

國立臺灣科技大學103學年度碩士班招生試題

系所組別：材料科學與工程系碩士班丙組

科目：材料導論

(總分為100分)

1. Calculate the bonding energy and bonding length of the $X^+ - Y^-$ by using the attractive and repulsive energies E_A and E_R as below

$$E_A = \frac{-2.59}{r}, E_R = \frac{4.28 \times 10^{-5}}{r^{10}} \quad (10 \text{ points})$$

(Note: unit of r is nm and unit of E_A and E_R are eV)

2. Element Platinum (Pt) is one of well-known materials for catalysts.

(1) Draw the schamitic diagrams and calculate planar densities (PD) for the three basic planes of (100), (110) and (111) for Pt. **(15 points)**

(2) Based on the result of (a), please predict the surface energy order (from small to large) for these three planes and explain why. **(5 points)**

(3) As a materials engineer, please comment which plane (from (100), (110) and (111)) has the highest reactivity for catalysis applications. **(5 points)**

(Hint: Pt has the crystallographic structure of face centered cubic and atomic radius of 0.177nm)

3. The study of failure engineering is a very important for the field of materials science.

(1) Please point out the difference between transgranular and intergranular fractures.

(5 Points)

(2) Describe the structural changes for the fatigues of ductile metal after cyclic stresses **(10 Points)**

4. An n -type semiconductor has band gap energy (E_g) of 2 eV, donor level (E_D) of 0.05 eV and work function (ϕ_s) of 4 eV.

(1) Draw the energy levels of this semiconductor and the dependence of the Fermi energy (E_F) on temperature (T). **[5 points]**

(2) Draw the electron concentration versus temperature ($n_e - T$) curve of this semiconductor and mark different regions of electrical conduction. **[5 points]**

(3) Draw the energy band structures for rectifying contact and ohmic contact between a metal and this semiconductor. **[5 points]**

(4) Draw the current-voltage ($I-V$) curves for ohmic and Schottky contacts. **[5 points]**



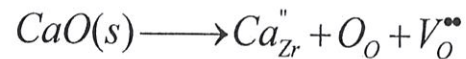
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5. Addition of CaO to ZrO_2 forms a solid solution with cubic fluorite structure. We can write the defect reaction as



- (1) Give definitions of the three products in above reaction. [5 points]
- (2) Write the defect reaction for the addition of Y_2O_3 to ZrO_2 . [5 points]
- (3) Why can the addition of CaO prevent crack of ZrO_2 during cooling? [5 points]

6. The Cu–Ag system is eutectic with maximum solid solubility of 8.8 wt% Cu (for Ag-rich alloy) and 8.0 wt% Ag (for Cu-rich alloy) at the eutectic temperature (779°C). The Si–Ge system is isomorphous. Diffusion couples were made by joining pure Cu to pure Ag and pure Si to pure Ge, respectively. The diffusion couples were held at 700°C for a length of time to allow some solid-state diffusion. Fick's first law of diffusion is $J = -D \cdot dC/dx$.

- (1) Draw the concentration profile $C_{Ag}(x)$ for the Cu–Ag diffusion couple. [5 points]
- (2) Draw the concentration profile $C_{Si}(x)$ for the Si–Ge diffusion couple. [5 points]
- (3) Derive Fick's second law of diffusion. [5 points]

