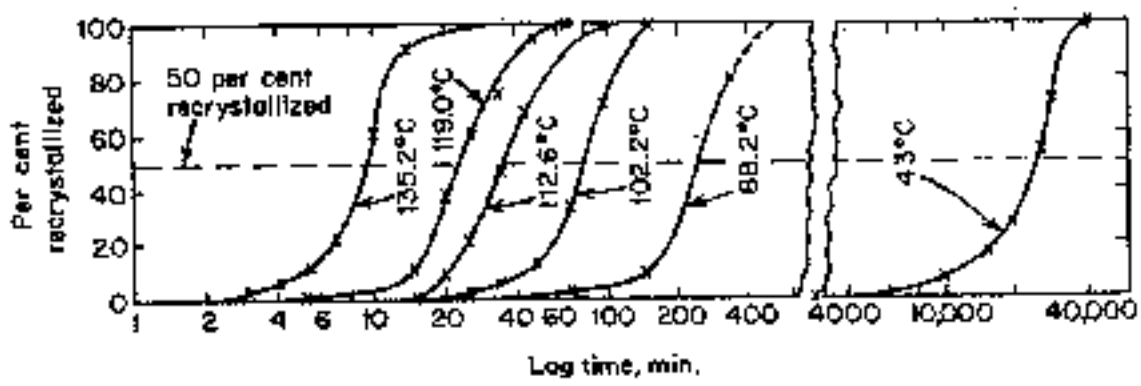
國 立 清 華 大 學 命 題 紙

八十四學年度核子工程與工程物理所＿＿＿組碩士班研究生入學考試

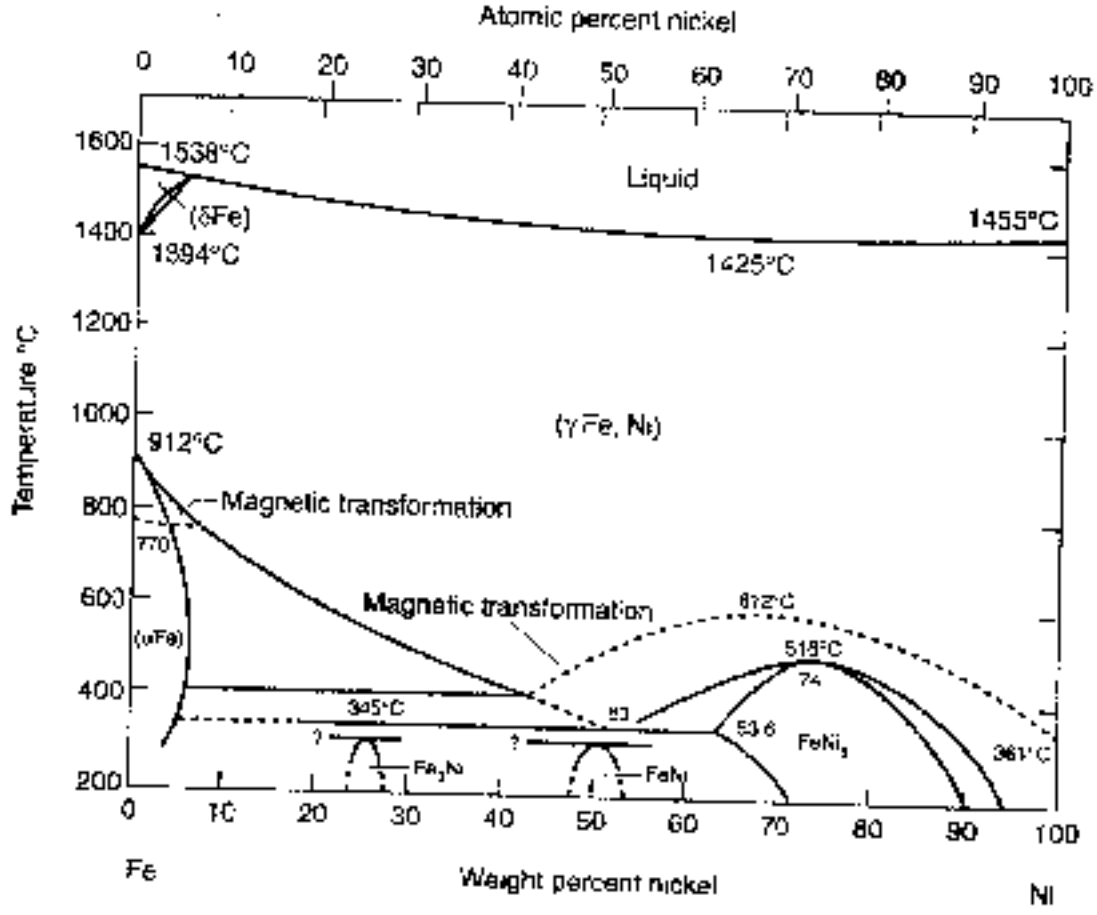
科目物理冶金 科號 331 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. (a) It has been estimated that the enhalpy for the formation of self-intersitial atoms in Cu is about 385 kJ/mole and for the formation of vacancy in Cu is about 83.7 kJ/mole. Compute the equilibrium concentrations of interstitial and vacancy, respectively, in Cu at 900°C.
(b) The activation enthalpy for the movement of the self-interstitial atoms in Cu is believed to be about 9.64 kJ/mole and for vacancy to be about 121 kJ/mole. Estimate the jump frequency of interstitial and vacancy, respectively, at 1000°K. (20%)

2. The following figure shows the isothermal recrystallization curves for pure Cu (99.999%) cold-rolled 98%.
(a) Use the data in the figure to determine the activation energy Q and the preexponential constant A in the rate equation for recrystallization.
(b) Determine the recrystallization temperature for the Cu.
(c) How long would it take to completely recrystalize the Cu at room temperature. (20%)



3. Consider the Fe-Ni peritectic transformation in the following figure.
(a) What are the compositions and weight percentages of the phases just above the peritetic temperature (1512°C)?
(b) Answer the same question with regard to a temperature just below the peritetic temperature.
(c) What phases are in equilibrium at the peritetic temperature and what relationship exists between the partial-molal free energies of these phases at this temperature?
(d) Sketch the relationship that must exist between the free energy versus composition curves of these phases at 1512°C.
(e) Make two additional sketches for the free-energy-composition curves of the system corresponding to a temperature about 25°C above and 25°C below 1512°C. (25%)



4. It is determined by experiment that the Kirkendall markers placed at the interface of a diffusion couple, formed by welding a thin plate of metal A to a similar plate of metal B, move with a velocity of 4.5×10^{-12}m/s toward the A component when the concentration $N_A=0.38$ and the concentration gradient, dn_A/dx, is 3.0×10^{2} per meter. The chemical diffusion coefficient $\boldsymbol{D}$ under these conditions is 3.5×10^{-14}m^2/s. Determine the values of the intrinsic diffusivities of the two components. (15%)

5. In the case of pure Ag, the maximum supercooling that has been observed is 227 degrees.
(a) Determine the homogeneous nucleation rate in Ag for this degree of supercooling using the following data.
(b) Determine the homogeneous nucleation rate when Ag is supercooled by 20 degrees.
(c) Determine the heterogeneous nucleation rate when Ag is supercooled 20 degrees.
(d) Discuss the difference between the heterogeneous and the homogeneous nucleation rates in terms of freezing at 20 degrees of supercooling. (20%)

$a=0.417$nm, $\upsilon=10^{13}$Hz, $T_m=1235$°K, $N=6.023\times10^{23}$atoms/mol,
$\gamma_{ls}=0.123$J/m^2, $\Delta g_a=6.4\times10^{-20}$J, $\Delta H_{le}=11,960$J/mol,
$I_{hom}=\upsilon N\exp[-(\Delta g_a+A/\Delta T^2)/kT]$, $A=4\eta^3\gamma_{ls}^3T_m^2/27(\Delta h_{lm})^2$
$I_{het}=\upsilon N^m\exp[-(\Delta g_a+\Delta G_c^{het})/kT]$, $\Delta G_c^{het}=(2-3\cos\theta+\cos^2\theta)A/4\Delta T^2$,
$N^m=1.45\times10^{19}$atoms/m^2