structure of metal?
a. FCC {100}<110> ; BCC {321}<111>;
b. FCC {111}<111> ; BCC {211}<111>;
c. FCC {111}<110> ; BCC {111}<110>;
d. FCC {111}<110> ; BCC {211}<111>;
e. FCC {110}<111> ; BCC {110}<111>

10. A single crystal of hypothetical metal that has FCC crystal structure and is oriented such that a tensile stress is applied along a [112] direction. If slip occurs on a (111) plane and in a [011] direction, and the critical resolved shear stress is 4.18 MPa, calculate the magnitude of the applied tensile stress necessary to initiate yielding.
a. 0 MPa;
b. 2.95 MPa;
c. 3.41 MPa;
d. 5.12 MPa;
e. 5.91 MPa

11. Choose correct statements. (multiple selection)
a. magnetic moment of materials arises from both electron orbital motion and the spin of electrons.
b. complete filled electron shell has large spin moment.
c. antiferromagnetic materials have incomplete cancellation of spin moments.
d. paramagnetic materials have permanent atomic dipoles.
e. diamagnetic and paramagnetic materials are non-magnetic.
f. ferromagnetism is permanent magnetization.
g. Materials with positive magnetic susceptibility is considered magnetic.

12. Select the properties that is associated with thermal energy activation process. (multiple selections)
a. vacancy concentration;
b. diffusion coefficient;
c. critical radius for nucleation;
d. intrinsic carrier concentration in a semiconductor;
e. steady-state creep rate;
f. number of stable nuclei.

13. Silicon has an energy bandgap of 1.12eV; which one in the following statements could be absorbed by Si? (multiple selections)
a. photons with the energy of 1eV;
b. photons with the energy of 1.5eV;
c. Light with a wavelength of 532nm;
d. Light with a wavelength of 1μm.

14. Choose the correct statement about semiconductors. (multiple selections)
a. Hall effect determines the majority carrier type, concentration, and mobility.
b. The energy corresponding to the highest filled state at 300K is Fermi energy.
c. An p-n junction diode turns on at forward bias and turns off at reverse bias.
d. Recombination of electrons from the conduction band to the valence band always results in photon generation.
e. At high temperature, extrinsic carrier concentration dominates.

15. Choose the wrong statement. (multiple selections)
a. creep occurs due to a lengthy period of stress fluctuations.
b. the maximum stress for fatigue must be higher than the static yield or tensile strength.
c. steady-steady creep rate and creep rupture lifetime increases with reducing stress level.
d. for most metals, creep occurs at $T > 0.4\ T_m$

Part 3. Fill the blanks. (20%)

16. Martensite is produced by rapidly quenching austenite to a sufficiently low temperature to prevent carbon _____. (2%)

17. Si has _____ band structure where electron changes its momentum when transit form valence band to conduction band. (2%)

18. Carbon may have several _____ forms, like diamond and graphite. (2%)

19. Solid solution strengthening results from _____ interactions between impurity atoms and dislocations. (2%)

20. Metallic corrosion is typically electrochemical, involving both _____reactions. (2%)

21. For non-equilibrium cooling, the transformation of materials is shifted to a lower temperature than indicated by the phase diagram. This phenomenon is termed _____. (2%)

22. During the thermal annealing process, _____ significantly reduce the dislocation density. (2%)

23. Metals can be strengthened by reducing grain size, _____ and _____. (each for 1%)

24. When light interact with materials, small angle deflection of transmitted light is termed as _____; large angle deflection (larger than 90°) is termed as _____. (each for 1%)

25. _____ is a kind of material failure due to the stress fluctuation with time. And _____ is a kind of material failure at elevated temperatures and constant stress. (each for 1%)