Chapter 9 Phase diagrams

- Introduction
- Solubility limit
- Phases
- Phase equilibria
- Binary isomorphous systems

Definitions and basic concepts

- Component: pure metals and/or compounds of which an alloy is composed
- System: a specific body of material under consideration
- A phase: a homogeneous portion of a system that has uniform physical and chemical characteristics
- Equilibrium: a system is at equilibrium if its free energy is at a minimum under some specified combination of temperature, pressure, and composition.
- Phase equilibrium: minimum energy for a system with multiple phases
- Phase diagram: Information about phases as function of $T$, composition, and pressure
Solubility limit

Examples: phase diagram - water-sugar system
Examples

- water-sugar system

![Temperature vs. Composition Graph](image)

B(100, 70) 1 phase  D(100, 90) 2 phases

L (liquid)  +  S (solid sugar)

A(70, 20) 2 phases

Temperature (°C)

Composition (wt% sugar)

Binary isomorphous systems

- Complete liquid and solid solubility of the two components
- Cu-Ni solid solution
- Liquidus line
- Solidus line
- Melting temperatures
- Phase composition
- Phase relative amount: tie line and lever rule
Determine phase composition: lever rule
- Liquid amount
- Solid amount

Determination of the number and types of phases present

- Rule 1: If we know T and C_0, then we know:
  --the # and types of phases present.

\[ T(°C) \]
\[ 160 \quad 150 \quad 140 \quad 130 \quad 120 \quad 110 \quad 100 \]
\[ 0 \quad 20 \quad 40 \quad 60 \quad 80 \quad 100 \quad \text{wt\% Ni} \]
The composition of each phase

- Rule 2: If we know $T$ and $C_0$, then we know:
  --the composition of each phase.

![Phase Diagram]

The amount of each phase

- Rule 3: If we know $T$ and $C_0$, then we know:
  --the amount of each phase (given in wt%).
- Examples:
Development of microstructure

Cu-Ag binary eutectic systems
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Pb-Sn Binary eutectic systems

- Low melting temp, solder
- Example:
- Known 40% Sn+60% Pt, T=150°C
- Find phases, phase composition, and relative amount
Binary eutectic systems (Example)

- Explain how spreading salt on ice that is at a temperature below 0°C can cause the ice to melt.