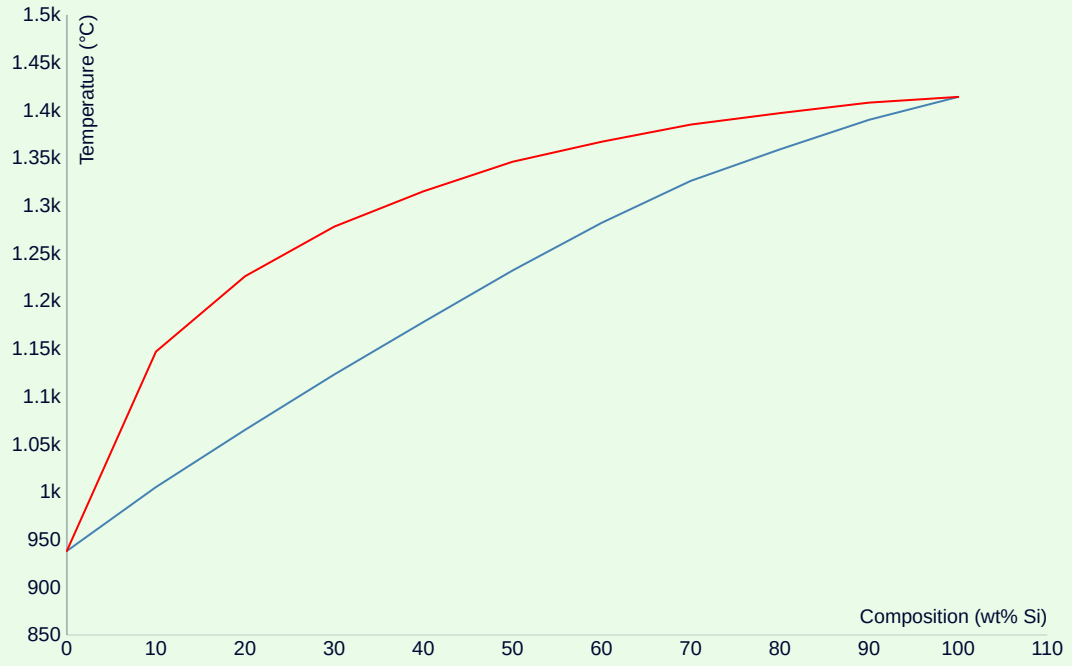
1

a

Using a spreadsheet or a MatLab program, and using the following dataset construct a phase diagram for the silicon-germanium system.

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

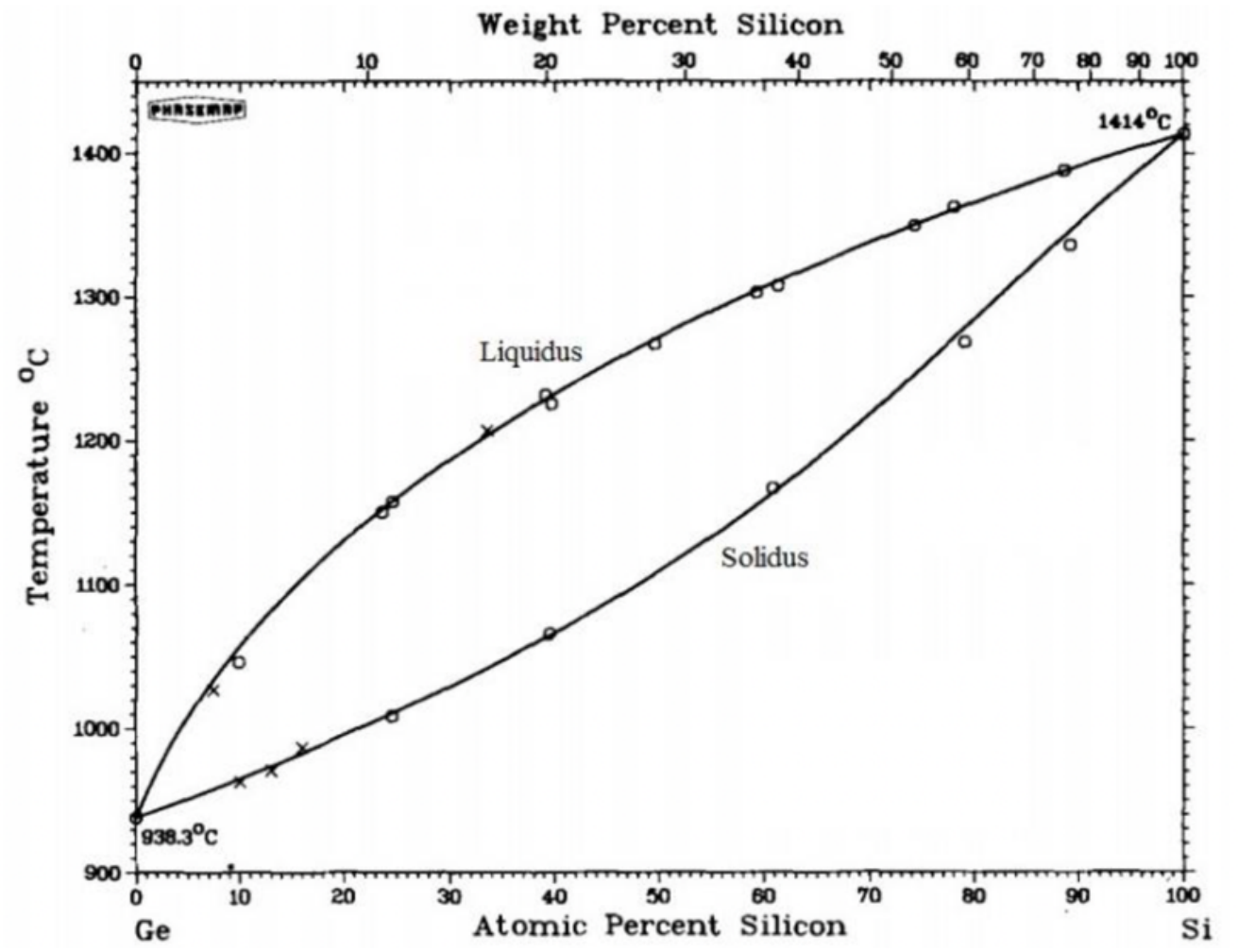
✓ Answer



b

Compare your diagram to this one published in ‘Littlejohns, Callum G., et al. "Silicon diffusion engineering in rapid melt growth of silicon-germanium on insulator." Electrochemical Society Meeting Abstracts 226. No. 35. The Electrochemical Society, Inc., 2014.’

If there are differences of notes describe them.

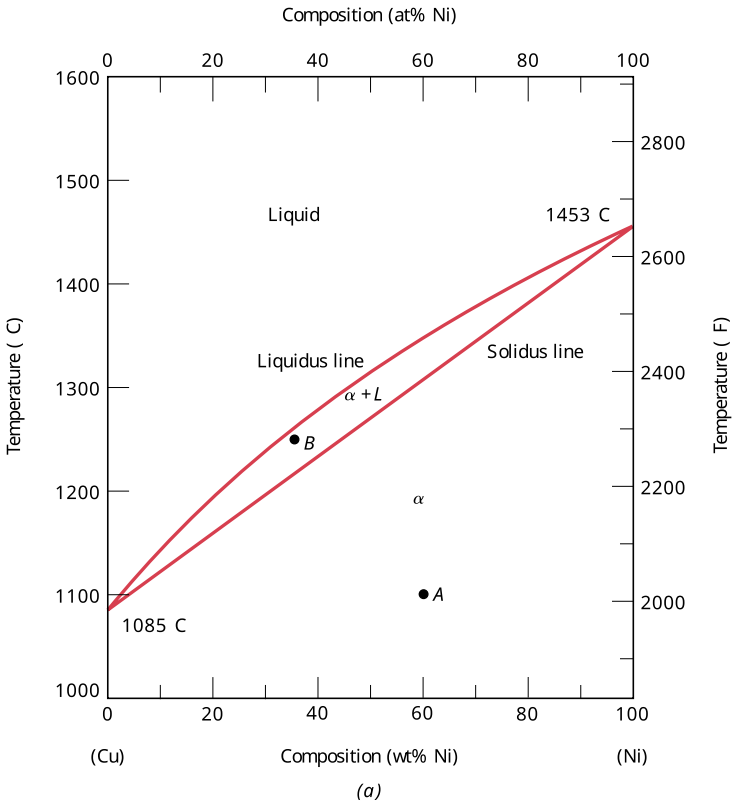


✓ **Answer**

Their solidus line has a positive curvature whilst the one we graphed does not. The liquidus line looks fairly similar. This is because their scale is non-linear on the weight percentage of silicon.

2

Using Fig 10.3, consider 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?

✓ **Answer**

Around 1325°C

b

What is the composition of this liquid phase?

✓ **Answer**

At 1325°C the liquid will be fully consisting of Cu as it has the lower melting point.

c

At what temperature does complete melting of the alloy occur?

✓ **Answer**

Around 1370°C

d

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

✓ **Answer**

Mainly Ni, as it has the higher melting point.

3

Referring to discussion in the book about Fig 10.14 and 10.15, briefly explain why, upon solidification, an alloy of eutectic composition forms a microstructure consisting of alternating layers of the two solid phases.

✓ **Answer**

The diffusion of the different metals at the eutectic point means both metals cool at the same time, solidifying with anything that diffused near to it.

4

In your own words is the difference between a phase and a microconstituent?

✓ **Answer**

A phase is a portion of the possible states in an alloy that is homogeneous
A microconstituent is a phase or a mixture of phases that create a unique visual appearance or structue.

5

Consider Gibbs Phase rule and using the diagrams in Chap 10 in the book and specify the number of degrees of freedom for the following alloys:

$$P + F = C + N$$

a

95 wt% Ag–5 wt% Cu at 780°C

✓ **Answer**

$P = 1$
$C = 1$
$N = 2$
$F = 2$

b

80 wt% Ni–20 wt% Cu at 1400°C

✓ **Answer**

$P = 2$
$C = 1$
$N = 2$
$F = 1$

c

44.9 wt% Ti–55.1 wt% Ni at 1310°C

✓ **Answer**

$P = 3$
$C = 1$
$N = 2$
$F = 0$

d

61.9 wt% Sn–38.1 wt% Pb at 183°C

✓ **Answer**

$P = 3$
$C = 1$
$N = 2$
$F = 0$

e

2.5 wt% C–97.5 wt% Fe at 1000°C

✓ **Answer**

$P = 1$
$C = 1$
$N = 2$
$F = 2$