

國立臺灣科技大學 110 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

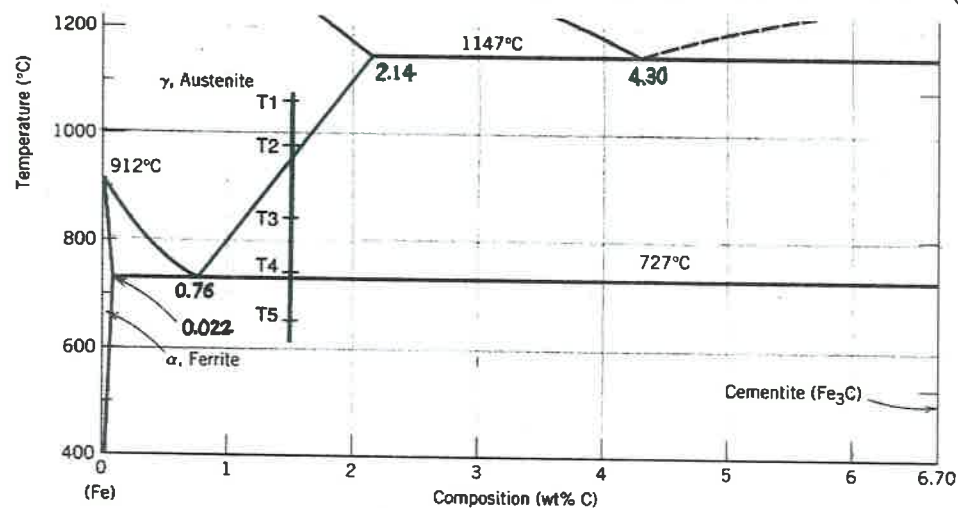
科目：材料導論

(總分為 100 分)

1. (20%)

The simplified Fe-C phase diagram is shown below for the following questions. A carbon-steel alloy containing 1.5wt% C is cooled down slowly from T_1 to T_5 .

- (1) Draw the a_0 - T plot (lattice constant vs. temperature) for the γ phase between T_1 and T_4 , assuming that the thermal expansion coefficient of γ is $0/^\circ\text{C}$. (5%)
- (2) Calculate the weight fraction of the γ phase at T_4 (just above 727°C). (5%)
- (3) Draw the microstructure for the carbon-steel alloy at T_4 and T_5 and indicate all the phases present in the drawings. (5%)
- (4) Describe the differences between the words *eutectic* and *eutectoid*. (5%)



2. (10%)

- (1) Draw the concentration profile $C(x)$ for the Constant Surface Concentration Diffusion at an arbitrary time t_1 . Compare the diffusion fluxes at positions x_1 and x_2 where $x_1 < x_2$. (5%)
- (2) Compare the mechanisms and activation energies for the carbon diffusion in *fcc* iron and the nickel diffusion in *fcc* iron. (5%)

3. (10%)

- (1) Compare the velocity of light in air and in a piece of glass. Also compare the sound velocity in air and in glass. (5%)
- (2) The refractive index of cubic zirconia is 2.1. Calculate the critical angle for Total Internal Reflection of cubic zirconia in air. Also calculate the reflectivity of cubic zirconia in air. (5%)

4. (10%)

- (1) Draw the band diagram for an *n*-type semiconductor and indicate energy levels in the drawing. (5%)
- (2) Draw the $\ln \sigma - 1/T$ plot for an *n*-type semiconductor over a wide range of temperature, where the σ is electrical conductivity. Correlate the slopes in the drawing with the band gap or energy levels. (5%)



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5. (Total:20 %) (1) Please provide the definitions of Frenkel defect (5 %) and Schottky defect (5 %). (2) Use MgO as an example material to draw the corresponding images for Frenkel defect and Schottky defect (10 %)
6. (Total:15 %) The metal aluminum has a FCC crystal structure. If the diffraction angle of two theta (2θ) for the (111) and (311) planes are 39.06° and 78.82° , when monochromatic X-radiation having a wave length of 0.15405nm is used, (1) compute the interplanar spacing (d-spacing) for the (111) and (311) planes and (5 %) (2) the two estimated lattice parameter values according to (111) and (311) planes (5 %). (3) Which value (from (111) or (311)) is more precise? (2 %) and Why? (3 %).
7. (Total:15 %) Two plants are prepared form the X alloy and Z ceramic, and their fracture toughness values are 60 and $5\text{MPa}\sqrt{\text{m}}$. The alloy and ceramic plates are exposed to the same tensile stress of 375MPa . (1) Please determine the minimum length of surface cracks for this alloy and ceramic. Assume the value of 1.5 for Y dimensionless constant (10 %). (2) Which crack is longer and why (5 %)?

