

The Gibbs energy basis of a phase diagram.

It is instructive to consider phase diagrams represented as a series of Gibbs energy curves as shown in Figure 1.

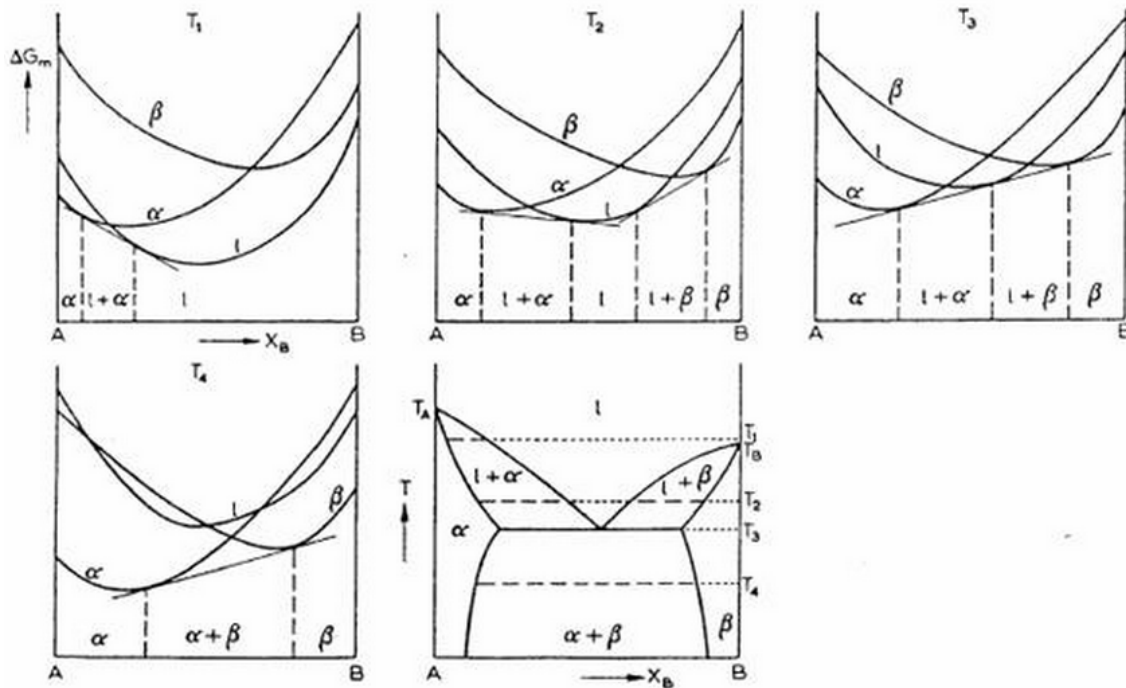


Figure 1: Gibbs energy curves for α , β and liquid, and their relationship to the eutectic phase diagram. After Prince^[1] (available [here](#)).

Taking the Gibbs energy curve corresponding to T_1 , the Gibbs energy of the liquid is lower for all compositions than the Gibbs energy of the β phase, so we would expect this temperature to be above the melting point with respect to β , which can be seen by referring to the phase diagram. The Gibbs energy curves of the α phase and liquid intersect, indicating that at some composition they are in equilibrium and so will co-exist. At T_2 the Gibbs energy curves of the α phase and liquid and the β phase and liquid intersect and a common tangent construction¹ represents the range of compositions defined by the points of tangency which delimit the single phase regions (i.e. those compositions outside the range of the common tangent) and the two phase

¹See document on the Chemical potential and the document of Phase Diagrams.

regions (i.e. those compositions inside the range of the common tangent). At T_3 , the eutectic temperature, a common tangent to all three curves exists, indicating that α , β and the liquid are in equilibrium, so the chemical potentials of the components A and B are equal in all phases, $\mu_A^\alpha = \mu_A^\beta = \mu_A^{\text{liquid}}$ and $\mu_B^\alpha = \mu_B^\beta = \mu_B^{\text{liquid}}$. Finally at T_4 the Gibbs energy of the liquid is greater at all compositions than the solid phases and so the system comprises of only solid phases (either solid solutions or pure phases or intermetallic compounds).

References

- [1] A. Prince, *Alloy Phase Equilibria*. Elsevier, 1966.