國立台灣科技大學九十七學年度碩士班招生試題

系所組別： 材料科技研究所碩士班

科　　目： 材料導論

材料導論；共 8 大題，總分 100 分；請於答案卷內依序作答。

1. Compute the atomic packing factor for the rock salt crystal structure in which $r_c/r_a = 0.414$. (10%)

2. (a) Calculate the number of lattice sites for the Silver chloride. (b) Calculate the number of Frenkel defects per cubic meter in AgCl at 350°C. The energy for defect formation is 1.1 eV. The density of AgCl is 5.5 g/cm^3. The atomic weights of Ag and Cl are 107.87 and 35.45 g/mol, respectively. (15%)

3. Compare the temperature dependence of the (a) conductivity and (b) carrier concentration for metals and intrinsic semiconductors. (10%)

4. Compare thermal conductivity of a metal in crystalline state and in amorphous state. (5%)

5. Calculate the temperature at which there is 5% probability that an electron will occupy an energy state of 0.4 eV above the Fermi energy. (Boltzmann constant: 1.38×10^{-23} J/K, 1 eV=1.6×10^{-19} J) (10%)

6. Below the superconducting transition temperature (T_c), a superconductor has an energy gap in the excitation spectrum that prevents the scattering of electrons and produces zero electrical resistance. The 1957 theory of John Bardeen, Leon Cooper, and J. Robert Schrieffer (BSC) used a very elegant formula to predict the dependence of T_c on two fundamental constants (Boltzmann's constant k_B and Planck's constant $\hbar$) and three basic materials parameters:

$$k_B T_c = 1.13\,\hbar\,w_D \exp[-1/VN(E_F)],$$

where $\hbar\,w_D$ is the characteristic phonon energy, $N(E_F)$ is the electronic density of states, and V is the electron-electron attractive interaction arising from the electron-phonon interaction.

(a) Based on this formula, why should one search for new superconductors from lighter-element and transition-metal compounds? (10%)

(b) The simple binary compound, magnesium diboride (MgB_2), is a newly found superconductor by Jun Akimitsu et al. in 2001. Explain its high T_c at 40K. (15%)

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7. What is the Gibbs phase rule? (5 %)
8. In Fig.1, the point X is in the three-phase region, and in this tie triangle consists of α, β, and γ. What is the composition of the point X in Fig. 1? Can you calculate the degree of freedom in this three-phase region? Meanwhile, can you use the lever rule to determine the relative amount for point X in terms of α, β, and γ. Then, use this proportion to recalculate the composition of point X in terms of A, B, and C again. The answer is the same that you obtained previously. (20 %)

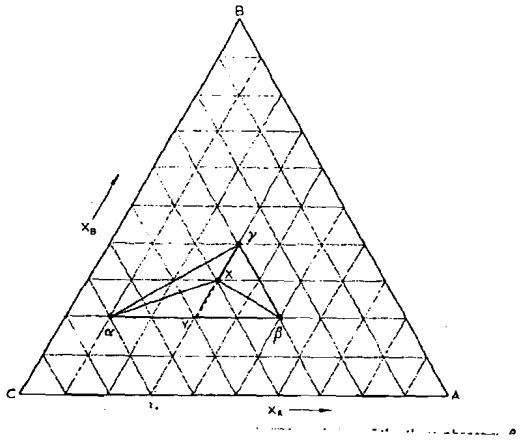

Fig.1 The isothermal section of the A-B-C ternary system.