Notes:

Homework : Set #10 is posted, due next Tuesday.

Today/tomorrow: Continue with chapter 18 after completing chapter 9.
I will skip section 9.6 (Gibbs phase rule) but cover 9.7 (phases of binary mixtures).

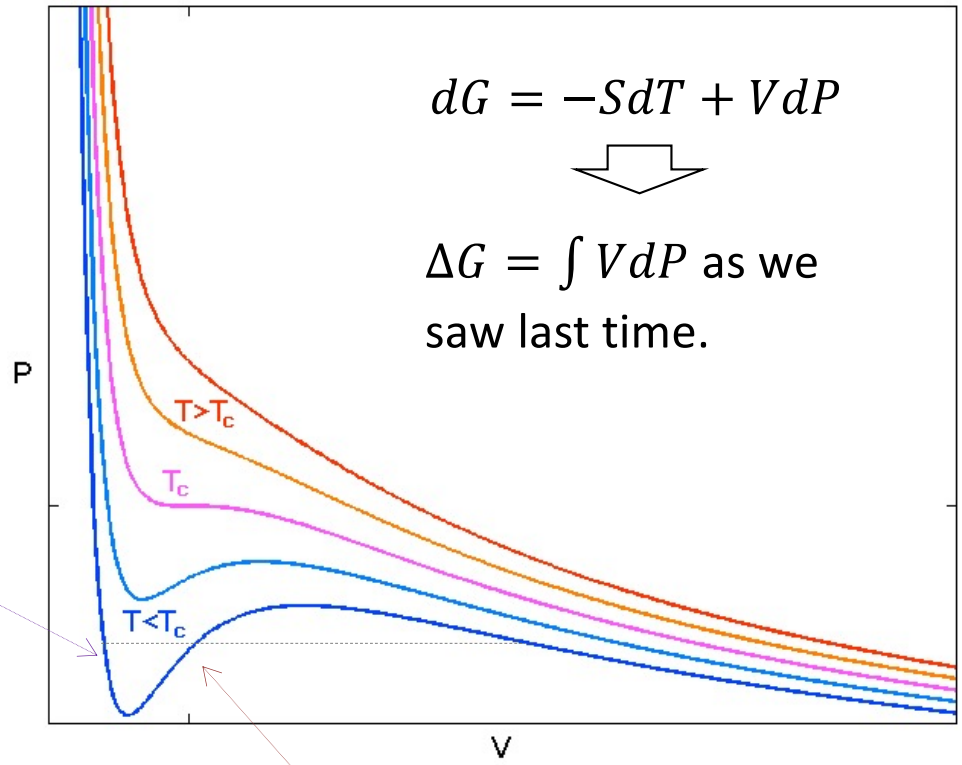
Phase Transformations:

Van der Waals gas: model system for 1st order transformation.

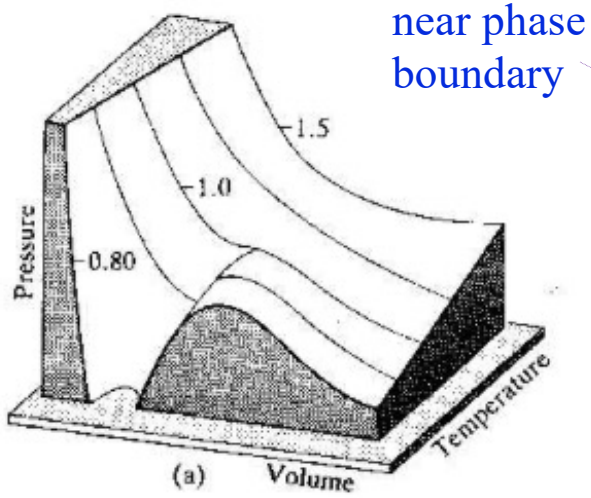
$$\left[P + a\left(\frac{n}{V}\right)^2\right]\left(\frac{V}{n} - b\right) = RT$$

$$dG = -SdT + VdP$$

$$\Delta G = \int VdP \text{ as we saw last time.}$$



Hysteresis near phase boundary

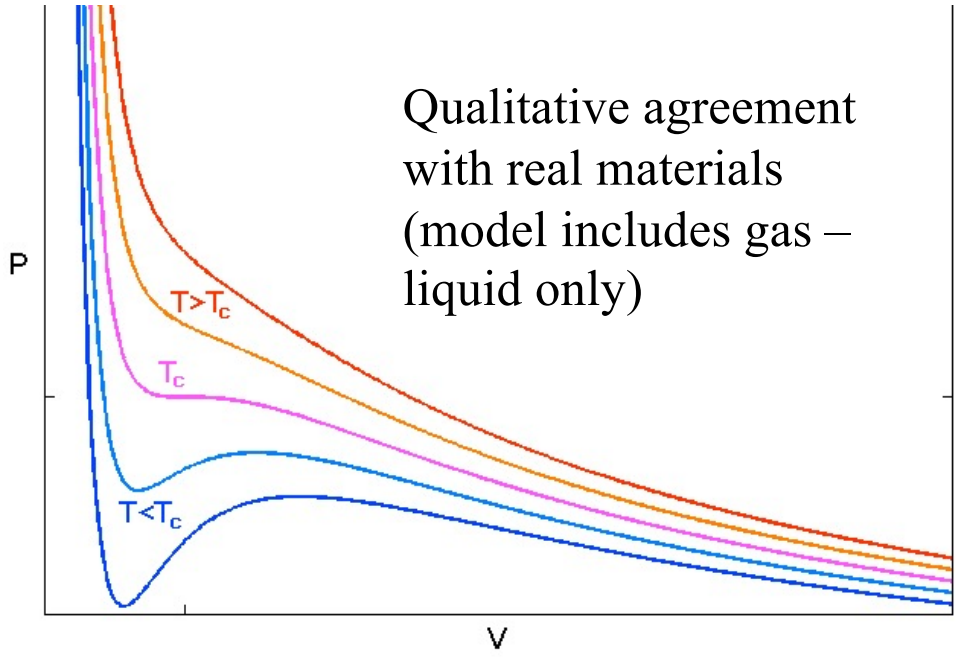


$T < T_c$, always unstable point

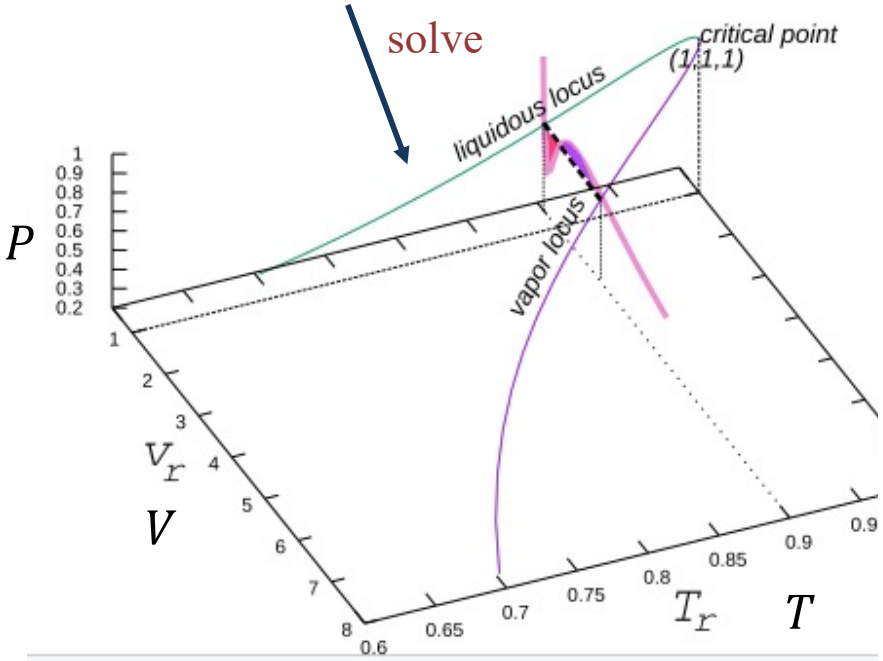
Maxwell construction (equal areas): determines equilibrium phase boundaries

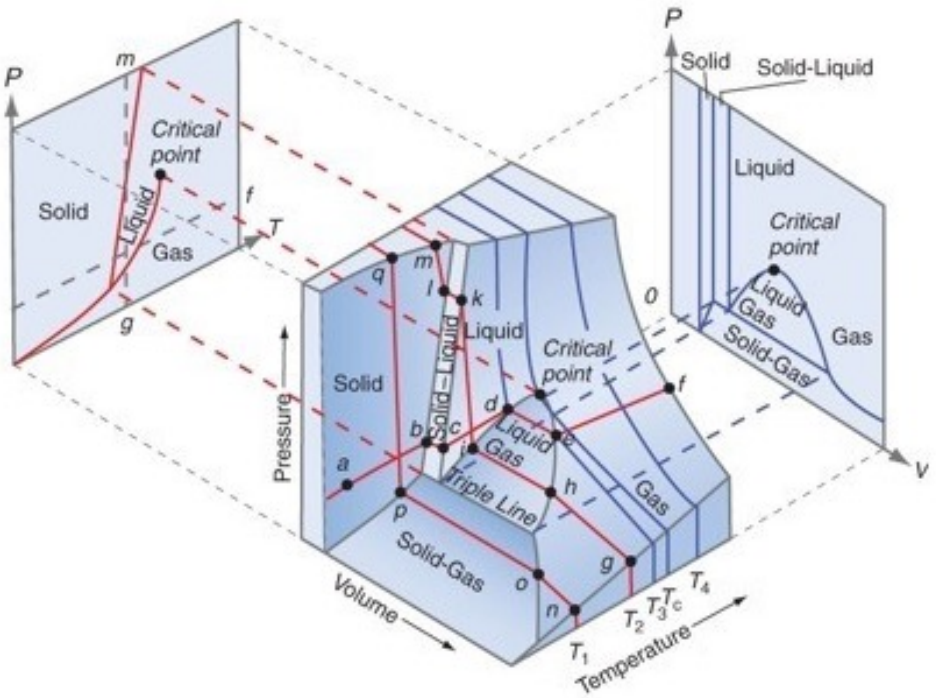
Phase Transformations:

$$\left[P + a\left(\frac{n}{V}\right)^2\right]\left(\frac{V}{n} - b\right) = RT$$



Qualitative agreement with real materials (model includes gas – liquid only)





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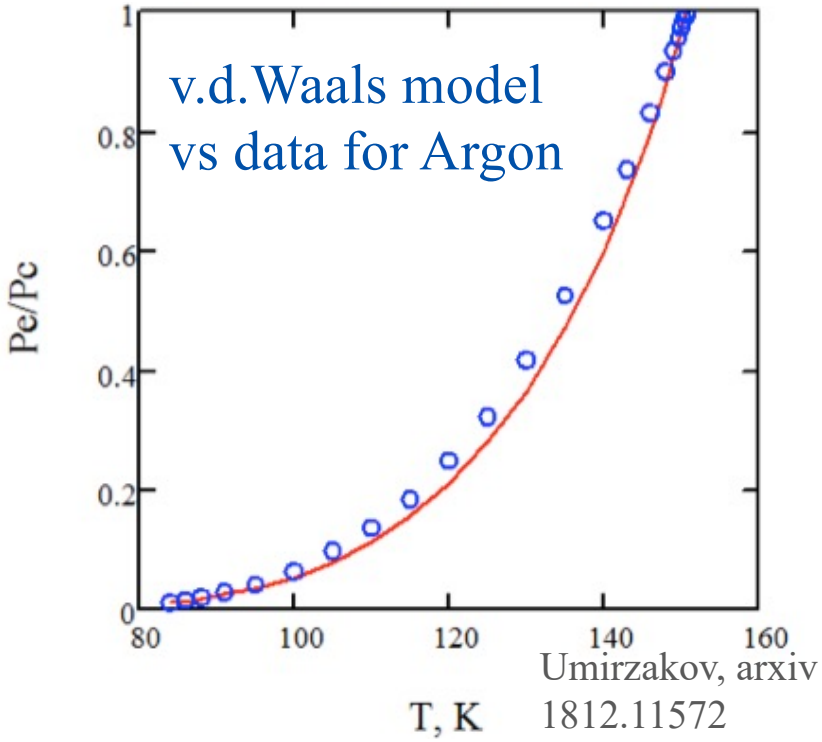
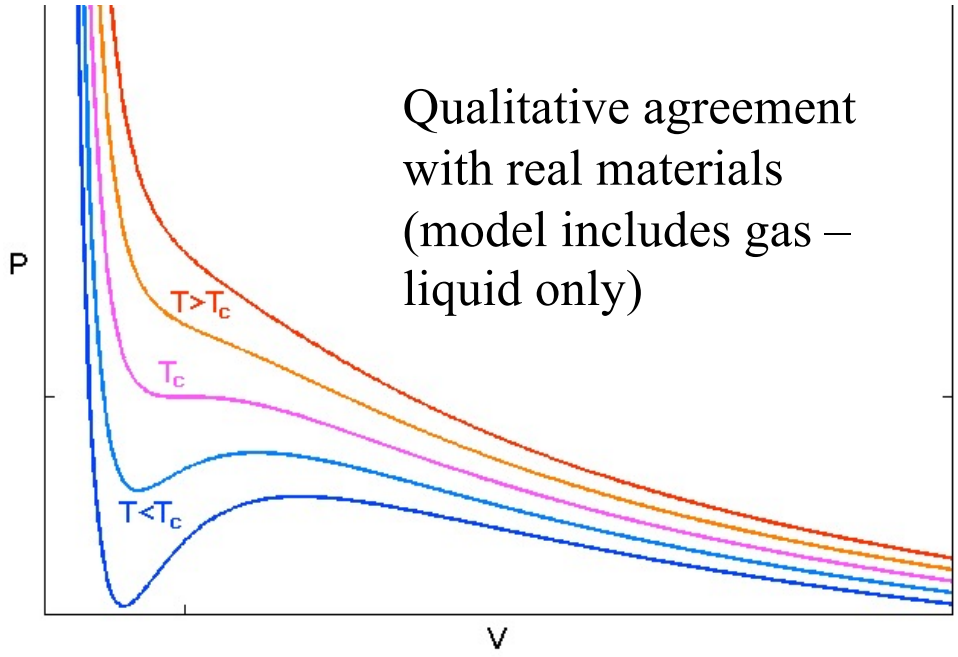


Umirzakov, arxiv 1812.11572



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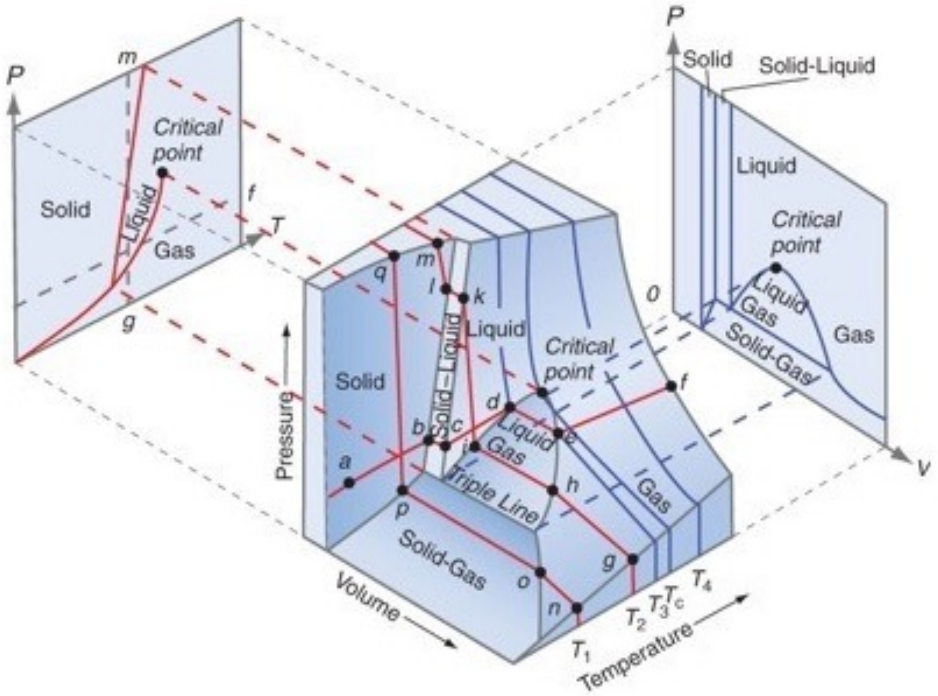
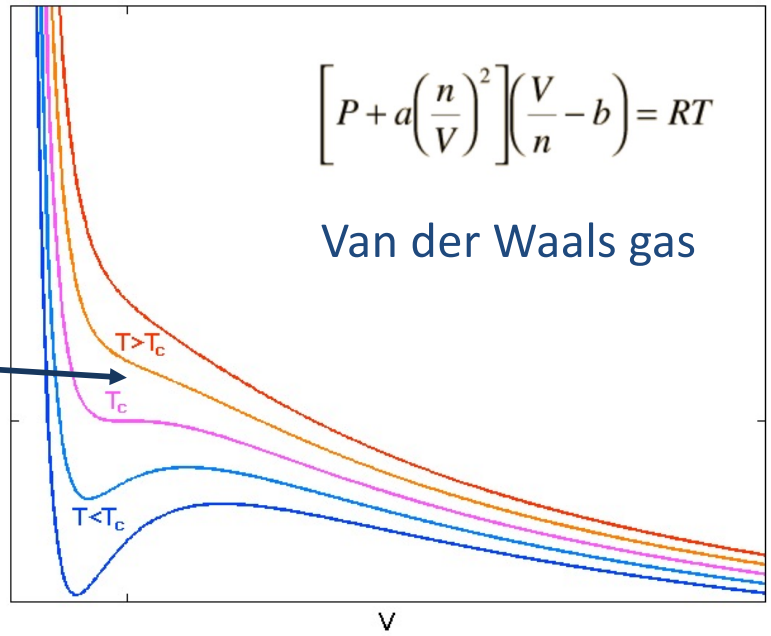
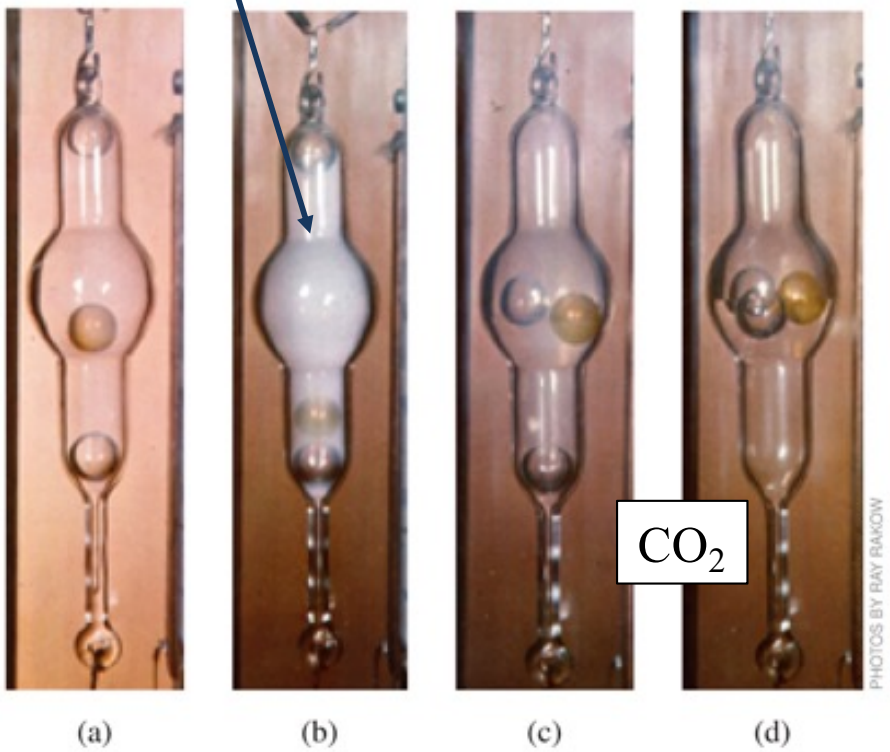


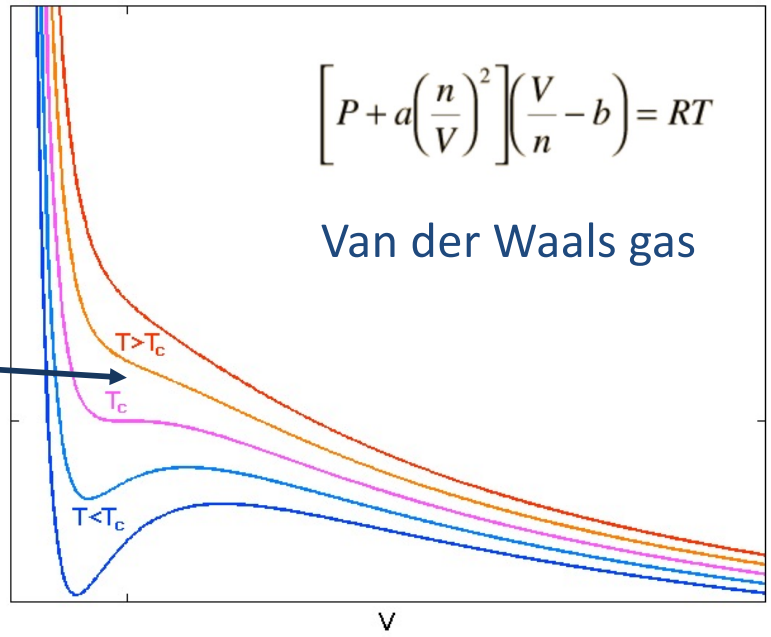
Critical opalescence at T_c (**2nd order phase transition**)

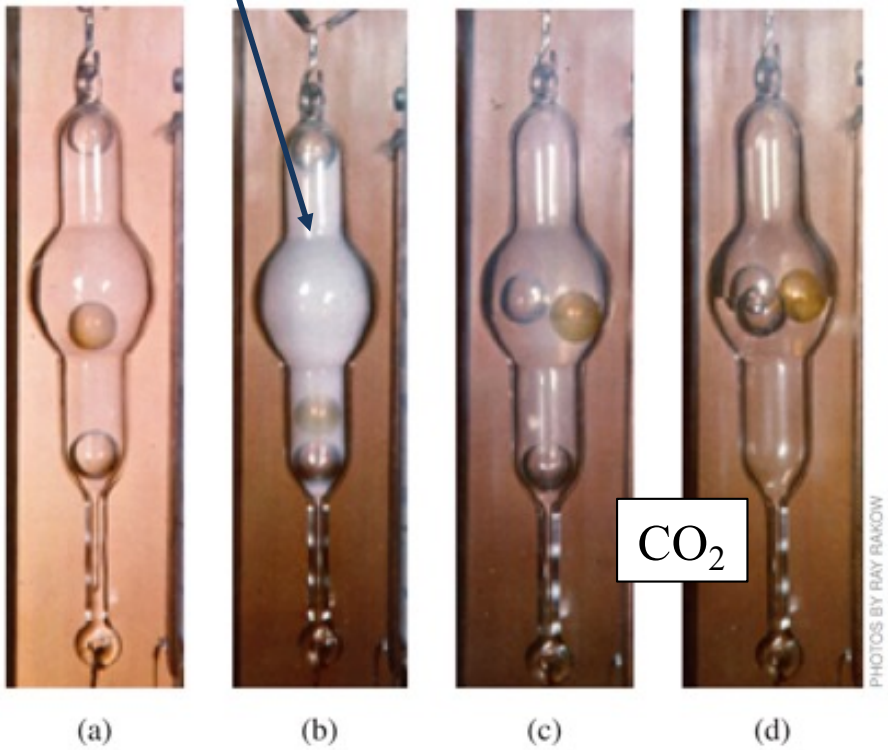


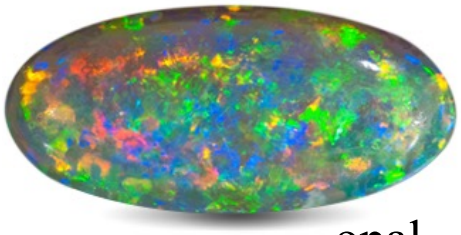


Infinite $\kappa = \frac{1}{V}\frac{\partial V}{\partial P}\Big)_T$, saw this in the previous HW problem.

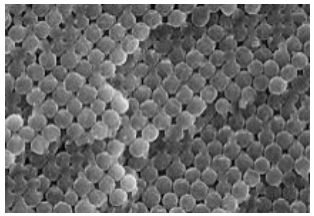
Critical opalescence at T_c (**2nd order phase transition**)



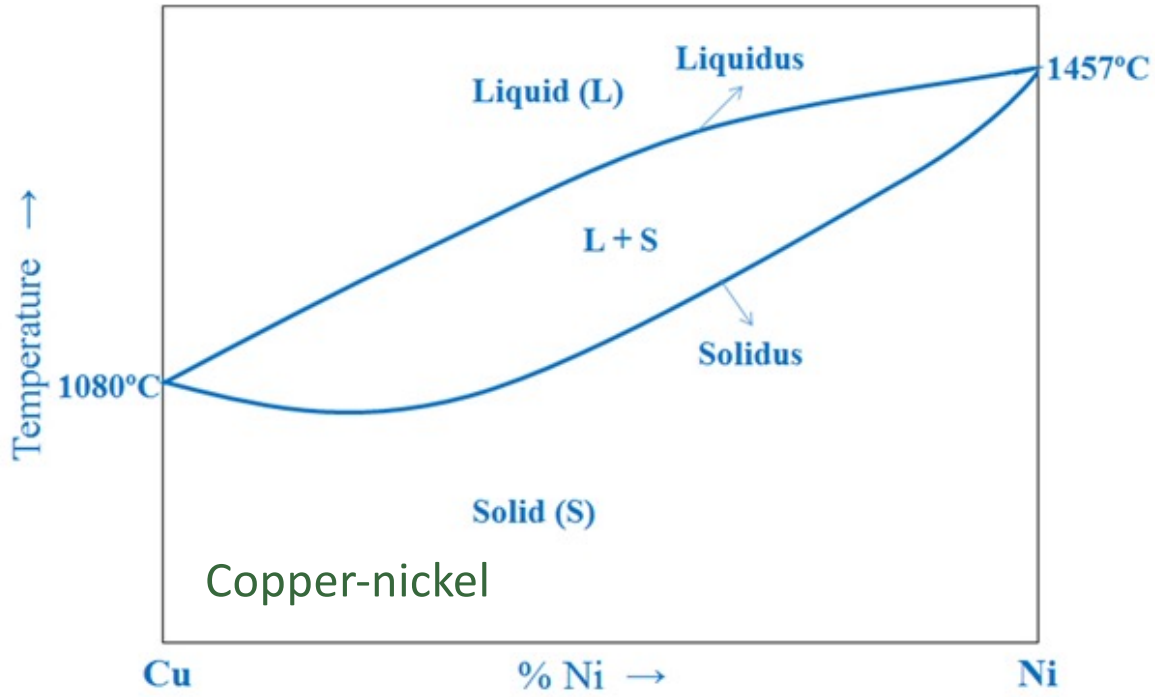




opal

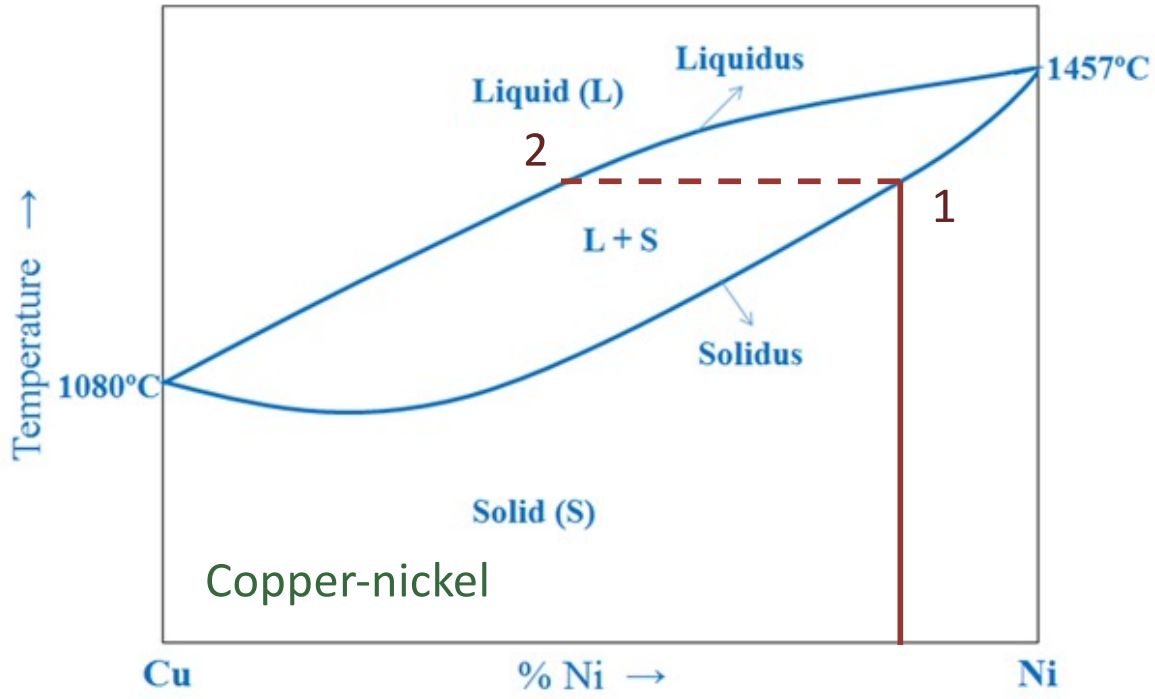


Mixed-phases



- Solid is random mixture (no ordering transition).
- Shown for specific pressure.
- Similar cases can occur for liquid to gas.
- 2-phase region: L/S phases in equilibrium have different compositions
- Importance of mixing entropy.

Mixed-phases



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- Similar cases can occur for liquid to gas.
- 2-phase region: L/S phases in equilibrium have different compositions
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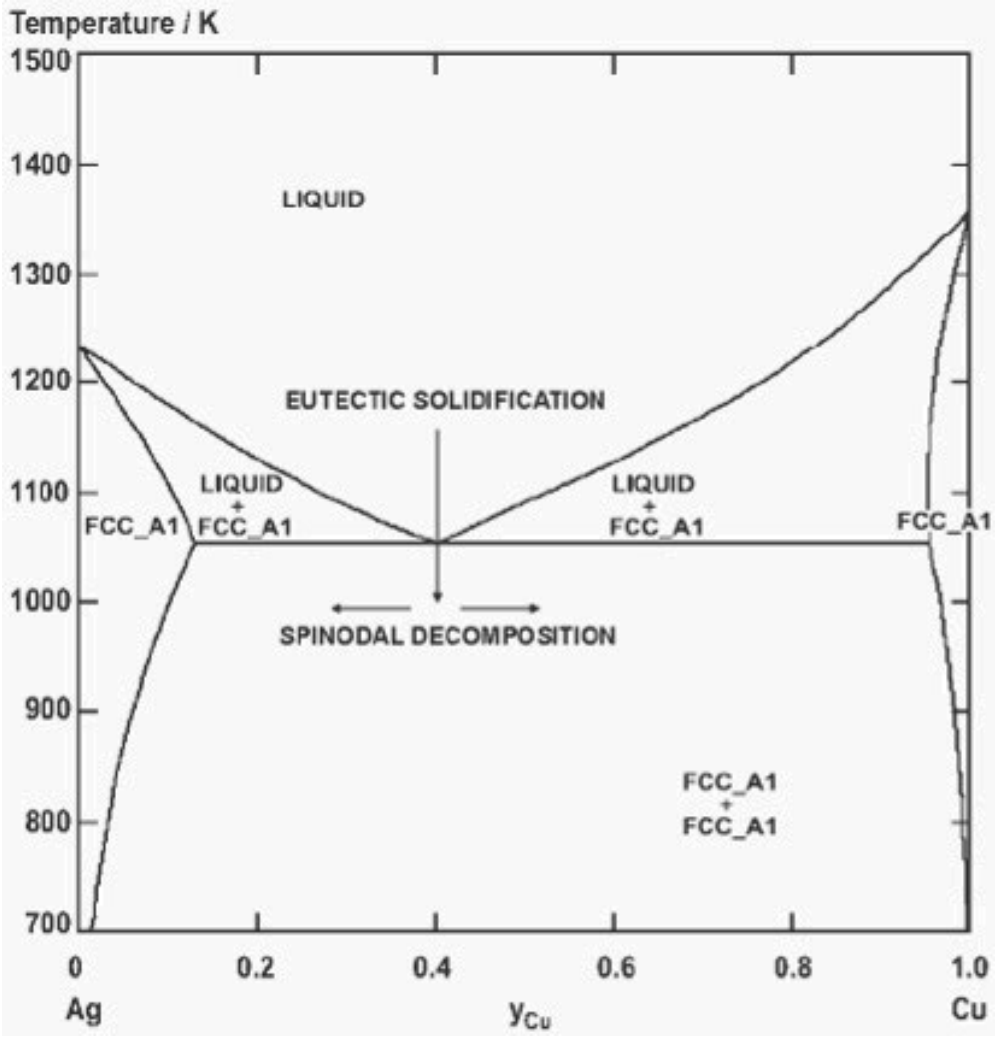
Mixed-phases

- This case: energy increases in solid due to mixing.
- Mixing entropy + interaction energy control stability, similar to previous example

Silver-copper



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Power-law coarsening in network-forming phase separation governed by mechanical relaxation

Michio Tateno[1,2] & Hajime Tanaka[1]✉

Randomly selected paper from this year: free energy & phase segregation dynamics can be used to make local structures in polymer mixtures, other applications.

Fig. 1: Phase separation and dynamic asymmetry.