ELEC-D8710 Principles of materials science **Intermediate Exam II**
9.4.2020

1. Figure 1 shows a) the experimentally determined In-Sn binary phase diagram (NB. the dashed lines represent uncertain equilibria) and b) Gibbs energy - composition diagram at 50°C. Based on the diagrams please answer following questions:

a) What is the solubility of Tin in tetragonal Indium at room temperature? (1p)

b) If the nominal composition of the SnIn alloy is x_{Sn}=0.6 and T=50°C, what phases are in equilibrium, what are their compositions and what are their relative amounts (fractions)? (3p)

c) Please explain, how the above mentioned equilibrium (x_{Sn}=0.6 and T=50°C) can be determined from the Gibbs energy - composition diagram (Figure 1 b) and show graphically, what is the chemical potential of Sn in β - and γ- phases (μ_{Sn}^{β} *and* μ_{Sn}^{γ}) in that equilibrium. (2p)

d) Explain the equilibrium (D_{Liq}=D_{solid}=∞) solidification (i.e. the compositions and amounts/fractions of phases as a function of temperature) from 250°C to 25°C when the nominal composition of the alloy is x_{Sn}=0.75. (2p)

e) Please discuss, how the solidification of the same alloy (x_{Sn}=0.75) could differ, if microsegregation (D_{Liq}=∞ and D_{solid}=0) would occur? (1p)

2. Thick single crystalline Tin (Sn) and Indium (In) metal plates are attached against each other (=semi-infinite diffusion couple) at the temperature of 100°C.

a) Based on the phase diagram (see. Fig. 1a), draw the structure of the diffusion couple with superimposed composition profile for Indium, 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!) (3p)

b) Please discuss on the possible diffusion mechanisms and types in that diffusion couple? (1p)

c) Based on the Gibbs energy - composition diagram (see Figure 2) define the driving force for Sn to diffuse through γ phase (i.e from Sn|γ interface to γ|β interface) at 100°C. (2p)

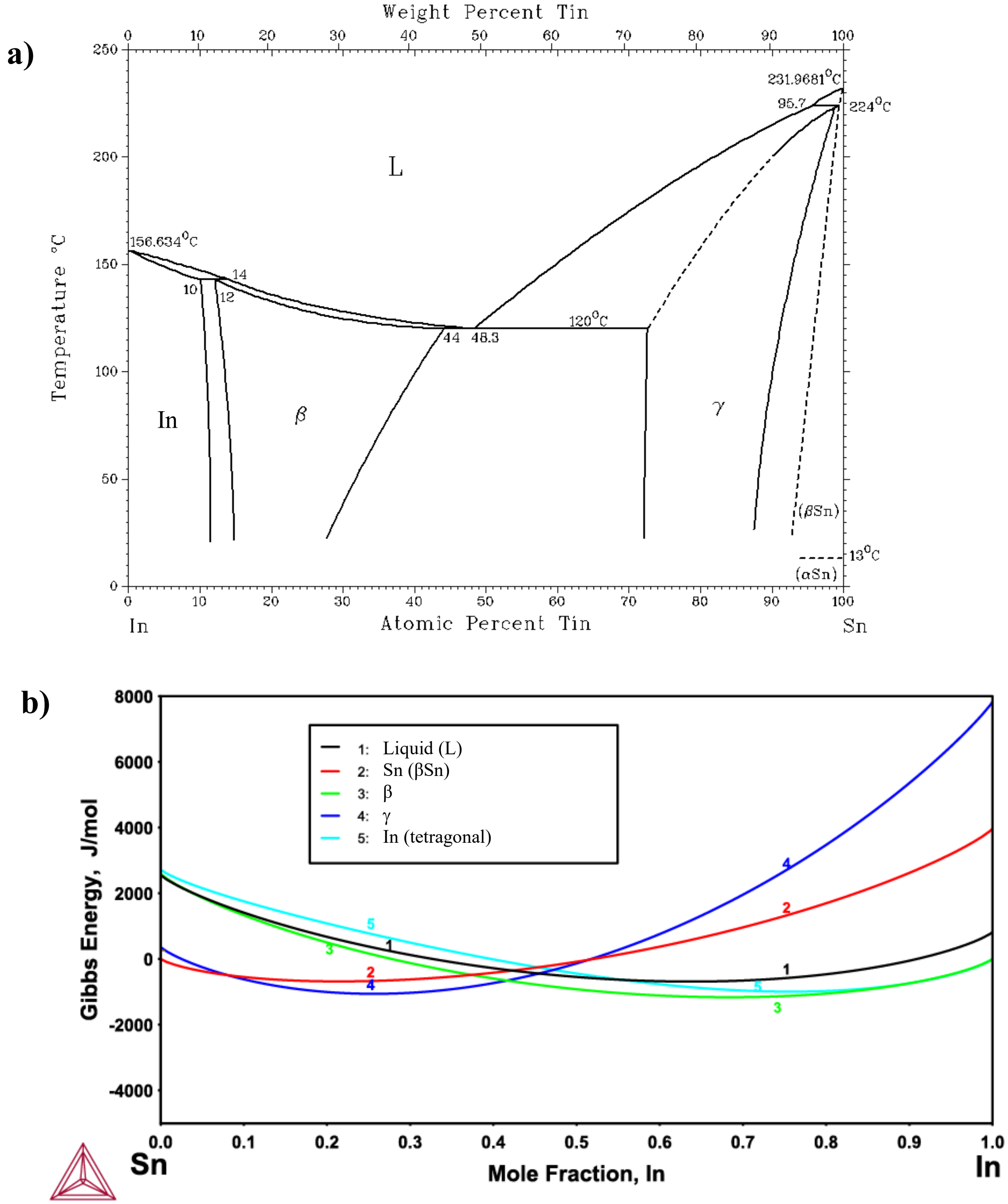

Figure 1 a) In-Sn binary phase diagram and b) Gibbs energy - composition diagram at 50°C.

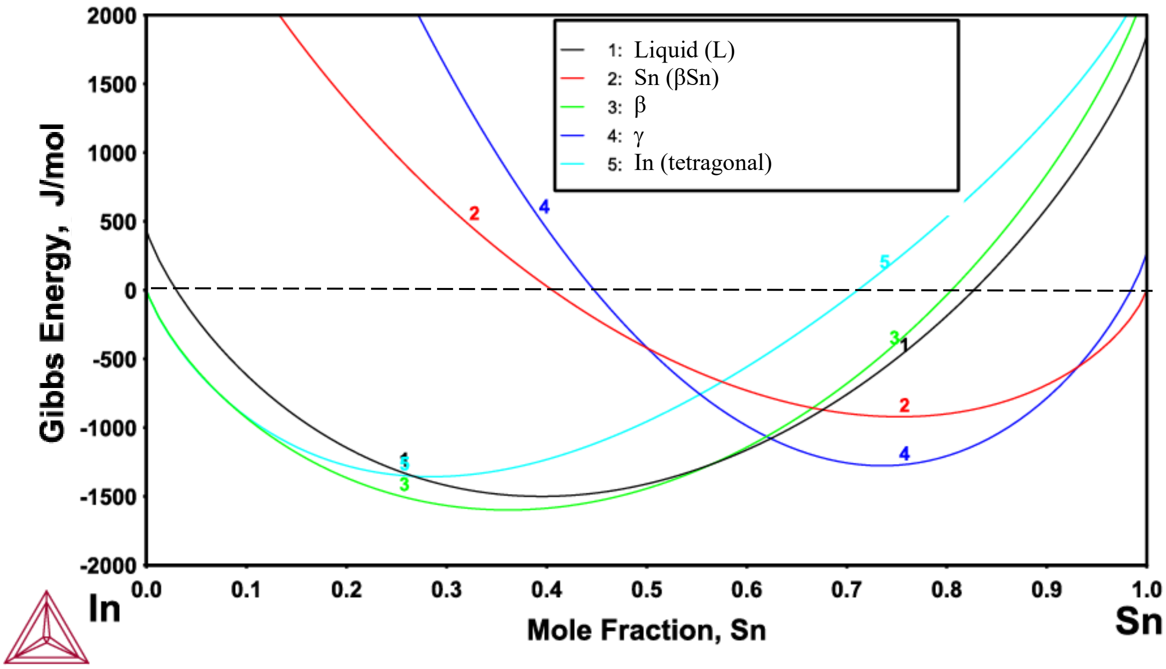

Figure 2. Gibbs energy - composition diagram at 100°C from Sn-In system