Fundamentals of Materials Science Homework 17

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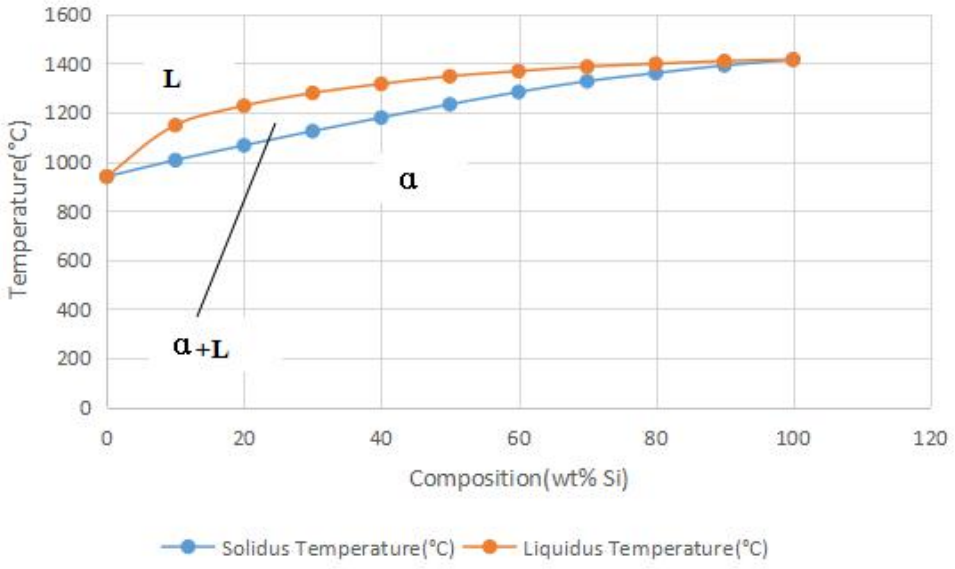
Homework Problems:

1. **Given here are the solidus and liquidus temperatures for the germanium-silicon system. Construct the phase diagram for this system and label each region.**

Composition (wt% Si)	Solidus Temperature (°C)	Liquidus Temperature (°C)
0	938	938
10	1005	1147
20	1065	1226
30	1123	1278
40	1178	1315
50	1232	1346
60	1282	1367
70	1326	1385
80	1359	1397
90	1390	1408
100	1414	1414

Solution:



2. A copper-nickel alloy of composition 70 wt% Ni-30 wt% Cu is slowly heated from a temperature of 1300°C (2370°F).

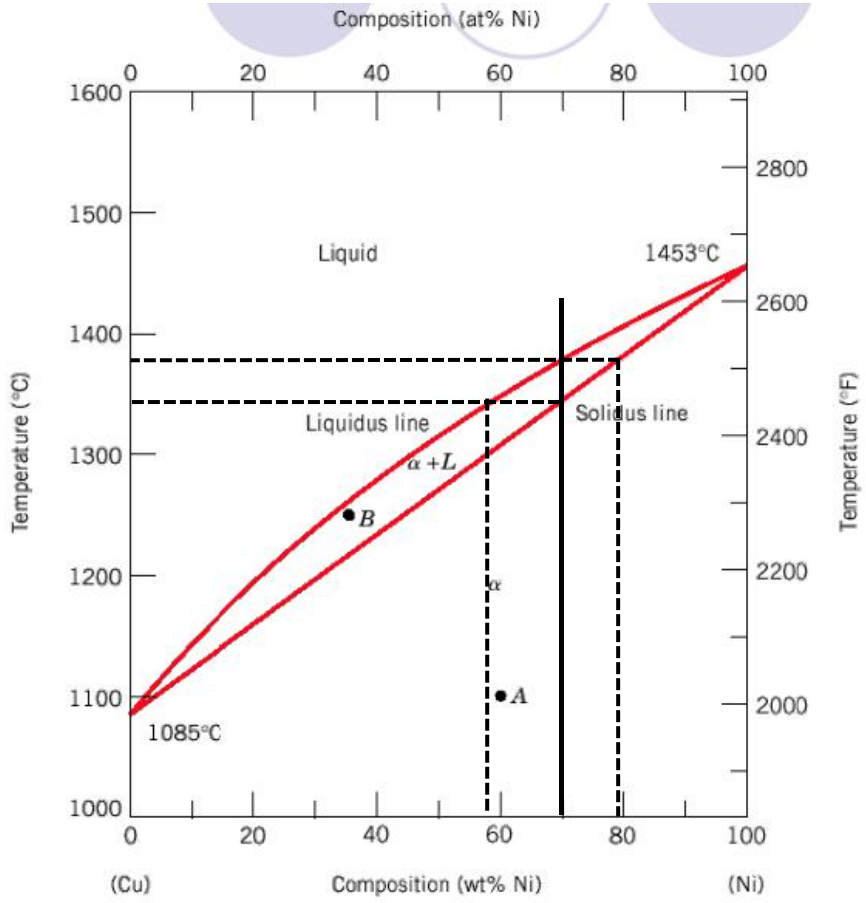
(a) At what temperature does the first liquid phase form?

(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 prior to complete melting?

Solution:



(a)from the figure:1340℃

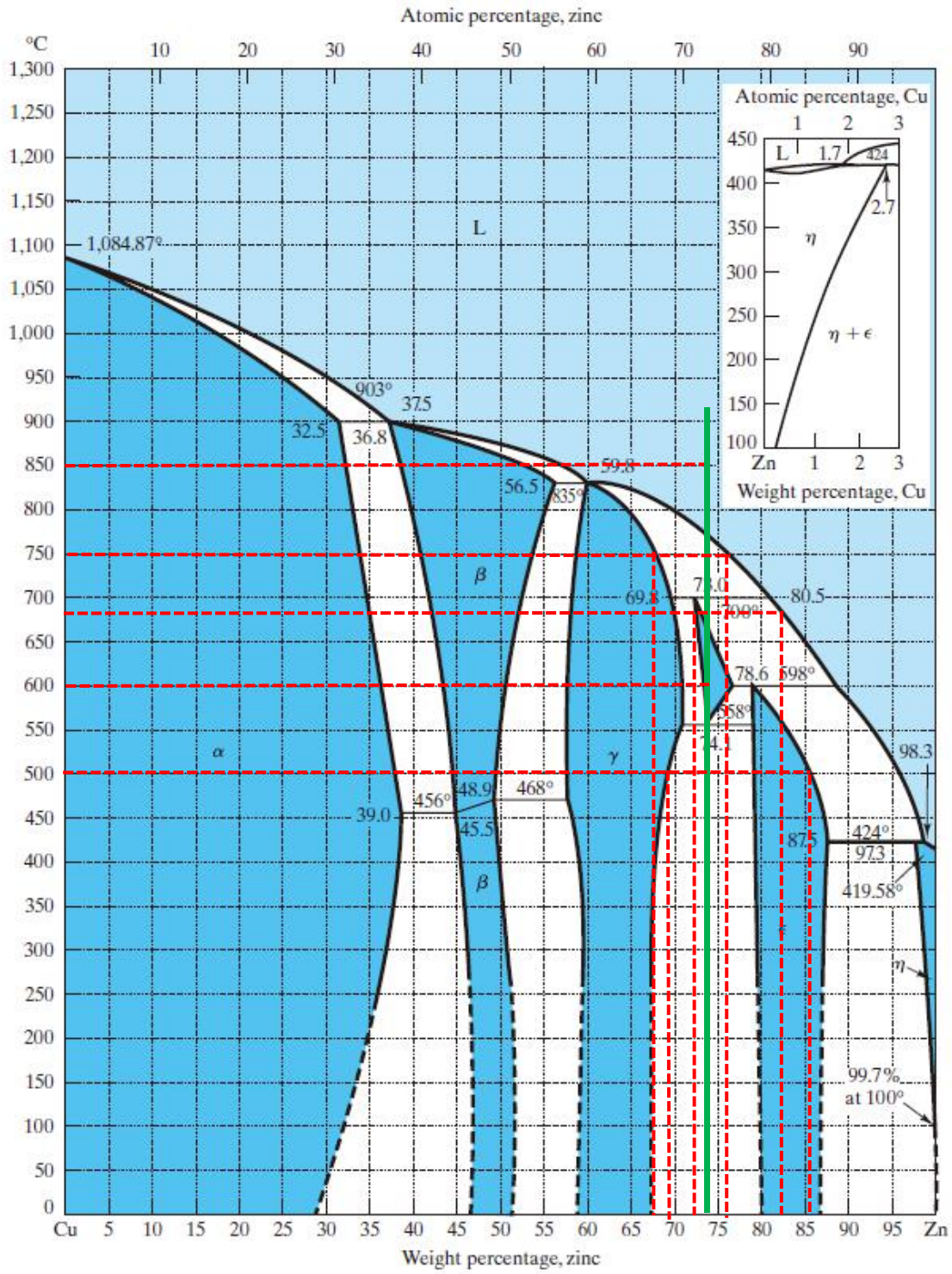
(b)58 wt% Ni-42 wt% Cu

(c)from the figure:1380℃

(d)79 wt% Ni-21 wt% Cu

3. For an alloy of composition 74 wt% Zn-26 wt% Cu, cite the phases present and their compositions at the following temperatures: 850°C, 750°C, 680°C, 600°C, and 500°C.

Solution:



850℃: C_L= 74 wt% Zn-26 wt% Cu

750℃: C_γ=67.5 wt% Zn-32.5 wt% Cu ;C_L= 76.5 wt% Zn-23.5 wt% Cu

680℃: C_δ=73 wt% Zn-27 wt% Cu ;C_L= 82 wt% Zn-18 wt% Cu

600℃: C_δ=74 wt% Zn-26 wt% Cu

500℃: C_γ= 69 wt% Zn-31 wt% Cu ;C_ε=80 wt% Zn-20 wt% Cu

4. Cite the phases that are present and the phase compositions for the following alloys:

(a) 90 wt% Zn-10 wt% Cu at 400°C (750°F)

(b) 75 wt% Sn-25 wt% Pb at 175°C (345°F)

(c) 55 wt% Ag-45 wt% Cu at 900°C (1650°F)

(d) 30 wt% Pb-70 wt% Mg at 425°C (795°F)

(e) 2.12 kg Zn and 1.88 kg Cu at 500°C (930°F)

(f) 37 lb_m Pb and 6.5 lb_m Mg at 400°C (750°F)

(g) 8.2 mol Ni and 4.3 mol Cu at 1250°C (2280°F)

(h) 4.5 mol Sn and 0.45 mol Pb at 200°C (390°F)

Solution:

(a)C_ε=87wt% Zn-13 wt% Cu ; C_η=97wt% Zn-3 wt% Cu

(b)C_α=16 wt% Sn-84 wt% Pb ; C_β= 97 wt% Sn-3 wt% Pb

(c)C_L= 55 wt% Ag-45 wt% Cu.

(d)C_α= 30 wt% Pb-70 wt% Mg.

(e)C_β= 49 wt% Zn-51 wt% Cu ; C_γ= 58 wt% Zn-42 wt% Cu.

(f)C_{Mg2Pd}= 81 wt% Pd- 19 wt% Mg ; C_L= 93 wt% Pd- 7 wt% Mg.

(g)64 wt%Ni-36 wt% Cu

(h)C_L=74 wt% Sn-26 wt% Pd ; C_β=97wt% Sn-3 wt% Pd

5. Determine the relative amounts (in terms of mass fractions) of the phases for the alloys and temperatures given in Problem 4.

Solution:

(a) $W_\varepsilon = \dfrac{C_\eta - C_L}{C_\eta - C_\varepsilon} = \dfrac{97-90}{97-87} = 0.7$; $W_\eta = \dfrac{C_L - C_\varepsilon}{C_\eta - C_\varepsilon} = \dfrac{90-87}{97-87} = 0.3$

(b) $W_\varepsilon = \dfrac{C_\beta - C_L}{C_\beta - C_\alpha} = \dfrac{97-75}{97-16} = 0.27$; $W_\eta = \dfrac{C_L - C_\alpha}{C_\beta - C_\alpha} = \dfrac{75-16}{97-16} = 0.73$

(c) $W = 1$; (d) $W = 1$;

(e) $W_\varepsilon = \dfrac{C_\beta - C_L}{C_\gamma - C_\alpha} = \dfrac{58-53}{58-49} = 0.56$; $W_\eta = \dfrac{C_L - C_\alpha}{C_\gamma - C_\alpha} = \dfrac{53-49}{58-49} = 0.44$

(f) $W_{Mg_2Pd} = \dfrac{C_L - C_l}{C_L - C_{Mg_2Pd}} = \dfrac{93-85}{93-82} = 0.73$; $W_\eta = \dfrac{C_l - C_{C_{Mg_2Pd}}}{C_L - C_{Mg_2Pd}} = \dfrac{85-82}{93-82} = 0.27$

(g) $W = 1$;

$$W_{Mg_2Pd} = \frac{C_L - C_l}{C_L - C_\beta} = \frac{97-85}{97-74} = 0.52$$

(h)

$$W_\eta = \frac{C_l - C_\beta}{C_L - C_\beta} = \frac{85-74}{97-74} = 0.48$$

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