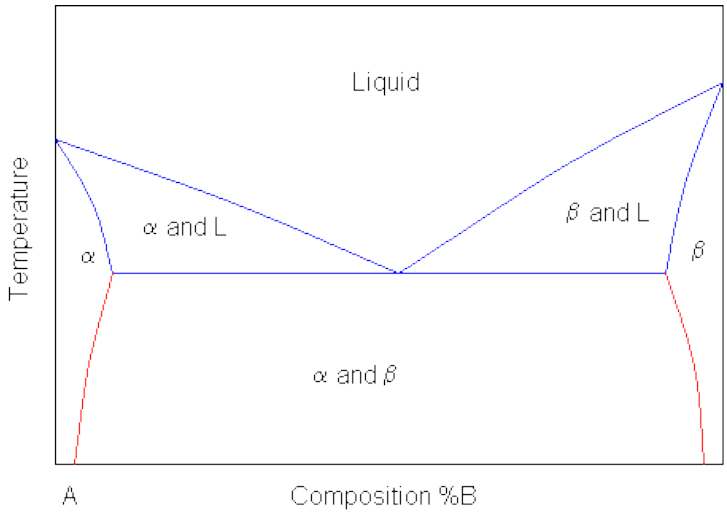
Phase diagrams and Solidification

Introduction :

The phase diagram is a crucial part of metallurgy - it shows the equilibrium states of a mixture, so that given a temperature and composition, it is possible to calculate which phases will be formed, and in what quantities. As such it is very valuable to be able to construct a phase diagram and know how to use it to predict behaviour of materials.

The main theory behind phase diagrams is based around the latent heat that is evolved when a mixture is cooled, and changes phase. This means that by plotting graphs of temperature against time for a variety of different compositions, it should be possible to see at what temperatures the different phases form.

It is relatively easy to produce a rough binary phase diagram, as will be shown later in the package, but although it is quick to take readings for the top part of a phase diagram, it takes longer, and hence more sensitive equipment to monitor the changes that take place when a solid changes phase. A typical simple binary phase diagram is as follows:



Where L stands for liquid, and A and B are the two components and ⟨ and ® are two solid phases rich in A and B respectively. The blue lines represent the liquidus and solidus lines, which are relatively simple to measure. The red lines involve a solid-to-solid transition, and so require much more sensitive equipment.

However, there is also a lot of thermodynamic theory behind phase diagrams, which allows more problematic or more complex systems to be predicted, and this can lead to faster creation of phase diagrams, as it can take a long time to pick up all the stable phases in experiments, and there is not always the time available for such practical work.

A crucial point to remember is that a phase diagram should always display the equilibrium phases, and so with cooler temperatures, these are hard to attain due to kinetic problems. Even at higher temperatures, there may be problems of having enough time for the solid to fully equilibrate as the system is cooling.

Source: http://www.doitpoms.ac.uk/tlplib/phase-diagrams/intro.php