MT 250 Metallurgical Concepts

Physical Metallurgy

Home Assignment 4 (Due 20.10.2003)

1. In the Ag-Cu phase diagram
   (a) Identify the points/lines in this diagram where the number of degrees of freedom (in the modified Gibbs phase rule for condensed systems) is zero.
   (b) At 800 C, identify the phases in an equilibrated alloy with 15 weight % Cu. Also, estimate the amount of each phase in this alloy.
   (c) At 600and 800 C, identify the phases in an equilibrated alloy with 70 weight % Cu.

2. The Bravais lattice of sodium chloride (NaCl) is *fcc*, with Cl^- ions occupying the lattice sites, and Na^+ ions occupying the octahedral void sites. Draw a schematic of one unit cell of NaCl structure.
   Calculate the packing factor, assuming the ionic radii of Na^+ and Cl^- ions to be 0.097 and 0.181 nm, respectively.

3. The activation energy Q for diffusion of Al in Cu is 43×10^3 cal mol^{-1}. If the diffusion coefficient (D) of Al in Cu at 773 K is $D_{773} = 2.6 \times 10^{-17}$ m^{2}s^{-1},
   (a) calculate the temperature T at which $D_T = 2D_{773}$.
   (b) calculate D at 1000 K.

4. When cooled rapidly from near the melting point, aluminium at room temperature has a density of 2.698×10^3 kg m^{-3}. Compare this value with the theoretical density calculated using the room temperature lattice parameter of $a = 0.4049$ nm. What is this difference in densities due to?

5. A sheet of copper (whose melting point is 1084 ° C) is rolled at room temperature to reduce its thickness by more than 50 %. Three samples from this rolled sheet are annealed for one hour at 200, 500 and 800 ° C. Compare the three samples in terms of (a) grain size
   (b) grain shape
   (c) hardness.
   (d) Draw schematic microstructures of the three samples.

6. Sketch the Arrhenius plots depicting the temperature dependence of volume (bulk) diffusivity, grain boundary diffusivity and surface diffusivity. What are the main differences in the behaviour of these three diffusivities?