

國立臺北科技大學 105 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

第三節 材料科學與工程導論 試題 (選考)

第一頁 共一頁

注意事項：

1. 本試題共九題，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。

1. (a) Define the term "stiffness" of a material. (3%)
(b) Compare the stiffness of Al and Al_2O_3 . Which one is expected to have the higher stiffness? Why. (4%)
(c) Compare the stiffness of Al and Fe. Which one is expected to have the higher stiffness? Why. (4%)
2. Titanium has the hexagonal close-packed crystal structure. If the c/a ratio is 1.588, atomic radius is 0.145 nm, and atomic mass is 47.87 g/mol. Determine
(a) the density for titanium. (6%)
(b) the planar packing fraction for the $(11\bar{2}0)$ plane. (6%)
(Avogadro constant = 6.022×10^{23} atom/mol)
3. If electroneutrality of each following structure is to be preserved, what kind of point defects would you expect to form?
(a) MgO is added as an impurity to Al_2O_3 ; (4%)
(b) Fe_2O_3 is added as an impurity to MgO; (4%)
4. A 0.25wt% carbon steel is successfully performed a carburizing heat treatment at 950°C in 8 hours. The surface concentration is to be maintained at 1.2 wt% carbon and achieve a carbon content of 0.8 wt% at a position 0.5 mm below the surface. How long will it take to obtain the same diffusion result if we decide to increase the carburizing temperature to 1100°C . Assuming activation energy $Q = 137,700$ J/mol, $D_0 = 2.3 \times 10^{-5}$ m^2/s , and $R = 8.314$ J/mol·K. (12%)

5. (a) Sketch a curve showing the total free energy (including surface and volume free energies) change as a function of the radius of the solid particle for a solid-liquid system during solidification. And explain the meaning of this curve. (8%)
(b) Explain the terms of embryo and nuclei. (6%)
6. A steel contains 93% pearlite and 7% primary cementite (6.67 wt% C) at room temperature. Assuming carbon content at eutectic point is 0.77 wt%.
(a) Estimate the carbon content of the steel. (6%)
(b) Estimate the amount of ferrite phase present at room temperature. (6%)
7. (a) What is meant by the term creep? (3%)
(b) Sketch a typical creep curve of a material obtained by a creep test.
Explain in detail. (6%)
(c) How does the test temperature affect the creep curve? (4%)
8. We would like to produce an extrinsic *p*-type semiconductor based on silicon, which provides a constant electrical conductivity of $1500 \text{ ohm}^{-1} \cdot \text{cm}^{-1}$ over a range of temperatures. Determine the amount of aluminum (at%) required to make the *p*-type semiconductor. The lattice constant of Si is $5.4307 \times 10^{-8} \text{ cm}$, and Si has a diamond cubic structure. The mobility of hole for Si is $480 \text{ cm}^2/\text{V}\cdot\text{s}$. (10%)
9. Ferrite (Fe_3O_4) is a ferrimagnetic ceramic material, which has a spinel crystal structure. Please describe the magnetic behavior of the ferrimagnetic material in terms of magnetic moments of Fe ions. (8%)