*For a lead–tin alloy of composition 70 wt% Sn–30 wt% Pb and at 180°C (355°F) do the following:*

*(a) Determine the mass fractions of the α and β phases.*

*(b) Determine the mass fractions of primary β and eutectic microconstituents.*

*(c) Determine the mass fraction of eutectic β.*

Solution

(a) This portion of the problem asks that we determine the mass fractions of $\alpha$ and $\beta$ phases for an 80 wt% Sn-20 wt% Pb alloy (at 180°C). In order to do this it is necessary to employ the lever rule using a tie line that extends entirely across the $\alpha + \beta$ phase field. From Figure 9.8 and at 180°C, $C_{\square}$ = 18.3 wt% Sn, $C_{\square}$ = 97.8 wt% Sn, and $C_{\text{eutectic}}$ = 61.9 wt% Sn. Therefore, the two lever-rule expressions are as follows:

$$W_\alpha = \frac{C_\beta - C_0}{C_\beta - C_\alpha} = \frac{97.8 - 70}{97.8 - 18.3} = .349$$

$$W_\beta = \frac{C_0 - C_\alpha}{C_\beta - C_\alpha} = \frac{70 - 18.3}{97.8 - 18.3} = .651$$

(b) Now it is necessary to determine the mass fractions of primary $\beta$ and eutectic microconstituents for this same alloy. This requires that we utilize the lever rule and a tie line that extends from the maximum solubility of Pb in the $\beta$ phase at 180°C (i.e., 97.8 wt% Sn) to the eutectic composition (61.9 wt% Sn). Thus, mass fractions of primary $\beta$ and eutectic microconstituents (denoted by $W_{\beta'}$ and $W_e$, respectively) are determined using the following lever-rule expressions:

$$W_{\beta'} = \frac{C_0 - C_{\text{eutectic}}}{C_\beta - C_{\text{eutectic}}} = \frac{70 - 61.9}{97.8 - 61.9} = .225$$

$$W_e = \frac{C_\beta - C_0}{C_\beta - C_{\text{eutectic}}} = \frac{97.8 - 70}{97.8 - 61.9} = .774$$

(c) And, finally, we are asked to compute the mass fraction of eutectic $\beta$, $W_{e\square}$. This quantity is simply the difference between the mass fractions of total $\beta$ and primary $\beta$ as follows:

$$W_{e\beta} = W_\beta - W_{\beta'}$$

$$=.651-.225 = .426$$