9.11 Upon heating a lead-tin alloy of composition 30 wt% Sn-70 wt% Pb from 150°C and utilizing Figure 9.8:

(a) The first liquid forms at the temperature at which a vertical line at this composition intersects the eutectic isotherm--i.e., at 183°C.

(b) The composition of this liquid phase corresponds to the intersection with the $(\alpha + L)$–$L$ phase boundary, of a tie line constructed across the $\alpha + L$ phase region just above this eutectic isotherm--i.e., $C_L = 61.9$ wt% Sn.

(c) Complete melting of the alloy occurs at the intersection of this same vertical line at 30 wt% Sn with the $(\alpha + L)$–$L$ phase boundary--i.e., at about 260°C.

(d) The composition of the last solid remaining prior to complete melting corresponds to the intersection with $\alpha$–($\alpha + L$) phase boundary, of the tie line constructed across the $\alpha + L$ phase region at 260°C--i.e., $C_\alpha$ is about 13 wt% Sn.
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9.51 We are called upon to consider various aspects of 6.0 kg of austenite containing 0.45 wt% C, that is cooled to below the eutectoid.

(a) Ferrite is the proeutectoid phase since 0.45 wt% C is less than 0.76 wt% C.

(b) For this portion of the problem, we are asked to determine how much total ferrite and cementite form.

For ferrite, application of the appropriate lever rule expression yields

\[ W_\alpha = \frac{C_{\text{Fe}_3\text{C}} - C_0}{C_{\text{Fe}_3\text{C}} - C_\alpha} = \frac{6.70 - 0.45}{6.70 - 0.022} = 0.94 \]

which corresponds to \((0.94)(6.0 \text{ kg}) = 5.64 \text{ kg} \) of total ferrite.

Similarly, for total cementite,

\[ W_{\text{Fe}_3\text{C}} = \frac{C_0 - C_\alpha}{C_{\text{Fe}_3\text{C}} - C_\alpha} = \frac{0.45 - 0.022}{6.70 - 0.022} = 0.06 \]

Or \((0.06)(6.0 \text{ kg}) = 0.36 \text{ kg} \) of total cementite form.

(c) Now consider the amounts of pearlite and proeutectoid ferrite. Using Equation 9.20

\[ W_p = \frac{C_0 - 0.022}{0.74} = \frac{0.45 - 0.022}{0.74} = 0.58 \]

This corresponds to \((0.58)(6.0 \text{ kg}) = 3.48 \text{ kg} \) of pearlite.

Also, from Equation 9.21,

\[ W_\alpha' = \frac{0.76 - 0.45}{0.74} = 0.42 \]

Or, there are \((0.42)(6.0 \text{ kg}) = 2.52 \text{ kg} \) of proeutectoid ferrite.

(d) Schematically, the microstructure would appear as:
9.37 Schematic sketches of the microstructures that would be observed for a 52 wt% Zn-48 wt% Cu alloy at temperatures of 950°C, 860°C, 800°C, and 600°C are shown below. The phase compositions are also indicated. (Note: it was necessary to use the Cu-Zn phase diagram, Figure 9.19, in constructing these sketches.)
Development of Microstructure in Eutectic Alloys

9.28 Upon solidification, an alloy of eutectic composition forms a microstructure consisting of alternating layers of the two solid phases because during the solidification atomic diffusion must occur, and with this layered configuration the diffusion path length for the atoms is a minimum.
9.20 For this problem, we are asked to determine the composition of the $\beta$ phase given that

\[ C_0 = 40 \text{ (or 40 wt% B-60 wt% A)} \]

\[ C_\alpha = 13 \text{ (or 13 wt% B-87 wt% A)} \]

\[ W_\alpha = 0.66 \]

\[ W_\beta = 0.34 \]

If we set up the lever rule for $W_\alpha$:

\[ W_\alpha = 0.66 = \frac{C_\beta - C_0}{C_\beta - C_\alpha} = \frac{C_\beta - 40}{C_\beta - 13} \]

And solving for $C_\beta$:

\[ C_\beta = 92.4 \text{ (or 92.4 wt% B-7.6 wt% A)} \]

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