3.020 – Thermodynamics of Materials Recitation 6

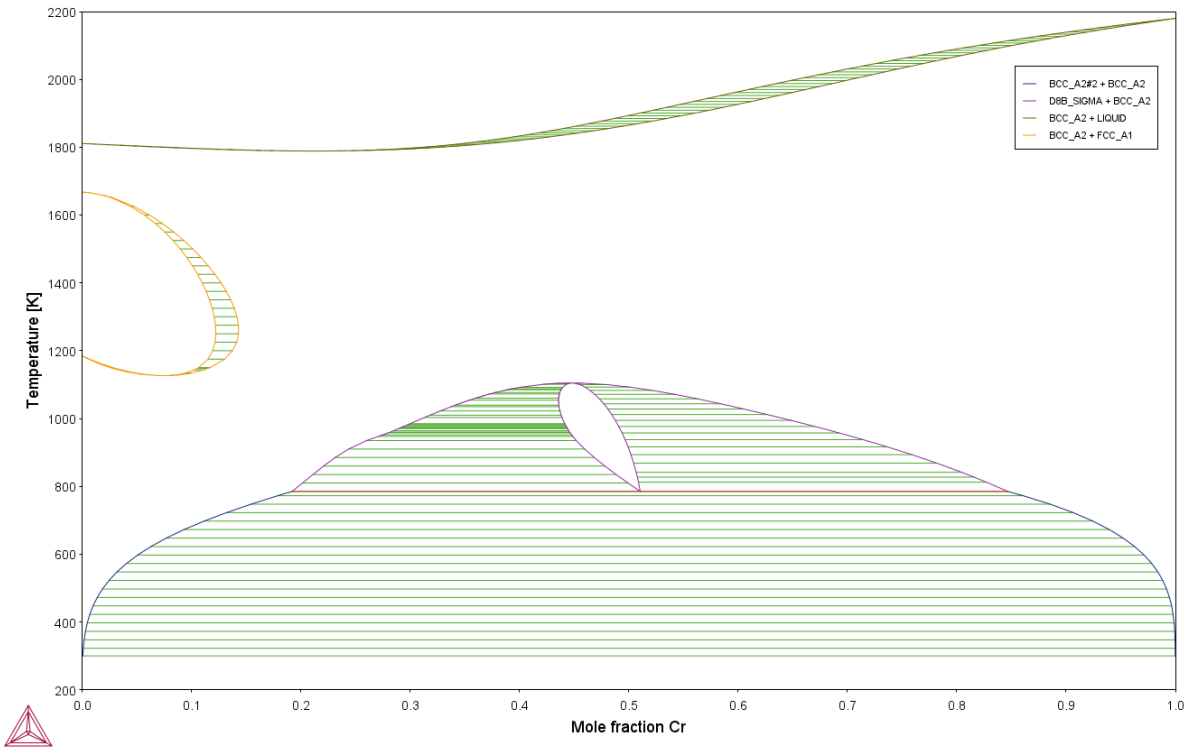
Problem 1

In lecture 25, we have studied the phase diagram of the Cr-Fe system. We have shown how the simplified phase diagram (without the δ phase) behaves as a spinodal system. Here, we will study the oversimplified general case (e.g. without δ, FCC and liquid phases), using simply one solution model in the general form of $\Delta H_{mix} = a_0 X_1 X_2$ with a_0 a constant.

a) For which values of a_0 the solution is ideal, or regular.
b) For which values of a_0 the solution is endothermic, or exothermic.
c) Calculate for which a_0, spontaneous unmixing occurs. Interpret the result for realistic values of X_2 and T. What does it mean?
d) From (c) we know what kind of a_0 values can lead to spontaneous unmixing. Now, let's calculate the temperature range at which spontaneous unmixing can occur. The maximal temperature at which spontaneous unmixing occurs is called the critical temperature (T_c).
e) Write down the set of equations that we need to solve in order to construct the binary phase diagram of this system described by this solution model (hint: common tangent conditions).

Take $a_0 = 15\ 125\ J/mol$.

f) Make the $\Delta G_{mix}(X_2)$ sketch of this system at $\mathrm{T} = 800\ \mathrm{K}$, $\mathrm{T} = 900\ \mathrm{K}$ and $\mathrm{T} = 1000\ \mathrm{K}$.
g) Use the sketch in (f) to estimate the $\mathrm{T}(X_2)$ graph (e.g. binary phase diagram) and draw the three isotherms.



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