

國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別： 工程技術研究所碩士班
材料科技學程

組別：甲組、乙組

科目：材料導論

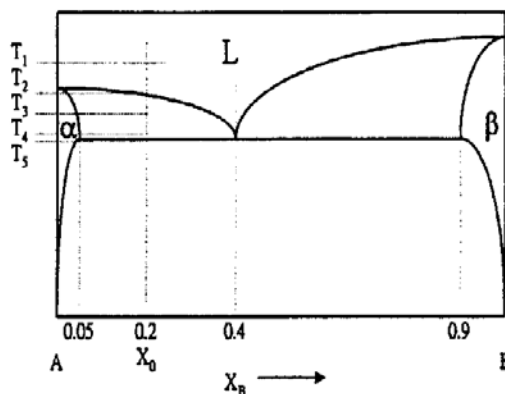
共 100 分

1. (20%)

Figure 1 shows a binary eutectic phase diagram on which an alloy of overall composition $X_0=0.2$ is gradually cooled from temperature T_1 to T_5 . (T_5 is just below the eutectic temperature.)

- Determine the total fraction of α phase in the alloy at temperature T_5 . (5 分)
- Sketch the microstructure at temperature T_5 and label all the phases. (5 分)
- Sketch equilibrium cooling curve (temperature versus time) for alloy X_0 and put related temperature points in your drawing. (5 分)
- Draw the free energy curves for each of the phases in the above eutectic system at T_5 . Label all the phases. (Plot mole fraction along the ordinate versus free energy along the abscissa.) (5 分)

Figure 1



2. (10%)

- Calculate the Atomic Packing Factor (APF) of the face-centered cubic (FCC) crystal structure. (hint: $APF = [\text{volume of atoms in the unit cell}] / [\text{volume of unit cell}]$) (5 分)
- Determine whether it is possible for a boron atom to fit into a tetrahedral site in FCC aluminum. Atomic radii of boron and aluminum are 0.46 Å and 1.43 Å, respectively. (5 分)

3. (10%)

- Which crystal plane will appear as the first X-ray diffraction peak of FCC aluminum? (3 分)
- Calculate the diffraction angle of the peak in above question. (Atomic radius of aluminum is 1.43 Å. The wavelength of X-ray irradiation is 1.54 Å.) (7 分)

4. (20%)

- Two silica glasses (SiO_2) containing 5 wt% and 10 wt% soda (Na_2O) are studied. How will their glass transition temperature compare? Why? (7 分)
- Two amorphous polymers, A and B have the same molecular weight but different glass transition temperatures. How will their elastic modulus values compare? Why? (7 分)
- Compare the Degree of Crystallization of polyethylene $[\text{C}_2\text{H}_4]_n$, polypropylene $[\text{C}_2\text{H}_5(\text{CH}_3)]_n$ and polystyrene $[\text{C}_2\text{H}_5(\text{C}_6\text{H}_5)]_n$. (6 分)

5. (10%)

- Suppose a metal, semiconductor and an insulator all have the same resistance at 20°C. Which material will have the highest resistance at 50°C? (5 分)
- Plot resistivity versus temperature diagram of a superconductor. (5 分)

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6. (10%)

What is a Light Emitting Diode and how does it work? (10 分)

7. (10%)

(A) Which of the following dielectric materials will achieve the highest charge density in a simple parallel plate capacitor at room temperature: diamond (C), quartz (SiO_2), barium titanate (BaTiO_3) or HDPE (C_2H_4)_n?

(4 分)

(B) What is the polarization mechanism of the dielectric material you just selected? (6 分)

8. (10%)

Diamond and copper are the best heat conductors in nature. Explain the mechanism of their high thermal conductivity. (10 分)