Chapter 11 homework solutions

Problem 1 – answer page 384. The matrix should be soft and ductile. The hard dispersed phase should be discontinuous. The dispersed phase should be small and numerous. The dispersed phase particles should be round. Higher concentrations of dispersed phase strengthen alloy.

Problem 6 - answer page 390. When three phases are in equilibrium during the reaction, there are no degrees of freedom. These reactions occur at a fixed temperature and composition, and it is also understood to be at a fixed pressure. Using the Gibbs phase rule, $1 + C = F + P$ where C = components, F = degrees of freedom and P = phases, One calculates $F = 1 + C - P = 1 + 2 - 3 = 0$ at the invariant point. These reactions are known as invariant.

Problem 9 and 23

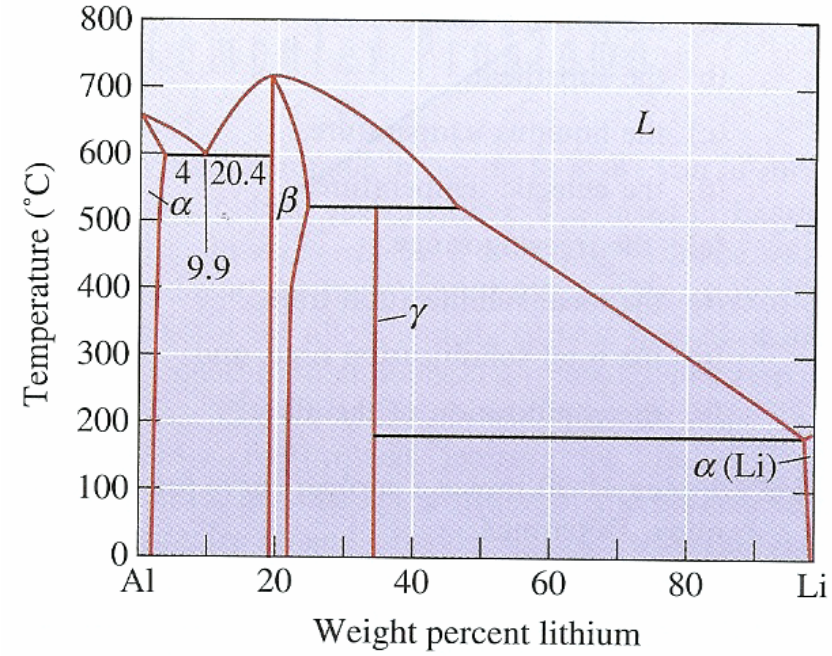


Figure 11-27 The aluminum-lithium phase diagram (for Problem 11-23).

9)

(a) β is non-stoichiometric @ 21 wt% Li:

$$\text{at\% Li} = \frac{21\text{ g}/6.94\text{ g/mol}}{21/6.94 + 79/26.981} \times 100\% = 50\text{ at\% Li} \quad \therefore \text{AlLi}$$

γ, is stoichiometric @ 34 wt% Li:

$$\text{at\% Li} = \frac{34\text{ g}/6.94\text{ g/mol}}{34/6.94 + 66/26.981} \times 100\% = 66.7\%\text{ Li} \quad \therefore \text{AlLi}_2$$

(b) 600°C: $L \rightarrow \alpha + \beta$ eutectic L: 9.9% Li

α: 4% Li β: 20.4% Li

510°C: $\beta + L \rightarrow \gamma$ peritectic β: 25% Li

L: 47% Li γ: 34% Li

170°C: $L \rightarrow \gamma + \alpha(\text{Li})$ eutectic L: 98% Li

γ: 34% Li α(Li): 99% Li

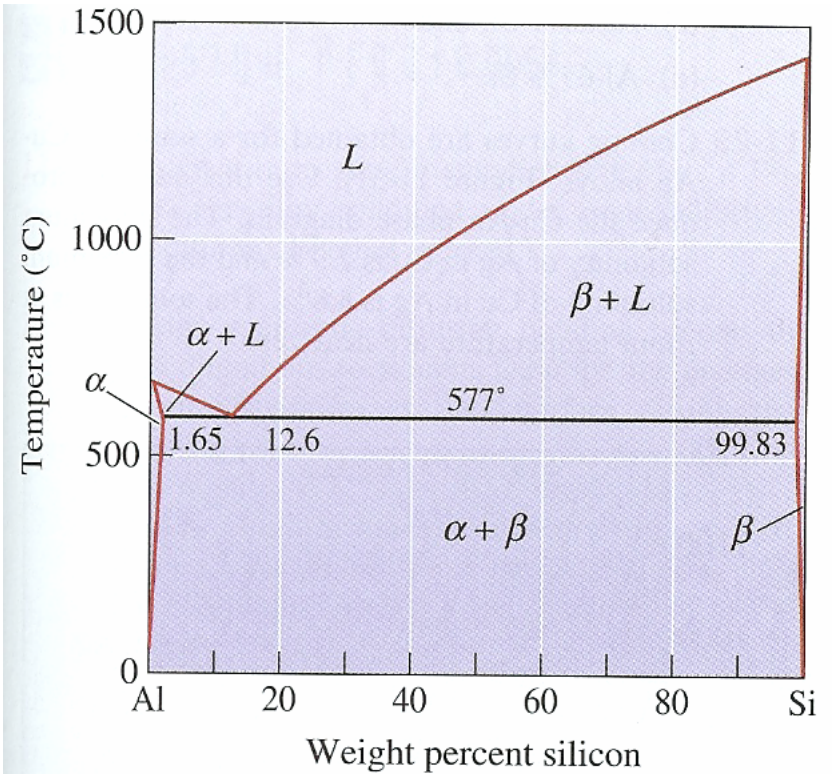
23)

(a) $28 = \dfrac{20.4 - x}{20.4 - 9.9} \times 100$ or $x = 17.46\%$ Li Hypereutectic

(b) $\%\ \alpha_{\text{Eut}} = \dfrac{20.4 - 9.9}{20.4 - 4} \times 100\% = 64\%$ and $\%\ \beta_{\text{Eut}} = 36\%$

Problem 23 correction: 23b) $\%\ \alpha_{\text{Eut}} = ((20.4 - 17.46)/(20.4 - 4)) \times 100\% = 17.9\%$ an $\%\ \beta_{\text{Eut}} = 82.1\%$

Problems 17 and 18



17)

(a) hypoeutectic

(b) 1% Si

(c) α: 1.65% Si L: 12.6% Si

$$\% \alpha = \frac{12.6 - 4}{12.6 - 1.65} = 78.5\% \quad \% L = 21.5\%$$

(d) α: 1.65% Si β: 99.83% Si

$$\% \alpha = \frac{99.83 - 4}{99.83 - 1.65} = 97.6\% \quad \% \beta = 2.4\%$$

primary α: 1.65% Si % primary α = 78.5%
eutectic: 12.6% Si % eutectic = 21.5%

(e) α: 0% Si β: 100% Si $\% \alpha = \frac{100 - 4}{100 - 0} = 96\%$ $\% \beta = 4\%$

18)

(a) hypereutectic

(b) 100% Si

(c) β: 99.83% Si L: 12.6% Si

$$\% L = \frac{99.83 - 25}{99.83 - 12.6} = 85.8\% \quad \% \beta = 14.2\%$$

(d) α: 1.65% Si β: 99.83% Si

$$\% \alpha = \frac{99.83 - 25}{99.83 - 1.65} = 76.2\% \quad \% \beta = 23.8\%$$

(e) primary β: 99.83% Si % primary β = 14.2%
eutectic: 12.6% Si % eutectic = 85.8%

(f) α: 0% Si β: 100% Si $\% \alpha = \frac{100 - 25}{100 - 0} = 75\%$ $\% \beta = 25\%$

Problem 13

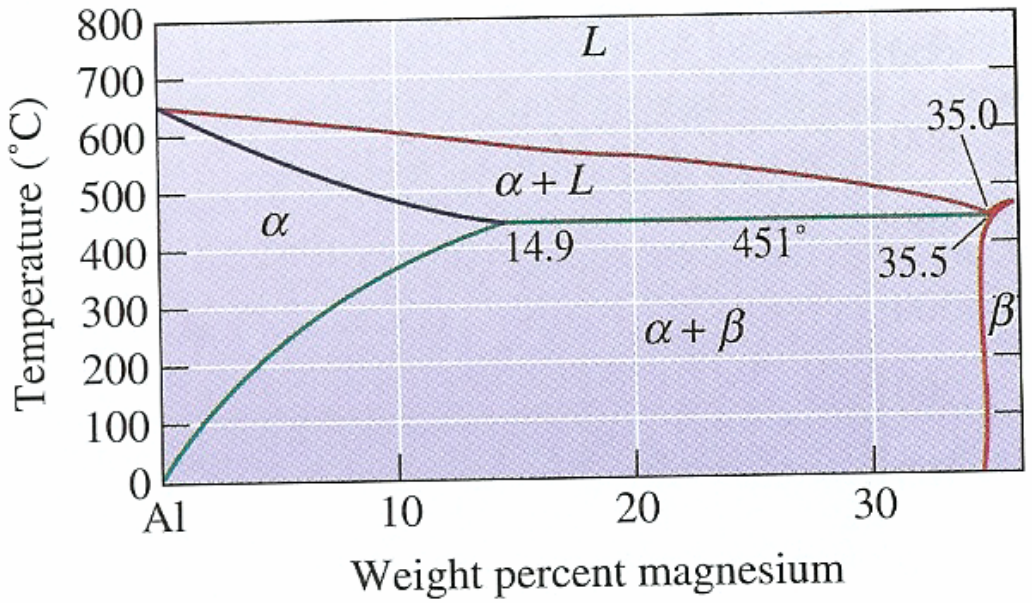


Figure 11-28 Portion of the aluminum-magnesium phase diagram (for Problem 11-13).

13)

(a) 2.5% Mg

(b) liquidus = 600°C, solidus = 470°C,
solvus = 400°C, freezing range = 130°C

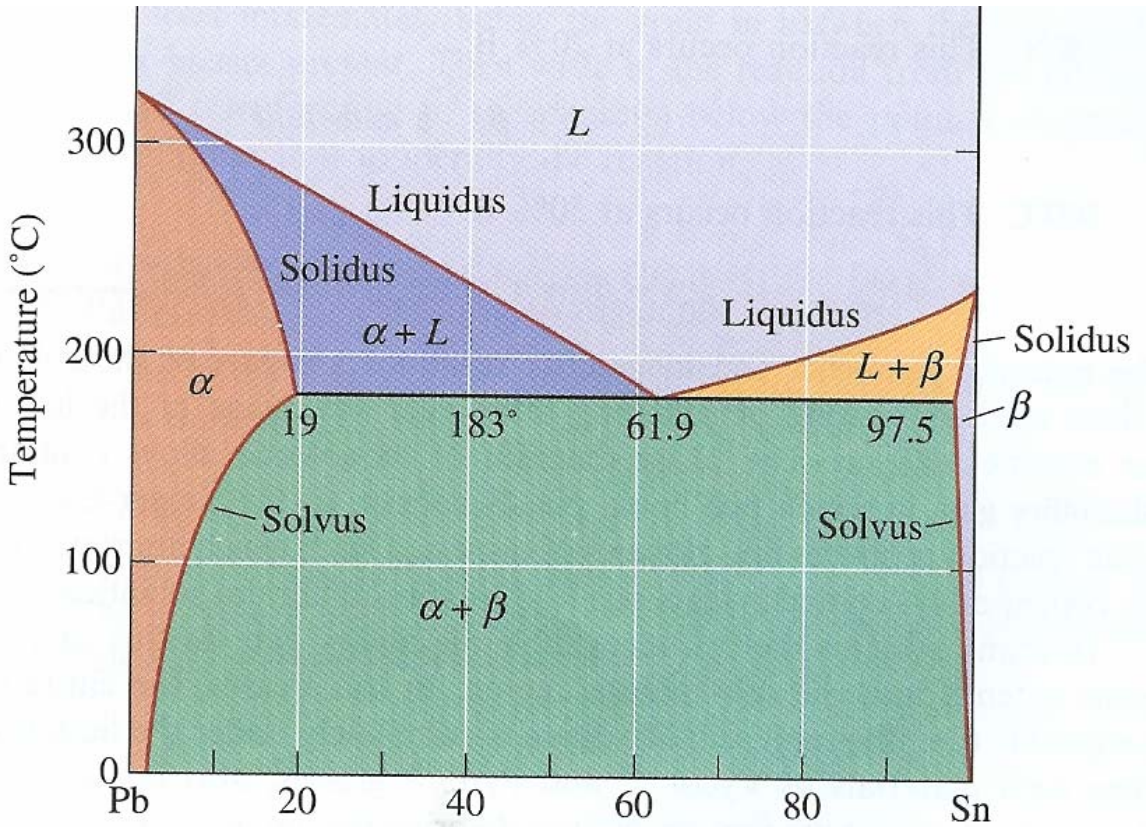
(c) L: 26% Mg α: 7% Mg;

$$\% \alpha = \frac{26 - 12}{26 - 7} \times 100\% = 74\% \quad \% L = 26\%$$

(d) α: 12% Mg 100% α

(e) α: 1% Mg β: 34% Mg

$$\% \alpha = \frac{34 - 12}{34 - 1} \times 100\% = 67\% \quad \% \beta = 33\%$$



Problems12 and 21

12)

(a) 8% Sn

(b) liquidus = 290°C, solidus = 240°C,
solvus = 170°C, freezing range = 50°C

(c) L: 30% Sn α: 12% Sn;

$$\%\ L = \frac{15 - 12}{30 - 12} \times 100\% = 17\% \quad \%\ \alpha = 83\%$$

(d) α: 15% Sn 100% α

(e) α: 2% Pb β: 100% Sn

$$\%\ \alpha = \frac{100 - 15}{100 - 2} \times 100 = 87\% \quad \%\ \beta = 13\%$$

21)

$$\%\ \text{primary}\ \alpha = 23 = \frac{61.9 - x}{61.9 - 19} \times 100 \quad \text{or} \quad x = 52\%\ \text{Sn}$$