國立臺北科技大學 101 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）

注意事項：

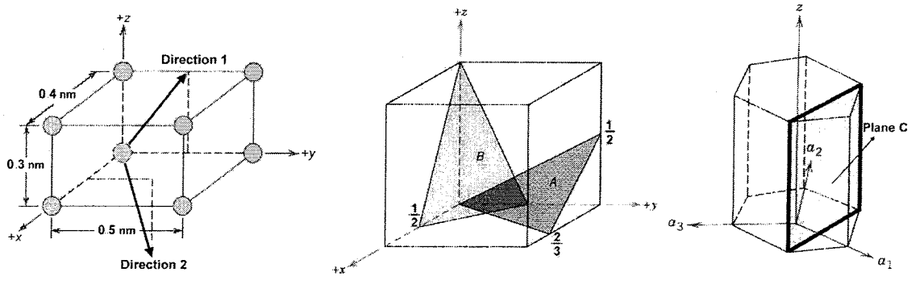
1. 本試題共九題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、Please completely explain or define the following terms: **(20%)**

(1). Twin
(2). Plastic deformation
(3). Compacted graphite iron
(4). CMC (Ceramic-Matrix Composites)
(5). Glass-Ceramic

二、(1). What are the indices for the direction indicated by the two vectors (directions 1 and 2) in the following sketch? **(4%)**

(2). Determine the Miller indices for the three planes (planes A, B and C) shown in the following unit cell? **(6%)**



三、Please completely explain of the TTT and CCT curves, and draw the TTT and CCT diagrams.**(10%)**

四、Please completely explain the intergranular corrosion and hydrogen embrittlement. In addition, please write the measures to reduce the effects of intergranular corrosion and hydrogen embrittlement. **(10%)**

五、(1). Using the data in Table 1, calculate the diffusion coefficient for copper in aluminum at 500°C. **(5%)**

(2). What time will be required at 600°C to produce the same diffusion result (in terms of concentration at a specific point) as for 10 h at 500°C? **(5%)**

Table 1 A Tabulation of Diffusion Data

Diffusing Species	*Host Metal*	$D_0(m^2/s)$	*Activation Energy* Q_d *kJ/mol*	*Activation Energy* Q_d *eV/atom*	*Calculated Value* $T(°C)$	*Calculated Value* $D(m^2/s)$
Fe	α-Fe (BCC)	2.8×10^{-4}	251	2.60	500	3.0×10^{-21}
					900	1.8×10^{-15}
Fe	γ-Fe (FCC)	5.0×10^{-5}	284	2.94	900	1.1×10^{-17}
					1100	7.8×10^{-16}
C	α-Fe	6.2×10^{-7}	80	0.83	500	2.4×10^{-12}
					900	1.7×10^{-10}
C	γ-Fe	2.3×10^{-5}	148	1.53	900	5.9×10^{-12}
					1100	5.3×10^{-11}
Cu	Cu	7.8×10^{-5}	211	2.19	500	4.2×10^{-19}
Zn	Cu	2.4×10^{-5}	189	1.96	500	4.0×10^{-18}
Al	Al	2.3×10^{-4}	144	1.49	500	4.2×10^{-14}
Cu	Al	6.5×10^{-5}	136	1.41	500	4.1×10^{-14}
Mg	Al	1.2×10^{-4}	131	1.35	500	1.9×10^{-13}
Cu	Ni	2.7×10^{-5}	256	2.65	500	1.3×10^{-22}

Source: E. A. Brandes and G. B. Brook (Editors), *Smithells Metals Reference Book*, 7th edition, Butterworth-Heinemann, Oxford, 1992.

六、A cylindrical rod 100 mm long and having a diameter of 10.0 mm is to be deformed using a tensile load of 27,500 N. It must not experience either plastic deformation or a diameter reduction of more than 7.5×10^{-3} mm. Of the materials listed as follows, which materials are possible candidates? Please justify your choice(s). **(10%)**

Materials	Modulus of Elasticity (GPa)	Yield Strength (MPa)	Poisson's Ratio
Aluminum alloy	70	200	0.33
Brass alloy	101	300	0.34
Titanium alloy	107	650	0.34
Steel alloy	207	400	0.30

七、Please completely define the brittle and ductile fractures, and describe the major differences between of brittle and ductile fracture. **(10%)**

注意：背面尚有試題

八、Please briefly define the hardenability and Jominy end-quench test **(6%)**. Furthermore, please use the Figure 1 to construct radial hardness profiles **(4%)** for the following: A 60-mm diameter cylindrical specimen of an 8620 steel alloy that has been quenched in moderately agitated water.

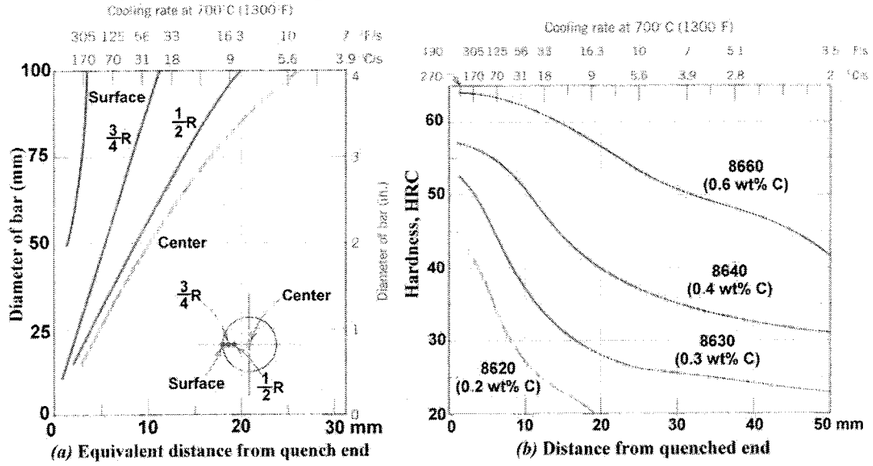


Figure 1 (a) The cooling rates at surface, three-quarter radius (3/4R), midradius (1/2R), and center positions of a water-quenched 60-mm diameter specimen is determined. (b) Hardenability curves for four 8600 series alloys of indicated carbon content.

九、Figure 2 is a portion of the titanium-copper phase diagram for which only single-phase regions are labeled. Specify all temperature-composition points at which eutectoid **(3%)**, peritectic **(3%)** and congruent phase transformation **(4%)** occur. Also, for each, white the reaction upon cooling. For example, there is one eutectic on this phase diagram, which exists about 51 wt% Cu-49 wt% Ti and 960°C. And its reaction upon cooling is: $L \rightarrow Ti_2Cu + TiCu$

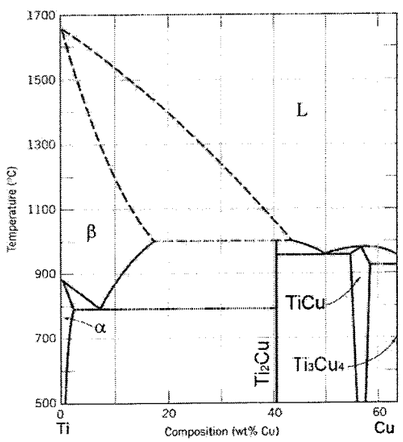


Figure 2 Phase diagram of Ti-Cu alloy