大同大學105 學年度 (暑)轉學入學考試試題

考試科目:材料導論　　系別:材料工程學系　　第1/2頁

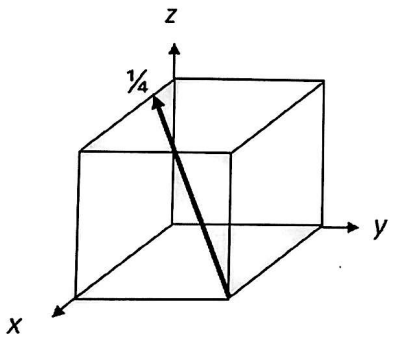
註:本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 不可以使用計算器。

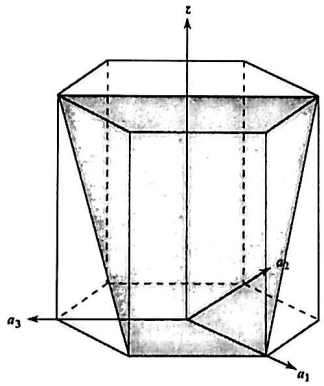
1. Identify the three crystal structure: Simple Cubic (SC), Body-Centered Cubic (BCC), Face-Centered Cubic (FCC), Hexagonal Close-Packed (HCP). (*r*: radius of sphere and *a*: length of cube side) (1%*15)

Crystal Structure	Atom/ unit cell	the relation between *r* and *a*	Coordination number	Atomic packing factor (APF)
SC				
BCC				
FCC				
HCP		a=2r, c=1.633a		

2. (　　) What factors affect the diffusion rate in solid metal crystals? (a) type of diffusion mechanism, (b) temperature of diffusion, (c) concentration of the diffusion species (concentration gradient), (d) type of crystal structure, (e) Type of crystal imperfections present. (5%)

3. Determine the **indices** for the direction or plane shown in the following cubic unit cell: (3%*2)





4. (a) The surface energy of a single crystal depends on crystallographic orientation. Does this **surface energy** increase or decrease with an increase in **planar density**? Why? (4%)

   (b) Would you expect the diffusion rate of copper (self diffusion) to be lower or higher in copper with ASTM grain size 4 than in copper with ASTM grain size 8? **Explain** your answer. (4%)

   (c) **Comparisons** of thermoplastic and thermosetting polymers. (4%)

5. 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 initial carbon content of the steel is 0.20 wt%, whereas the surface concentration is to be maintained at 1.00 wt%. For appropriate **900** ℃ heat treatment, **how long** will it take to achieve a carbon content of 0.60 wt% at a position 0.75 mm below the surface. (12%)

Diffusion Species	Host Metal	D_0 (m^2/s)	Q_d (J/mol)
C	Fe (γ -FCC)	2.3×10^{-5}	148,000

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

6. (a) **Plot** a typical tensile engineering stress-strain curve for a metal. (3%)

   (b) On the curve in (a), indicate the followings:

   i) Yield strength at a strain offset of 0.2% (3%)

   ii) Tensile strength (3%)

   iii) Ductility expressed by percent elongation (3%)

7. What is the **effects** of the following treatments/processes on the mechanical **strength and toughness** of a metal? (4*2%)
   (a) grain growth, (b) solid solution, (c) plastic deformation, (d) recrystallization.

8. **Define** the following terms: (a) K_{IC} and (b) fatigue (8%)

9. **Plot** a schematic binary phase-diagram containing a ***eutectoid*** invariant reaction (6%).

10. Consider the **solidification** of a pure metal ($L \rightarrow S$) at temperatures below melting point T_m. **Plot** curves for nucleation rate, growth rate, and overall transformation rate **versus temperature**. Indicate the position of T_m. (8%).

11. Describe the two heat treatments that are used to precipitation harden a metal. (8%)