Phase diagrams (of two component systems)

In general in a binary phase diagram the temperature or the pressure is plotted versus the molar fraction of one the two components. The variable of state that is not plotted is constant. The lines in the phase diagram are curves that divide different phases. They can divide different solid modification but also different states.

1. binary diagram with complete range of solution in the liquid and solid state

In this diagram we can see two curves. The two curves cross each other at the edges (molar fraction = 0 or 1). These points are the melting points of the pure components. The upper line is the liquidus curve, the lower one is the solidus curve. In between the curves two phases coexist. Hence the liquidus curve is the border between liquid state and a mixture of liquid and solid state and the solidus curve is the border between solid state and a mixture of liquid and solid state. Upon cooling a melt of a certain composition one crosses the liquidus curve at one point. One can easily determine the composition of the solid that crystallizes at that point by moving aside until one crosses the solidus curve. The solid that crystallizes has normally another composition than that of the melt, so the liquid gets poorer of one component.

2. eutectic system

When the two components do not form mixed crystals one can obtain a eutectic system. The liquidus curve has a minimum and the solidus curve is represented by a horizontal line that crosses the minimum. By cooling down a melt of a certain composition (not the eutectic composition) pure crystals of one of the two components solidify. Therefore the melt gets poorer on this component. The composition of the liquid moves further in the direction of the eutectic point until it finally reaches the eutectic point. By cooling down a melt with the eutectic composition all liquid solidifies. In this solid one can find pure crystals of both components but no mixed crystals.

3. eutectic system with partial solubility

A special case of the eutectic system is that the components show a minor solubility in each other. By cooling down a melt of a certain composition (not the eutectic composition) crystals of one component with a small content of the other component crystallize.

4. binary system with the formation of a congruently melting compound

In principle this phase diagram looks like two of the eutectic system. Therefore there are two eutectic points and one maximum of the liquidus curve. This maximum is at the composition of the compound and hence it has the value of the melting point of the compound. Congruently melting means that if we cool down a melt with exactly the composition of the compound the pure compound crystallizes.

5. binary system with the formation of an incongruently melting compound

An incongruently melting compound can not be purely obtained by cooling down a melt with exactly the composition of this compound. First pure crystals of one of the pure components solidify. Upon cooling more and more one finally reaches the peritectic point. This point is neither a minimum nor is it between the component that has solidified yet (A) and the compound (AB). At the peritectic point three phases are in equilibrium. These phases are A, AB and the liquid. By cooling the system the crystals of the compound solidify until one finally reaches the eutectic point where all liquid crystallizes.

The reaction at the peritectic point is the following:

A + liquid → AB + (liquid)

Theoretically all A-crystals would react with the liquid to form AB-crystals. Therefore one would only obtain AB and B-crystals after the whole system has solidified. But in practice one gets A, AB and B-crystals. This is due to the fact that the A crystals fall to the bottom and are lost to the system and that the peritectic reaction is a very slow reaction.