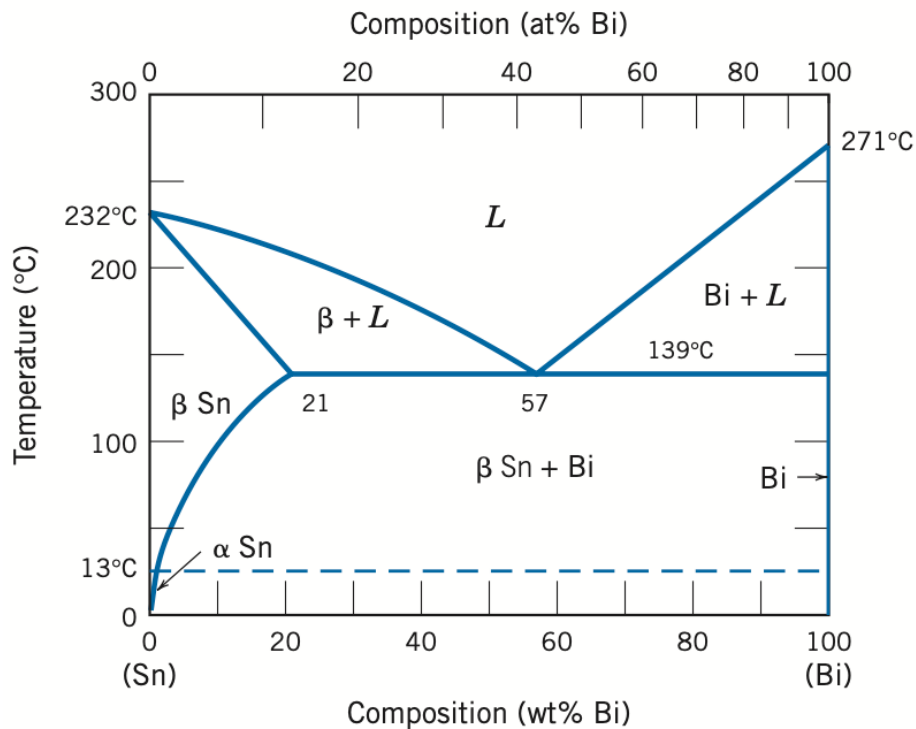


MSE 214 (Metals)
Exercise 8 – Phase Diagrams
26th November 2024

Question 1.

- a) The most common lead-tin solder has a composition of 63 wt% Sn – 37 wt% Pb. Give two reasons why this composition is chosen?
- b) A challenge with Sn-Pb solders is that lead is a mildly toxic metal. There is also serious concern about the environmental impact of disposed lead-containing products. Given that, there has been a push to find lead-free solders. One potential candidate is tin-bismuth alloys.

From the Sn-Bi phase diagram below, which composition do you think makes the most sense for solders? Briefly justify your reasons.



- c) For the composition that you identified in part b), use the phase diagram to identify the phases present at 100°C and the approximate composition of each phase in this alloy.

d) What is the approximate weight fraction of each phase?

e) For the composition that you identified in part b), sketch the microstructure of the alloy that you expect to see at room temperature.

Question 2.

For alloys of two metals A and B, there exist an α phase that is A-rich and a β phase that is B-rich.

From the mass fractions of both phases for two different alloys provided in the table below, (which are at the same temperature T), determine the composition of the phase boundary (or solubility limit) for both α and β phases at this temperature.

Assume that at temperature T, the compositions shown below are in the $\alpha + \beta$ two phase region.

Alloy Composition	Weight fraction α phase	Weight fraction β phase
60 wt% A – 40 wt% B	0.57	0.43
30 wt% A – 70 wt% B	0.14	0.86

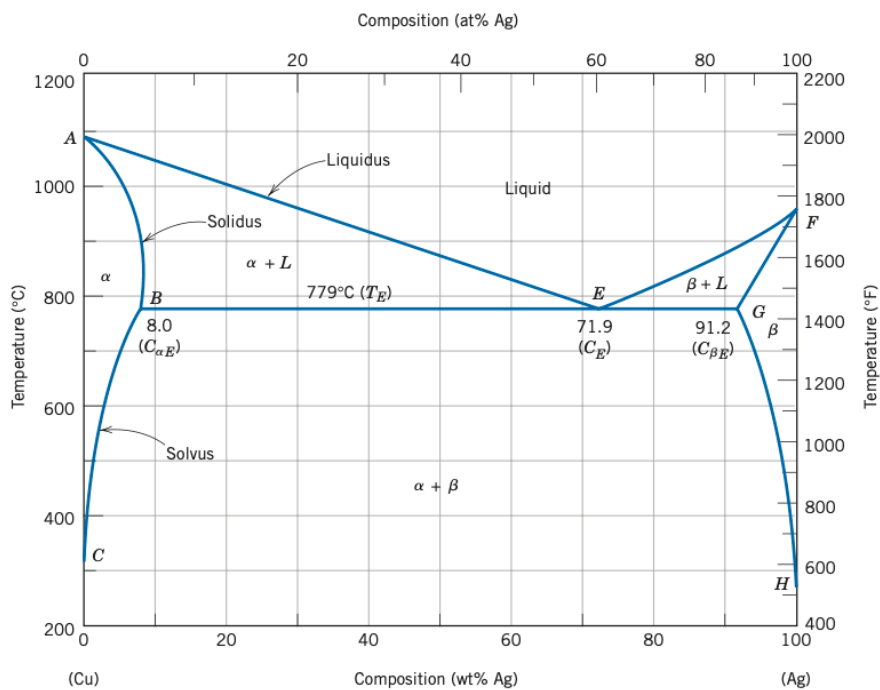
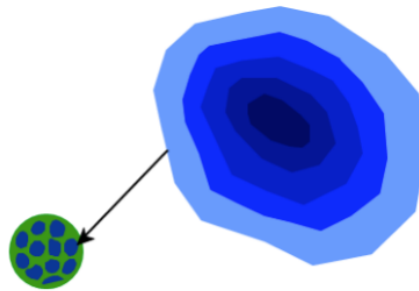
Hint: Use the lever rule

Question 3.

A small amount of carbon is often added to strengthen iron. In fact, steel is basically iron + carbon. Give two reasons why the addition of carbon strengthens iron.

Question 4.

The microstructure drawn below is for a 10 wt% Cu – 90 wt% Ag alloy at 780°C. The equilibrium phase diagram for this alloy is also shown below.



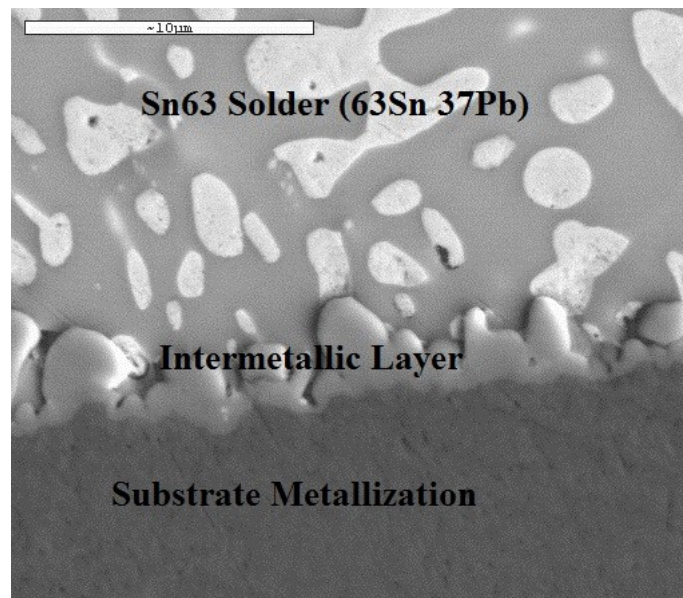
a) Why does the solid phase have a layered appearance?

b) What phase is the cored structure?

c) What is the approximate concentration of silver in the center region of the cored structures?

Question 5.

During soldering, a thin layer of intermetallic is often formed between the solder and the metallic substrate. See image below:



With copper substrates, the intermetallics formed with Sn-Pb solders are often Cu_3Sn and Cu_6Sn_5 .

a) How do you think these intermetallics are formed?

- b) Why is it important to know the properties of the intermetallic?
Hint: What happens if the intermetallic is brittle?