

3.40J/22.71J  
Problem set 4  
Physical Metallurgy

Problem set 4 Due 27 April 2004, either in class or on line

Problem 1. Consider homogeneous nucleation in a solid solution with the physical properties of copper. Assume spherical nuclei which are nearly pure solute. The solubility of some solute is 0.1 a/a at 1000K. Assume a pre-exponent in the solubility equation of unity. From this you can get the solubility at any temperature.

Below plot the natural logarithm of  $\Delta G^*/kT$  for the temperature range  $200K < T < 800K$ . Indicate the temperature range for which  $\Delta G^*/kT < 60$ , and that according to my ROT nucleation should occur at an observable rate.

Consider the following three cases.

a. Incoherent nucleation with no strain energy. Assume that the particle: matrix interfacial energy is  $0.5 \text{ J/m}^2$  (typical of an incoherent grain boundary). COMMENT on your answer.

b. Repeat a for homogeneous coherent nucleation with a particle: matrix interfacial energy is  $0.1 \text{ J/m}^2$  (typical of a coherent interface). Assume that there is no strain energy. COMMENT on your answer.

c. Repeat b, except that there is a strain energy corresponding to  $\Delta a/a = 0.04$  and for  $\Delta a/a = 0.4$ . COMMENT on your answers. Compare the results of the **FOUR** calculations.

Problem 2. Do problems 6.5, 6.6 in Reed-Hill and Abbaschian.