

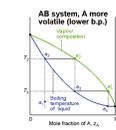
59-240
Lecture 19
Phase Diagrams

Temperature-Composition Phase Diagrams

at constant pressure
 $F = 3 - P$

Liquid-Vapour Diagrams

Basic diagram

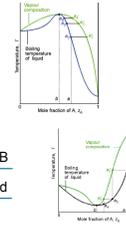


Fractional distillation

explain on diagram
theoretical plates

Azeotropes

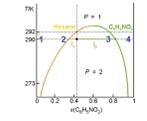
- boiling without changing
- high boiling
 - distill A to the left of the azeotrope
 - distill B to the right of the azeotrope
- low boiling
 - cannot distill either A or B
 - only azeotrope is distilled



Liquid-Liquid Diagrams

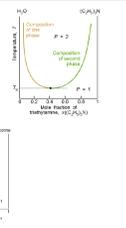
Immiscible liquids

- Total vapour pressure close to $p = p_A^* + p_B^*$
- Each component saturated in the other
- saturated solution: components boil off at lower temperatures than they would normally
- basis of steam distillation

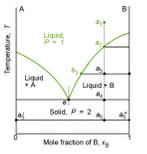


partially miscible liquids

- do not mix in all proportions
- upper critical temperature example
 - one-phase region: liquids are completely miscible
 - two-phase region: two separate phases: one hexane-rich, one nitrobenzene rich
 - compositions and relative amounts of phases given by tie lines & lever rule
- lower critical temperature example
 - H_2O /triethylamine
 - in-class demo
- in some rare cases, both upper and lower critical temperatures



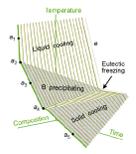
- Number of reacting species
- Melting temperatures of pure substances
- Different phase regions (& number of phases)
- Eutectic composition and temperature
- Sketch cooling curve from a1-a5



- "easily melted"
- direct from liquid to solid two-phase region
- lamellar structure
- examples
 - solder
 - water/salt

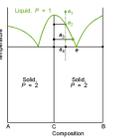
Thermal analysis

- cooling curves
- isopleths
- slopes for phase areas
- halts at phase transitions
- halts and eutectics and peritectics



Reacting Systems

- Vertical lines indicate new species
- Determine identity and stoichiometry from the mol% or wt%
- Most new species melt directly into solution (like pure substances)
- GaAs example



Incongruent melting

- Na/K example
- Peritectic temperature
- Peritectic behaviour occurs over a range of compositions up to the peritectic point.

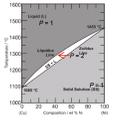
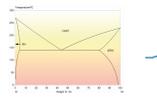
Temperature at which one solid phase transforms into another solid phase plus a liquid phase both of different chemical compositions than the original substance

Solid solutions, no "islands" or "dendrites" of another species observed under microscope

Edge areas have Bi doped/contaminated with Sn and vice versa

Granular regions

- Bi/Sn example
- No eutectic/peritectic behaviour
- Resemble L-V diagrams
- 2-phase region in middle
- No dendrites/islands
- Cu/Ni example
- liquidus and solidus lines



Examples

- interstitial substitutional alloys
 - Fe/C Steel
 - brittle vs. rigid
 - W/Sn Bullets
 - Eutectic
 - Liquid crystals

