(冶金及材料組)

Part I (50%)

1.

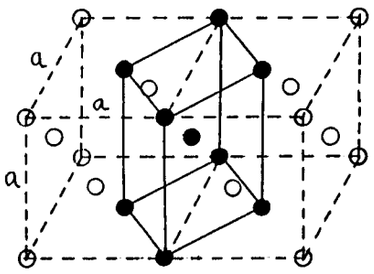

圖 1

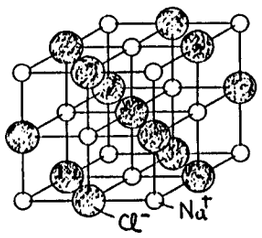

圖 2

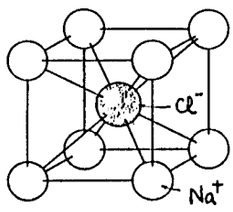

圖 3

(a) 圖1中虛線所構成之結晶為 Face-centered Cubic (FCC), 但同圖若以實線來考慮其結晶為 Body-centered Tetragonal (BCT)。你認為這兩種 Crystal Systems and Bravais Lattices 能否被考慮是獨立的晶系？說明之。 (5%)

(b) 圖2及圖3所顯示者分別是 NaCl 及 CsCl, 說明它們所屬的晶系。 (5%)

2. 圖4所示者為 A、B、C 三成份所構成在某一溫度下之相平衡圖, 而 P 點之成份係由 R、S 及 L 三相所組成。問

(a) R、S 及 L 等三相之化學成份組成 (composition of phase) 各為何？ (5%)

(b) P 點所組成的 R、S、L 三相, 其含量組成 (amount or fraction of phase) 為何？ (5%)

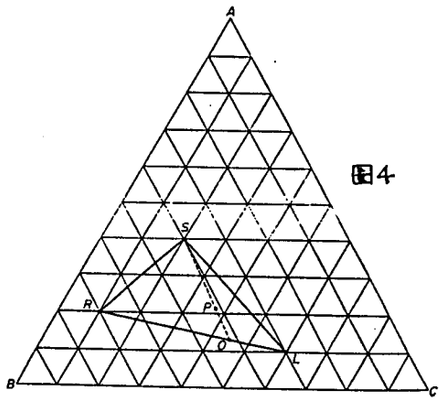

圖4

3. 一金屬鑄錠凝固, 形成典型的 Chill zone, Columnar zone 及 Central zone, 繪圖並解釋其形成之過程。 (10%)

4. 考慮鋼從 Austenite 冷却下來之 T-T-T diagram, 此曲線通常成 C 型或 S 型。(a) 解釋曲線成C或S型之原因 (5%), (b) 何以添加合金元素, 能使曲線向右 Shift (偏移)？ (5%)

5. 有一延性材料圓形試棒受到拉力而產生塑變。問

(a) 圖5顯示開始 Necking 時, 何以 void 總是在試棒之中心位置開始發生？

(b) 試棒最後拉斷 (圖6), 何以破斷面顯示 Cup and cone fracture？ (各5%)

圖5

圖 6

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Part II (50%)

1. The electrical conductivity of ionic crystals at high temperatures is principally due to the diffusion of charged ions. The conductivity σ varies with temperature T as

$$\sigma = \left(\frac{const}{T}\right) D$$

where D is the diffusion coefficient of the mobile ion. The conductivity of ZrO_2 is $3\times10^{-4}(ohm-cm)^{-1}$ at 700°C and $2\times10^{-2}(ohm-cm)^{-1}$ at 1100°C. What is the conductivity at 1000°C? (10%)

2. (a) What is the criterion for necking on a true stress vs. true strain curve? (2%)
   (b) What is the criterion for necking on an engineering stress vs. engineering strain curve? (3%)
   (c) A sample was deformed in tension to a true strain of 0.2 at a true stress of 150 MPa. Find the engineering strain and stress values (assume constant volume deformation). (5%)
   (d) What tensile stress must be applied along the [100] direction in a cubic crystal to cause slip on the system [1$\bar{1}$0](111) if the critical resolved shear stress is 135 MPa? (5%)

3. Suppose that for a copper tensile specimen the dislocation density varies with true strain as $\rho = 10^{10}\epsilon$. If the entire stress-strain curve can be described by a power law $\sigma = \sigma_0 \epsilon^n$, and necking occurs when $\epsilon = n$, What is the true stress at necking? For copper $G_T = 4\times10^{11}$ dynes/cm^2, b (Burgers vector) $= 3\times10^{-8}$ cm, and σ_y (yield strength) $= 10{,}000$ psi. (15%)

4. The grain size of a pure copper sample can be refined (made smaller) by heating it after it has been cold worked. The grain size of a large-grained iron sample can be refined by heating it without any prior cold working. Explain this difference. (10%)