

ELEC-D8710 Principles of materials science

2nd midterm exam 5.4.2018

1. Figure 1 shows the binary eutectic Ag-Cu phase diagram and $g-x_{Cu}$ diagram at 850°C.
 - a) Explain how the phase equilibria at 850°C (observed from the phase diagram) is based on (or derived from) the Gibbs energy diagram. (3p)
 - b) What can you say about the mutual interaction between Ag and Cu in Fcc phase? (1p)
 - c) Explain shortly what is chemical potential $[\mu_i^\phi]$ (i.e. partial molar Gibbs free energy of component i in phase ϕ) and how μ_{Ag}^{Liq} and μ_{Cu}^{Liq} can be (graphically) defined from the $g-x_{Cu}$ diagram at 850°C, when the nominal composition of the alloy is 40 at-% Cu?(1p)

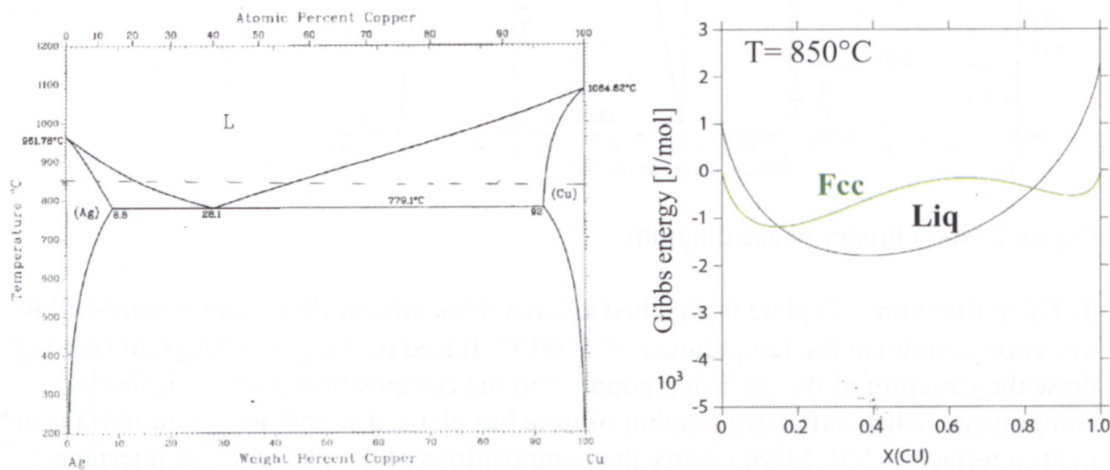


Figure 1 a) Binary Ag-Cu phase diagram and b) $g-x_{Cu}$ diagram from Ag-Cu system at 850°C

2. Figure 2 shows the Ni-Ti (Nickel-Titanium) phase diagram. With the help of the diagram answer following questions:
 - a) What can you say about the solubility of Nickel to Titanium and Titanium to Nickel at temperatures from 600°C to 900°C? (1p)
 - b) Explain the equilibrium ($D_{Liq}=D_{solid}=\infty$) solidification (i.e. the compositions and amounts of phases as a function of temperature) from 1800°C to 600°C when the nominal composition of the alloy is Ti80Ni20 (at-%). You need to include in your answer **at least** following details. i) What is the composition of the solid phase when first solid crystals nucleate from the liquid and at what temperature this occurs? ii) What is the composition of the liquid just before it is completely solidified? iii) What phases are in equilibrium at 850°C and 750°C, what are the compositions and relative amounts of the phases at these temperatures? (4p)

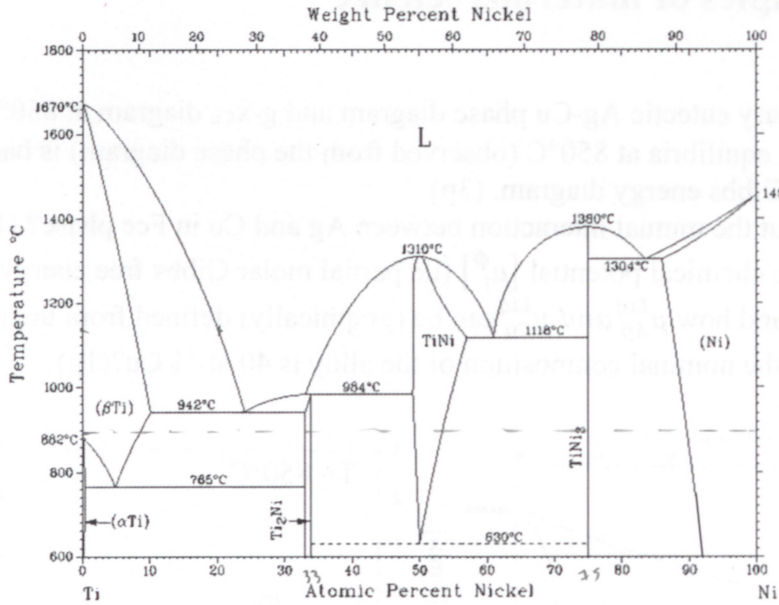


Figure 2 Ni-Ti binary phase diagram

3. Thick titanium (Ti) plate is attached against thick silicon (Si) wafer (=semi-infinite diffusion couple) at the temperature of 1200°C. Based on the phase diagram (see Fig. 3) draw the structure of the diffusion couple and the composition profiles for both components, when sufficient amount of time has elapsed so that local equilibria is achieved in all interfaces. (NB. Mark clearly the compositions of the phases at all interfaces!) In addition, explain shortly what happens if the temperature is then decreased down to 800°C (5p)

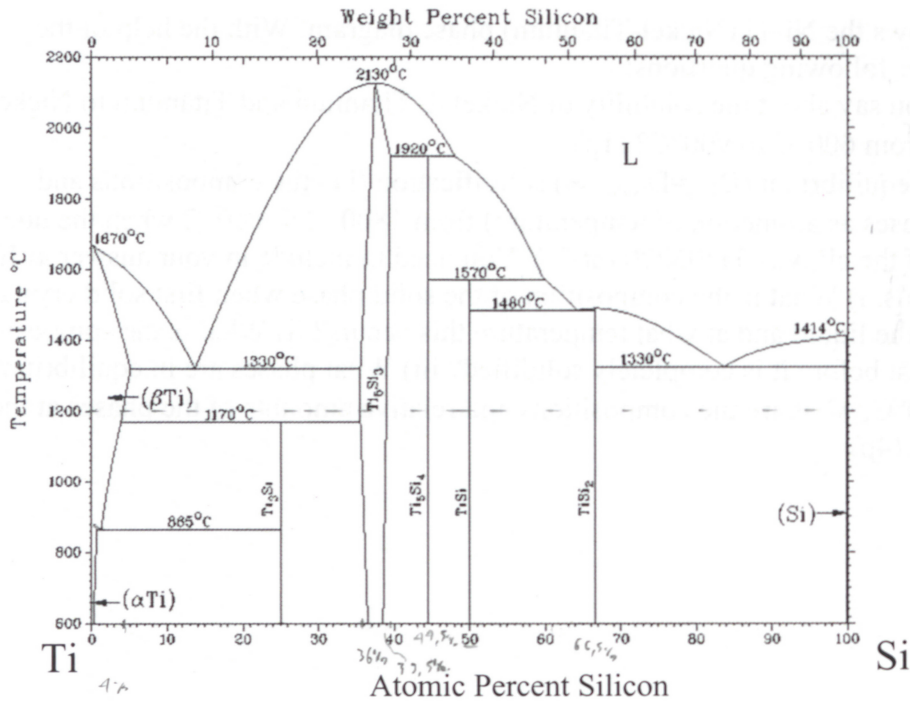


Figure 3 Ti-Si binary phase diagram [The phases in the Ti-Si system are: L(liquid), αTi, βTi, Si (diamond), Ti₃Si, Ti₅Si₃, Ti₅Si₄, TiSi and TiSi₂]