**MSEG HW#8 Spring 2018**

**1. Determine the compositions of the phases present, and if more than one, their relative amounts (in terms of mass fractions), for the following alloys and temperatures:**

**a) 15 wt% Sn – 85 wt% Pb at 100 C**

**b) 25 wt% Pb-75 wt% Mg at 425 C**

**c) 85 wt% Ag- 15 wt% Cu at 800 C**

**d) 55 wt% Zn-45 wt% Cu at 600 C**

**e) 1.25 kg Sn and 1.4 kg Pb at 200 C**

**f) 7.6 kg Cu and 144.4 kg Zn at 600 C**

**g) 21.7 mol Mg and 35.4 mol Pb at 350 C**

**h) 4.2 mol Cu and 1.1 mol Ag at 900 C**

a) Pb-Sn phase diagram is Figure 9.8. At 100 C, composition C0 of 15 wt% Sn is in the alpha-beta two phase region, closer to the alpha phase so it will be majority phase present. Amount of alpha phase Wa = Co-Cb / (Ca-Cb), where C0 is the overall composition, Ca is composition of the alpha phase (Ca= 5% from phase diagram), and Cb is the composition of the beta phase (98% Sn from phase diagram). So Wa = 89%, Wb = 100-Wa = 11%.

b) Pb-Mg phase diagram is Figure 9.20. At 25% Pb and 425 C, is in the single phase alpha region. So phase = alpha (100%), with 25 wt% Pb.

c) Cu-Ag phase diagram is Figure 9.7. At 85 wt% Ag and 800 C, is beta + liquid. Amount of beta and liquid about the same. Composition of liquid = 76wt% Ag-24wt% Cu, Composition of beta = 93wt% Ag-7wt% Cu. Amount of liquid = 93-85/(93-76) = 47 wt%. Amount of beta = 100-WL = 53wt%

d) Zn-Cu phase diagram is Figure 9.19. At 600 C, 55 wt% Zn is beta + gamma. Composition of beta = 51 wt% Zn-49wt%Cu, composition of gamma = 58 wt% Zn-42 wt% Cu. Amount of beta Wb = (58-55)/(58-51) = 43 wt%, so amount of gamma = 100-43 = 57 wt%.

e) Total mass is 1.25 + 1.4 kg = 2.65 kg. Wt fraction Sn = 1.25 / 2.65 = 47 wt%. So Pb = 53 wt%. At 200 C, Figure 9.8 gives alpha + liquid. Composition of alpha = 17 wt % Sn, composition of liquid = 56 wt% Sn. Amount of alpha = (56-47)/(56-17) = 23 wt%. So liquid = 100-23 = 77 wt%.

f) Total mass is 7.6 + 144.4 = 152 kg. Wt % Cu = 7.6/152 = 5 wt%, so Zn = 95 wt%. At 600 C, FIgure 9.19 shows sample is 100% liquid.

g) 21.7 mol Mg (24.3 g/mol) = 527.3 g. 35.4 mol Pb (207.2 g/mol) = 7334.9 g. So total mass = 7862.2 g. Wt% Mg = 527.3/7862.2 = 6.7 wt%. So Pb = 93.3 wt%. Figure 9.20 shows that at 350 C, this composition is beta + Mg2Pb. Composition of beta = 99 wt % Pb, 1 wt% Mg; composition of Mg2Pb = 81 wt% Pb. Amount of beta = (93.3-81)/(99-81) = 68 wt%; amount of Mg2Pb = 32 wt%.

h).4.2 mol Cu (63.55 g/mol) = 266.9 g; 1.1 (107.87 g/mol) = 118.6 g. Total mass = 385.5 g. Wt% Cu = 266.9/385.5 = 69.2 wt%, Wt% Ag = 30.8 wt%. Figure 9.7 shows that at 900 C, is alpha + liquid. Composition of alpha = 8 wt% Ag, Composition of liquid = 43 wt% Ag. Amount of alpha = (43-31)/(43-8) = 34 wt%, so amount of liquid = 66 wt%.

**2. At lead-tin alloy of composition 30 wt% Sn-70 wt% Pb is slowly heated from a temperature of 150 C.**

**a) At what temperature does the first liquid phase form?**

**b) What is the composition of this first liquid phase?**

**c). At what temperature does complete melting of the alloy occur?**

**d) What is the composition of the last solid remaining prior to complete melting?**

Phase diagram of Sn-Pb is Figure 9.8.

a) For 30 wt% Sn, on heating, first liquid forms when crossing the eutectic temperature of 183 C. b) Composition of this liquid is eutectic composition of 61.9 wt% Sn.

c) Complete melting occurs at about 255 C. d) Composition of last solid remaining is alpha phase, with about 13 wt% Sn.

**3. A copper-zinc alloy of composition 75 wt% Zn-25 wt% Cu is slowly heated from room temperature.**

**a) At what temperature does the first liquid phase form?**

**b) What is the composition of this liquid phase?**

**c) At what temperature does complete melting of the alloy occur?**

**d) What is the composition of the last solid remaining before complete melting?**

Zn-Cu phase diagram is Figure 9.19. At low temperature is gamma + epsilon, then delta + epsilon, then delta. a) Liquid first appears at 620 C, b) composition is 85 wt% Zn. c) Complete melting occurs at 760 C, last solid remaining is gamma phase, with composition of 66 wt% Zn.

**4. Compute the mass fractions of proeutectoid ferrite and pearlite that should form in an iron-carbon alloy containing 0.35 wt% C that is slowly cooled to room temperature from the austenite () phase.**

Proeutectoid ferrite is the amount of alpha phase present just before the eutectoid reaction, pearlite is the amount gamma phase present before eutectoid. From iron-carbon phase diagram (Figure 9.24), just about eutectoid temperature (727 C), amount of alpha is (0.76-0.35)/(0.76-0.02) = 55 wt%. So 45 wt% is the gamma that will convert to pearlite on cooling.

So proeutectoid ferrite = 55 wt%, pearlite = 45 wt% in the cooled product.

**5. The microstructure of an iron-carbon alloy consists of proeutectoid cementite and pearlite; the mass fractions of these two constitutents are 0.10 and 0.90, respectively. Estimate the carbon composition of this alloy.**

Since there is proeutectoid cementite present, the composition must be above 0.76 wt% (it is a hypereutectoid steel). So above eutectoid temperature, sample is in the two phase gamma + Fe3C region. Solving for amount of cementite before cooling is (Co-0.76)/(6.7-0.76) = 0.1, so Co = 1.35 wt%.