# 大同大學 104學年度(寒)轉學入學考試試題

考試科目:材料導論　　系別:材料工程學系 請在答案本上依序書明題號作答

註:本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 不可以使用計算器。

1. Identify Face-Centered Cubic (FCC) crystal structure. (r: radius of sphere and a: length of cube side) (2%*4)

Crystal Structure	Atom/ unit cell	the relation between r and a	Coordination number	Atomic packing factor (APF)
FCC	(1)	(2)	(3)	(4)

2. Determine the **indices** for the (a) <u>direction</u> and (b) <u>plane</u> shown in the following cubic unit cell and hexagonal unit cells: (3%*4)

(a)   (b)
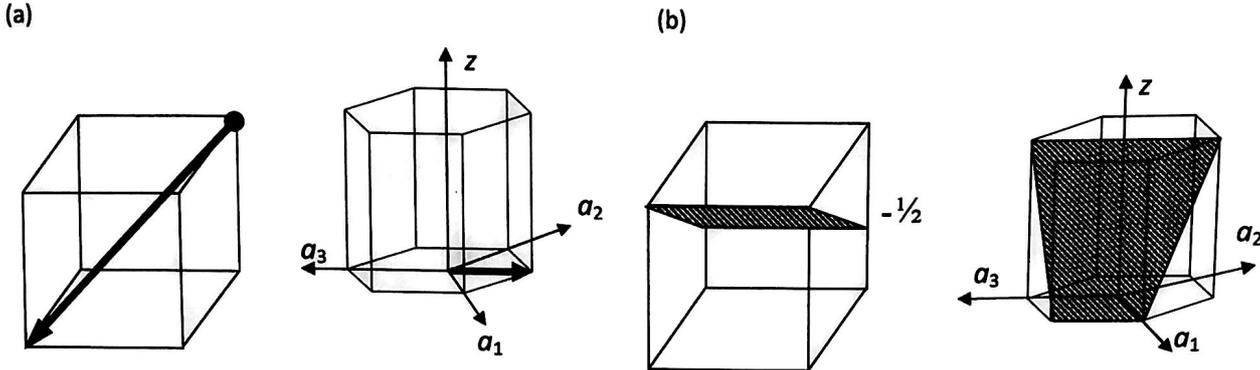
3. (a) The surface energy of a single crystal depends on crystallographic orientation. Does this <u>surface energy</u> **increase** or **decrease** <u>with an increase in planar density</u>? **Why**? (5%)

(b) For a given material, would you expect the <u>surface energy</u> to be **greater** than, the **same as**, or **less** than the <u>grain boundary energy</u>? **Why**? (5%)

(c) The grain boundary energy of a <u>small-angle grain boundary</u> is **greater** than, the **same as**, or **less** than for a <u>high-angle one</u>. **Why** is this so? (5%)

4. The wear resistance of a steel gear is to be improved by hardening its surface. This is to be accomplished by increasing the **carbon** content within an outer surface layer as a result of carbon diffusion into the steel (**γ-iron**); the carbon is to be supplied from an external carbon-rich gaseous atmosphere at an elevated and constant temperature. The <u>initial</u> carbon content of the steel is 0.20 wt%, whereas the <u>surface</u> concentration is to be maintained at 1.00 wt%. For appropriate 1000 ℃ heat treatment, **how long** will it take to achieve a carbon content of 0.60 wt% at a <u>position</u> 0.75 mm below the surface. (10%)

Diffusion Species	Host Metal	D_0 (m²/s)	Q_d (J/mol)
C	Fe (γ-FCC)	2.3×10^{-5}	148,000

Table Tabulation of Error Function Values

z	$erf(z)$	z	$erf(z)$	z	$erf(z)$
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

5. For a 40 wt% Sn–60 wt% Pb alloy (**Fig.1**) at 150℃ (300°F).

(a) What **phase(s)** is (are) present?(2%)

(b) What is (are) the **composition(s)** of the phase(s)?(4%)

(c) Calculate the relative amount of each phase present in terms of **mass fraction** and **volume fraction**.(6%)

(The densities of Pb:11.23 and Sn:7.24 g/cm³, respectively.)

Fig. 1
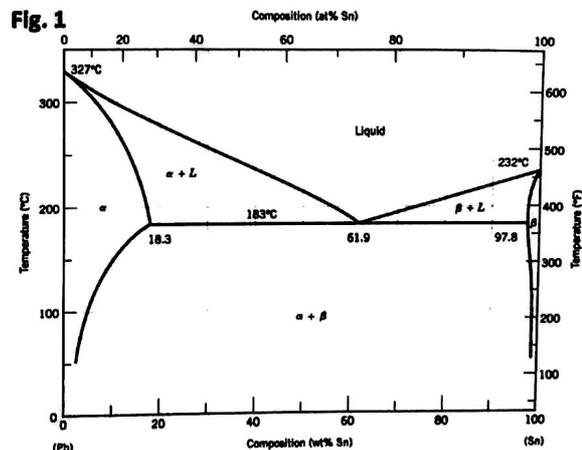
6. Briefly explain **why** <u>fine pearlite</u> is harder and stronger than <u>coarse pearlite</u>, which in turn is harder and stronger than <u>spheroidite</u>. (5%)
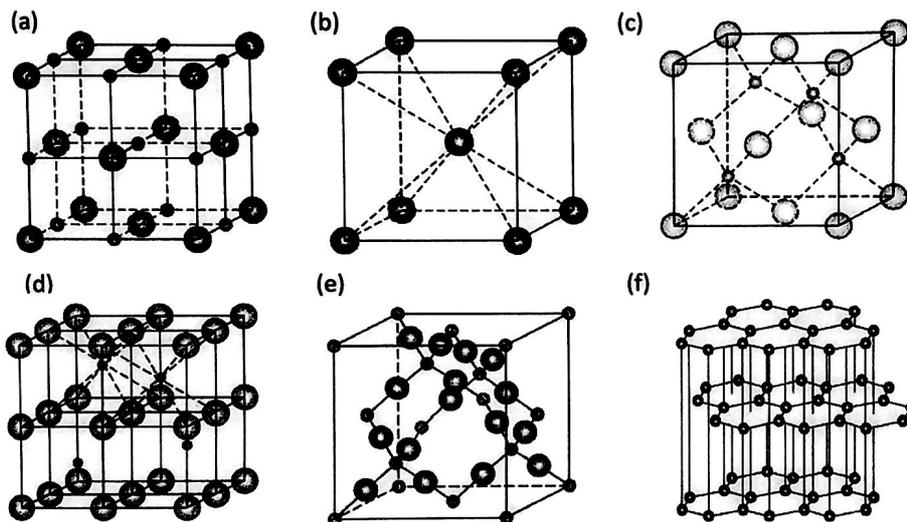
7. **Fig.2 Match** <u>Frenkel</u> and <u>Schottky</u> defects in ionic solids and **definition**. (3%*2)

Fig. 2
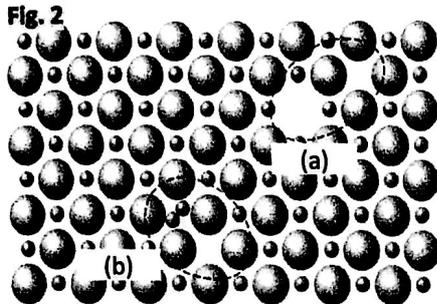
8. **Match Fig.3** shows a unit cell for (1-6) the crystal structure. (1%*6)
   (1) fluorite (CaF_2),   (2) zinc blende (ZnS),   (3) silica (quartz),   (4) sodium chloride (NaCl),   (5) diamond,   (6) graphite

Fig. 3

9. Make **comparisons** of <u>thermoplastic</u> and <u>thermosetting</u> polymers (6%*2)
   (a) on the basis of mechanical characteristics upon heating
   (b) according to possible molecular structures.

10. (a) The **degree of crystallinity of a polymer** depends on <u>2 reasons</u>? (3%*2)
    (b) Determine whether one item is **more likely to crystallize** than the other (2%*4)
    (1) linear polymer or branching polymer
    (2) large molecular weight or small molecular weight
    (3) atactic polymer or syndiotactic polymer
    (4) random and graft copolymer or alternating and block copolymer