3. Two metals completely soluble in each other in the liquid state and partially soluble in the solid state (Partial Solubility)

The partial solubility equilibrium diagram is derived from the previous two diagrams that indicated soluble and insoluble states. Few alloys exhibit total insolubility or total solubility and many metals combine to form a partial solubility system. The ends of the totally soluble system are amalgamated with the central portion of the insoluble or eutectic system to form the partially soluble in the solid state equilibrium diagram as shown in figure below. The partial solubility diagram looks very different to what we have encountered (happened) so far so we will work on its various components before we move on to seeing its uses. (**Lead-Tin**) combine to form solder and the equilibrium diagram is shown below. On this diagram we have included drawing of a typical microstructure for six different alloys of (Lead-Tin) these microstructures are fairly self-explanatory further explanations can be gotten by clicking on the relevant microstructure in figure below.

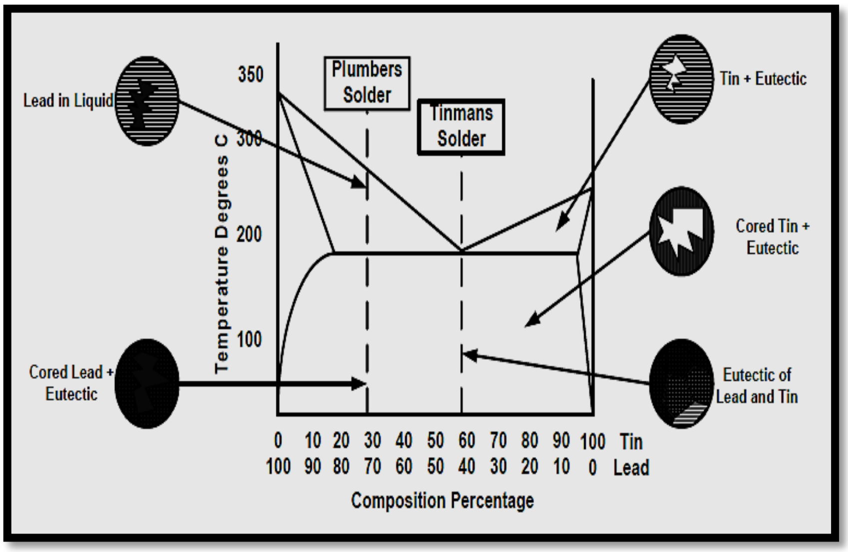

Figure 1. Lead-Tin (solder) partial solubility.

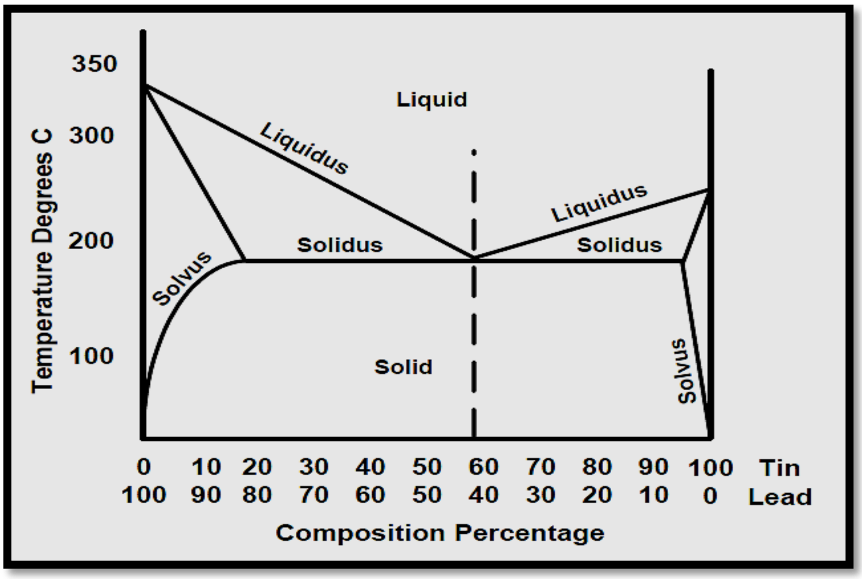

Figure 2. Liquidus and Solidus lines.

Inter-Metallic Compounds

Whilst some metal alloy systems exhibit total or partial solubility and others are insoluble in the solid state, a number of metals combine together to form an intermediate phase or intermediate compounds. There are two types of inter-metallic compounds which are often encountered (happen) in metallurgy. These compounds are usually **hard** and **brittle**.

1. Electron Compounds

These compounds are of definite chemical crystal structure and get up if the two alloying metals are of different crystal structure, valence, and if one of these metals is electro-positive with the other being electro-negative, an example of this type of electron compound would be an alloy of the elements (**Magnesium-Tin)** which combine to form an inter-metallic compound (**Mg_2Sn)**. The composition of the compound is fixed and consists of two atoms of Magnesium combining with one atom of Tin. Metallic compounds form a crystal lattice with the atoms of the alloying metals taking up specific positions within the lattice.

2. Interstitial Compounds

Interstitial compounds, as the name suggests form between metals, or metals and non- metallic elements, with atom sizes very similar to those that form interstitial solid solution. One set of atoms fit into the spaces or interstices, between the larger atoms. Iron Carbide (**Fe_3C**) or **Cementite** which is important in the study of (Iron-Carbon) diagrams is an example of an interstitial compound. As the chemical symbol for Cementite (**Fe_3C)**, we know that **Cementite** is an interstitial compound containing **3** iron atoms for every **1** atom of Carbon.

The Allotropy of Iron

Allotropy is the ability of some elements to exist in different physical forms (differing in color, hardness, melting point etc.). Iron is allotropic; at room temperature pure iron exists in the **BCC** crystal form but on heating transforms to a **FCC** crystal. The temperature that this first transformation takes place is known as a **Critical Point** and it occurs at **910** degrees Celsius. This change in crystal structure is accompanied by shrinkage in volume, since the atoms in the **FCC** crystal are more densely packed together than in the **BCC** crystal. At the **Second Critical Point** the **FCC** crystal changes back to a **BCC** crystal and this change occurs at **1390** degrees Celsius.

- Iron below **910** degrees is known as alpha iron (**α**) **BCC.**
- Iron between **910** and **1390** degrees is known as gamma iron (**γ**) **FCC**.
- Iron above **1390** degrees is known as delta iron (**δ**) **BCC.**