Definitions

Alloy A mixture of metal with other metals or non-metals.

Phase A region of material that has homogenous properties and composition.

Components The chemical elements which make up alloys.

Microstructure The distribution of the phases in a solid alloy.

Reading Phase Diagrams

Temperature of first liquid phase 183°C

Composition of liquid phase 61.9 wt% Sn

Temperature of complete melting 250°C

Composition of last solid prior to melting 15 wt% Sn

Mass of lead in alloy $8\,\text{kg} * 20\% = \textit{1.6 kg}$

How much more lead may be dissolved in α-phase

Let x be the amount of Pb added (kg).

$$\frac{1.6\text{ kg} + x}{8\text{ kg} + x} = 30\text{ wt\%}$$

$$1.6\text{ kg} + x = 0.3 * 8\text{ kg} + 0.3x$$

$$0.7x = 0.8 \qquad x = \textit{1.14 kg}$$

The Lever Rule

Determining the Composition of the β-phase

$$\frac{40\text{ wt\% B} - 13\text{ wt\% B}}{x\text{ wt\% B} - 13\text{ wt\% B}} = 0.5$$

$$\textit{x = 67 wt\% B = 33 wt\% A}$$

Determining the mass fractions of the α and β phases

$$\frac{90\text{ wt\% Sn} - 18.3\text{ wt\% Sn}}{97.8\text{ wt\% Sn} - 18.3\text{ wt\% Sn}} = \textit{0.9 } \beta = \textit{0.1 } \alpha$$

Determining the mass fractions of the primary β and eutectic microconstituents

$$\frac{90\text{ wt\% Sn} - 61.9\text{ wt\% Sn}}{97.8\text{ wt\% Sn} - 61.9\text{ wt\% Sn}} = \textit{0.78 Pre-Eutectic } \beta = \textit{0.22 Eutectic}$$

Determining the mass fraction of eutectic β

$$0.9\text{ Total } \beta - 0.78\text{ Pre-Eutectic } \beta = \textit{0.12 Eutectic } \beta$$

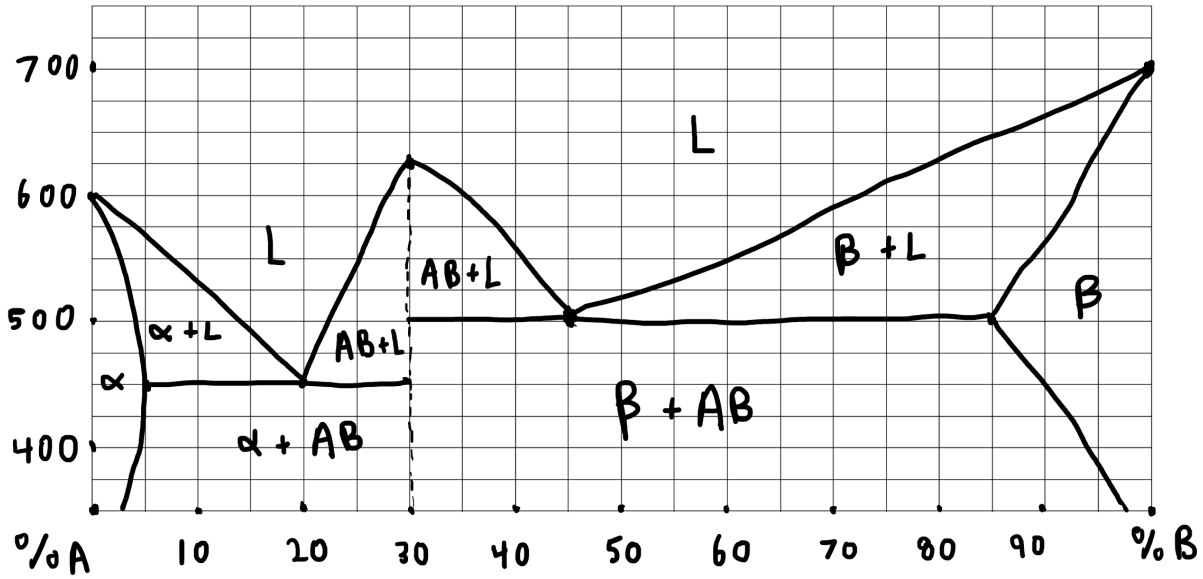
Determining the composition of an alloy

$$\frac{C_0 - 64\text{ wt\%}}{x - 64\text{ wt\%}} = 0.367 \qquad \frac{C_0 - 12\text{ wt\%}}{x - 12\text{ wt\%}} = 0.768$$

$$\left[\begin{array}{cc|c} \frac{1}{\text{Primary } \beta} & -1 & -\text{wt\%}_{\text{Eutectic}} + \frac{\text{wt\%}_{\text{Eutectic}}}{\text{Primary } \beta} \\ \frac{1}{\text{Total } \beta} & -1 & -\text{wt\%}_{\text{Eutectic}} + \frac{\text{wt\%}_{\text{Eutectic}}}{\text{Total } \beta} \end{array}\right] = \left[\begin{array}{cc|c} \frac{1}{0.367} & -1 & -64\text{ wt\%} + \frac{64\text{ wt\%}}{0.367} \\ \frac{1}{0.768} & -1 & -12\text{ wt\%} + \frac{12\text{ wt\%}}{0.768} \end{array}\right] = \left[\begin{array}{cc|c} C_0 & 0 & 75.04\text{ wt\% B} \\ 0 & x & 94.08\text{ wt\%} \end{array}\right]$$

$$\textit{C}_0 = \textit{75.04 wt\% B = 24.96 wt\% A}$$

Example Phase Diagram



Calculating Mass and Weight Percent

$$\text{Total Gold} = 3 * 50 \text{ g} * 40 \text{ wt\%} + 7 * 100 \text{ g} * 60 \text{ wt\%} + 9 * 30 \text{ g} * 50 \text{ wt\%} = 615 \text{ g}$$

$$\text{Total Silver} = 3 * 50 \text{ g} * 60 \text{ wt\%} + 7 * 100 \text{ g} * 40 \text{ wt\%} + 9 * 30 \text{ g} * 50 \text{ wt\%} = 505 \text{ g}$$

$$\text{Total Weight} = \text{Total Gold} + \text{Total Silver} = 615 \text{ g} + 505 \text{ g} = 1120 \text{ g}$$

$$\text{wt\% Gold} = \frac{\text{Total Gold}}{\text{Total Weight}} * 100 = \frac{615 \text{ g}}{1120 \textbf{ g}} * 100 = 55 \text{ wt\%}$$

Since Ericth Limaneth isolated the solid part, a line must be drawn to the α phase to determine the weight percent gold of the solid part. Once the line is drawn, the weight percent is determined to be *65 wt%*. Then, the mass fraction is calculated using the lever rule.

$$W_\alpha = \frac{55 \text{ wt\%} - 50 \text{ wt\%}}{65 \text{ wt\%} - 50 \text{ wt\%}} = \frac{1}{3}$$

Multiple the total weight calculated by the mass fraction to obtain the weight of the new ring.

$$W_\alpha * \text{Total Weight} = \frac{1}{3} * 1120 \text{ g} = \textit{373.33 g}$$

More on Phases

The proeutectoid phase is called *Ferrite* and the eutectoid microstructure for the iron-carbon system is called *Pearlite*.

$$\frac{0.45 \text{ wt\%} - 0.022 \text{ wt\%}}{0.76 \text{ wt\%} - 0.022 \text{ wt\%}} * 6 \text{ kg} = \textit{3.48 kg Eutectoid}$$

$$\text{Proeutectoid} = 6 \text{ kg} - 3.48 \text{ kg} = \textit{2.52 kg Proeutectoid}$$