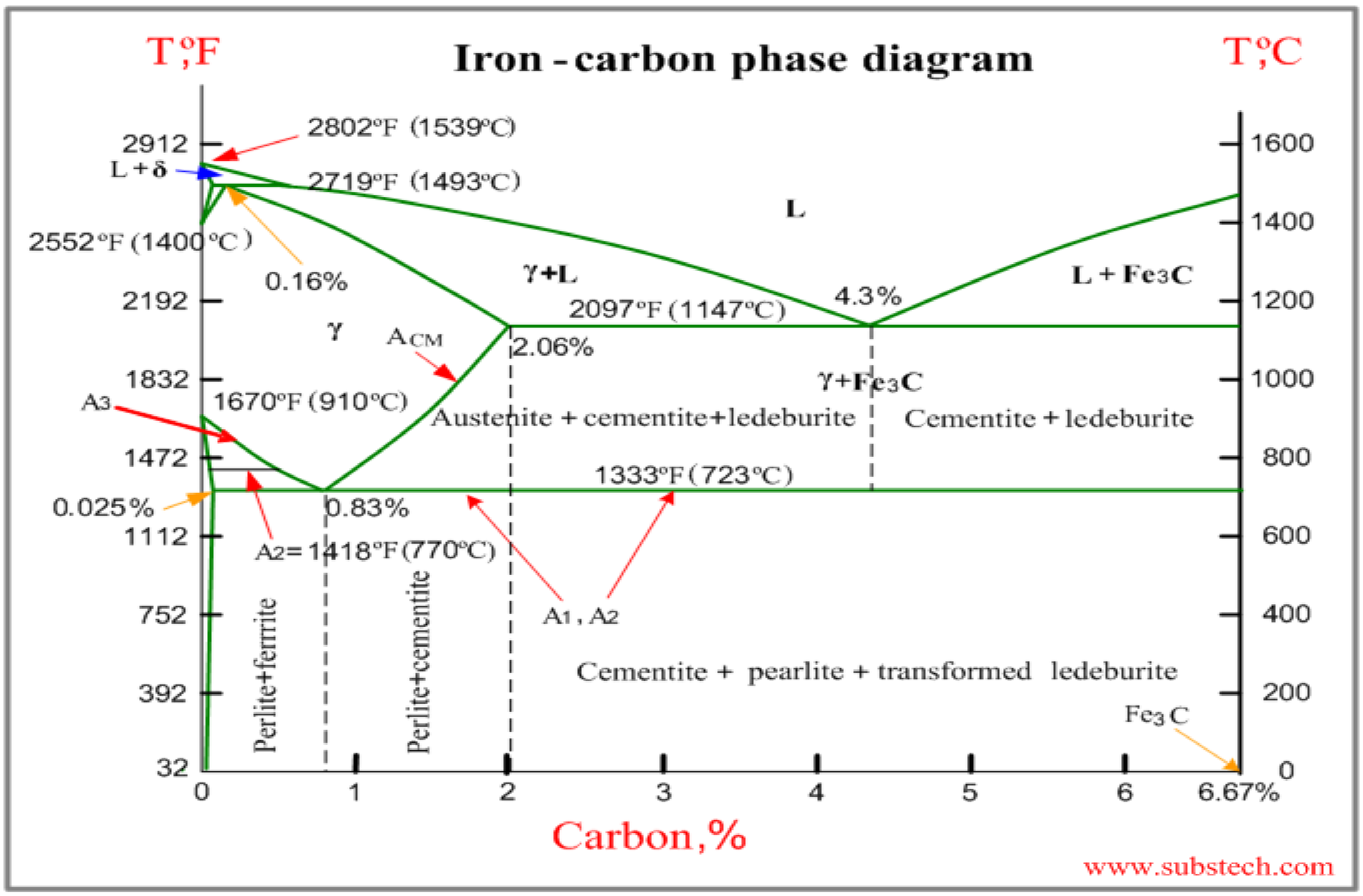
IRON – IRON CARBON EQUILIBRIUM DIAGRAM

(Explain the Iron –iron carbide equilibrium diagram with the reactions taking place in it.)

- The iron-carbon phase diagram is used to understand the different phases of steel and cast iron. Both steel and cast iron are a mix of iron and carbon.
- This iron carbon phase diagram is plotted with the carbon concentrations by weight on the X-axis and the temperature scale on the Y-axis.
- The carbon is present as an interstitial impurity.



Types of Ferrous Alloys on the Phase Diagram

- The weight percentage of carbon is from 0% to 6.67%.
- Up to 0.008% of Carbon, it is pure iron.
- It exists in the α-ferrite form at room temperature.
- From 0.008% up to 2.14% carbon, it is called steel. Within this range, there are different grades of steel known as low carbon steel (or mild steel), medium carbon steel, and high carbon steel.
- As the carbon content increases beyond 2.14%, it is cast iron.

Boundaries

- Boundaries are represented as lines in the diagram A1, A2, A3, A4, and ACM.

- A stands for ‘arrest’.
- As the temperature of the metal increases or decreases, phase change occurs at these boundaries.
- Along these lines (A1, A2, A3, A4, and ACM) the heating results in a realignment of the structure into a different phase and thus, the temperature stops increasing until the phase has changed completely. This is known as thermal arrest as the temperature stays constant.

Eutectic Point

- For the iron-carbon alloy diagram, the eutectic point is where the lines A1, A3 and ACM meet.
- At these points, liquid phase freezes into a mixture of two solid phases.
- The alloys formed at this point are known as eutectic alloys. On the left and right side of this point, alloys are known as hypoeutectic and hypereutectic alloys respectively.
- Hypo eutectoid steel – 0.008 to 0.8% of carbon
- Hypereutectoid steel – 0.8 to 2% of Carbon

Different Phases

α-ferrite (α- iron)

- Ferrite, also known as α-ferrite (α-Fe) or alpha iron, is **pure iron, with B.C.C crystal structure**.
- This phase is stable at room temperature and is magnetic below 768°C.
- It has a maximum carbon content of 0.022 % and it will transform to γ-austenite at 912°C.

γ-austenite (γ - iron)

- This phase is a solid solution of carbon in FCC structure(Fe).
- On further heating, it is converted into BCC δ-ferrite at 1395°C.
- This phase is non-magnetic.

δ-ferrite

- This phase has a B.C.C structure as that of α-ferrite but exists only at high temperatures. The phase can be spotted at the top left corner in the graph.
- It has a melting point of 1538°C.
- It is ferromagnetic.

Fe_3C or Cementite

- Cementite is a metastable phase of this alloy with a fixed composition of Fe_3C.
- It decomposes extremely slowly at room temperature into Iron and carbon (graphite).

Pearlite

- Pearlite is **the eutectoid mixture of cementite and ferrite**.

Ledeburite

- Ledeburite is a mixture of 4.3% carbon in iron and is a eutectic mixture of austenite and cementite.

Fe-C liquid solution

- 'L', is the liquid solution of carbon in iron.
- δ-ferrite melts at 1538°C, and this shows that melting temperature of iron decreases with increasing carbon content.

Reactions taking place is as follows,

→ Peritectic reaction equation may be written as (2720°F)

$$\text{Delta}(\delta) + \text{Liquid} \underset{\text{Heating}}{\overset{\text{Cooling}}{\rightleftharpoons}} \text{Austenite}$$

→ eutectic reaction takes place at (2066°F) and its equation may be written as

$$\text{Liquid} \underset{\text{Heating}}{\overset{\text{Cooling}}{\rightleftharpoons}} \text{Austenite} + \text{cementite (Ledeburite)}$$

→ Eutectic point is at 4.3% carbon.

→ Eutectoid reaction takes place at (1333°F) and its equation may be written as

$$\text{Solid} \underset{\text{Heating}}{\overset{\text{Cooling}}{\rightleftharpoons}} \text{Ferrite} + \text{cementite (pearlite)}$$