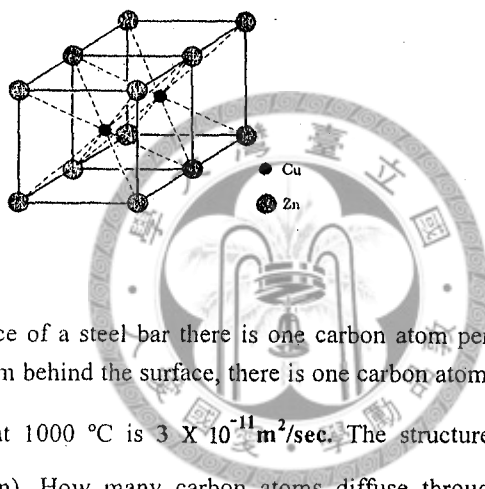


1. (a) White tin has a body-centered tetragonal structure with atoms at $0, 0, 0$; $1/2, 1/2, 1/2$; $1/2, 0, 1/4$; $0, 1/2, 3/4$. Show that the second and third sites above are not equivalent, but the third and fourth sites are equivalent. (5%)
 (b) Calculate the minimum cation-to-anion radius for a coordination number of 8. (5%)
2. A β' -brass is nominally an intermetallic compound, CuZn , with the simple cubic structure as show below. It may also be called a partially ordered solid solution, particularly since it is nonstoichiometric with a range of 46 to 50 **atomic percent (a/o)** of Zn at 450 °C. Assume 90% of the $1/2, 1/2, 1/2$ sites of the unit cell are occupied by Cu atom in **46Zn-54Cu (a/o)** alloy. What percent of $0, 0, 0$ sites are occupied by Cu atoms? (10%)



3. At the surface of a steel bar there is one carbon atom per 20 unit cells of iron crystal. 1 mm behind the surface, there is one carbon atom per 30 unit cells. The diffusivity at 1000 °C is $3 \times 10^{-11} \text{ m}^2/\text{sec}$. The structure is FCC at 1000 °C ($a=0.365 \text{ nm}$). How many carbon atoms diffuse through each unit cell per minute? (10%)
4. (a) Calculate the magnitude of $\frac{1}{3} [\bar{1} 0 1 0]$ in term of lattice parameters of hexagonal crystal. (5%)
 (b) Comment on the following statement. **Deformation by slip involves a shear of a specific magnitude, which reorients a part of the parent into a mirror orientation.** Is the statement right or wrong? Give your reason and explain. (5%)
5. (a) Plot a phase diagram to show that a substitutional solid solution (α) can be formed in all proportions of both solvent (A) and solute (B) atoms in a binary system. (5%)
 (b) Derive the lever rule using the figure drawn in the above question 5 (a). (5%)
6. (a) Briefly describe the principle of the light-emitting diode (LED). (5%)
 (b) The mean free paths of electrons in semiconductors are shortened at higher temperatures. However, this effect of temperature on conductivity can only be detected in the exhaustion (or saturation) region. Explain why? (5%)

7. (a) Give three reasons to explain why a much greater resistance to plastic deformation occurs in crystalline ceramics than in crystalline metals. (5%)
(b) Briefly explain why some transparent materials appear colored while others are colorless. (5%)
8. (a) Explain the relationship between transducers and piezoelectric materials. (5%)
(b) The zinc blende crystal structure is one that may be generated from close-packed planes of anions.
① Will the stacking sequence for this structure be FCC or HCP? Why?
② Will cations fill tetrahedral or octahedral positions? Why?
③ What fraction of the positions will be occupied? (5%)
9. (a) List two important characteristics for polymers that are to be used in fiber applications. (5%)
(b) Why must fiber materials that are melt spun and then drawn be thermosetting or thermoplastic? Cite two reasons. (5%)
10. (a) What is the principal difference between natural and artificial aging processes? (5%)
(b) Highly deformed copper (80% cold work) recrystallizes at lower temperatures than slightly deformed copper (20% cold work). Explain why. (5%)