MT 250 Metallurgical Concepts

Physical Metallurgy

Home Assignment 2 (Due 15.9.2003)

1. Calculate the packing fraction in the simple cubic, *bcc* and *fcc* structures, by assuming that the atoms occupying the lattice sites are spherical in shape.

2. Sketch the CsCl, NaCl and diamond cubic structures. For each, identify the Bravais lattice.

3. Calculate the size of the largest atom which can fit into the triangular, tetrahedral and octahedral voids in a *fcc* structure. For each void type, calculate the packing factor when all the voids of that type are occupied.

4. In a table, list the planes which give rise to the first 10 peaks in a powder diffraction pattern for each of the following structures:
   a. fcc
   b. bcc
   c. simple cubic

   Each table should contain at least the following information for each peak p: (i) $(hkl)_p$, (ii) d_p and (iii) d_p^2/d_1^2.

5. Calculate the diffraction angle (2θ) for the first four peaks of *fcc* Al ($a = 0.404$ nm) using Cu-K_α radiation of wavelength $\lambda = 0.1542$ nm.

6. Calculate the c/a ratio for an ideal *hcp* crystal. What would be the (*hkil*) indices for the three lowest diffraction angle peaks for this crystal?

7. For gold, ΔH_v, the vacancy formation energy is about 1 eV per vacancy. If the vacancy concentration at the melting point of gold is about 10^{-4}, determine the temperature at which the vacancy concentration will be (a) 5×10^{-5} and (b) 10^{-8}.