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

22.4.2024

1. Figure 1 shows Gibbs energy - composition diagrams from hypothetical eutectic A-B system at different temperatures.(NB $T_{eut}=T_4$) Based on this data:

a) Construct the binary phase diagram. (2p)

b) Estimate the composition of the eutectic point. Explain briefly, how you obtained the value. (1p)

c) Show graphically what is the chemical potential of A and B in α- and β- phases (i.e $\mu_A^\alpha, \mu_A^\beta, \mu_B^\alpha, \mu_B^\beta$), when $T=T_5$ and $x_B=0.5$. (2p)

NB! You can used the attached template to give your answers, add your name and student number.

2. Co-based alloys are commonly used for implants. Based on the Co-Mo phase diagram shown in Fig. 2:

a) What is the solubility of Molybdenum in αCobalt and Cobalt in Molybdenum at 1300°C? (1p)

b) If the nominal composition of the CoMo alloy is $x_{Co}=0.6$ and T=800°C, what phases are in equilibrium and what are their compositions and relative amounts? (2p)

c) Please explain the equilibrium ($D_{Liq}=D_{solid}=\infty$) solidification (i.e. the compositions and amounts of phases as a function of temperature) from 2800°C to 400°C when the nominal composition of the alloy is $x_{Mo}=0.95$. (2p)

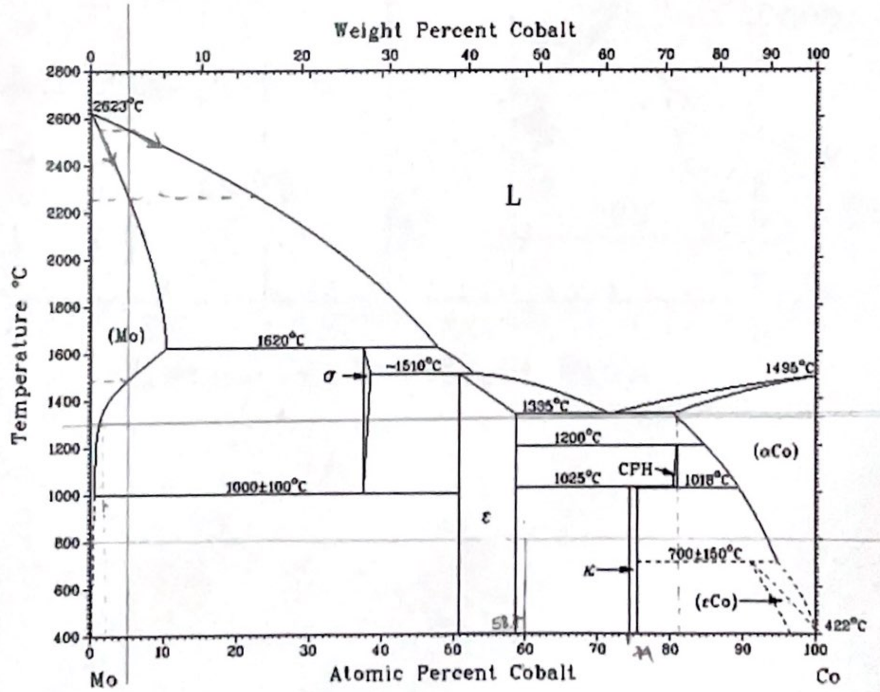

Figure 2 Co-Mo binary phase diagram (NB. The dashed lines indicate equilibria that is not defined unambiguously)

3. Thick Cobalt (Co) and Titanium (Ti) metal plates are attached against each other (=semi-infinite diffusion couple) at the temperature of 900°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, please explain briefly how the structure of the diffusion couple is changed if the temperature is then decreased down to 750°C? (4+1p)

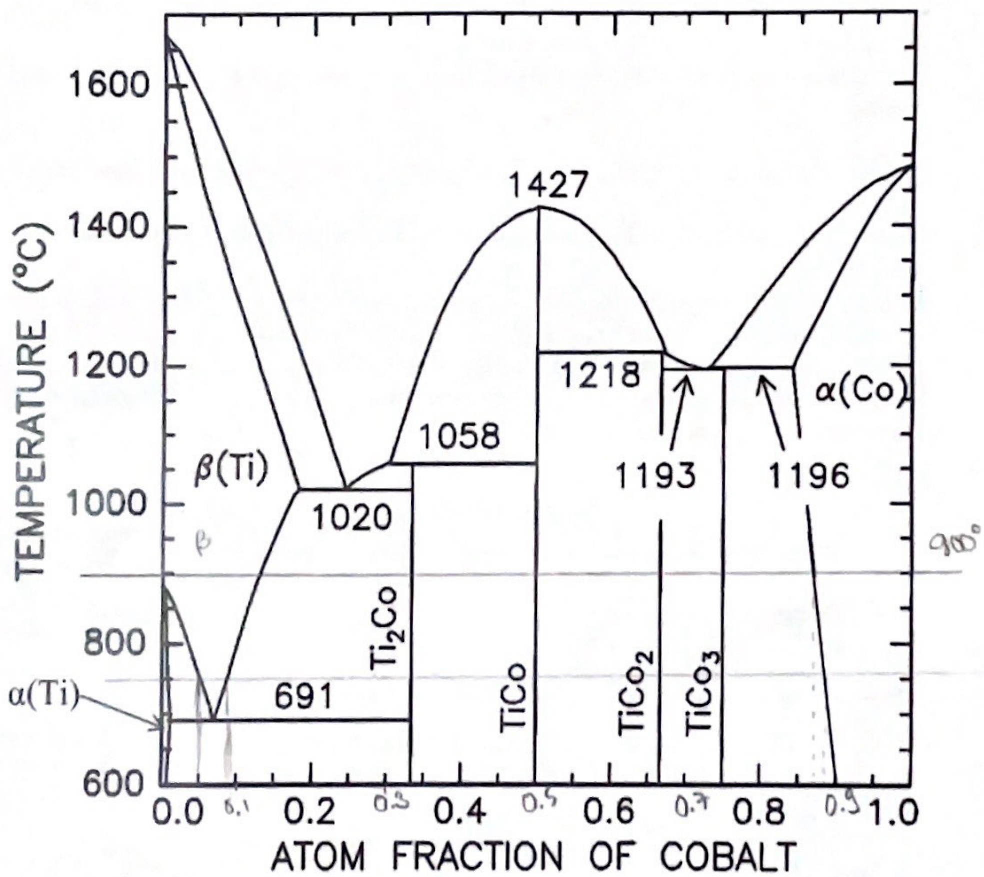

Figure 3 Ti-Co binary phase diagram

β(Ti) Ti2CO TiCO