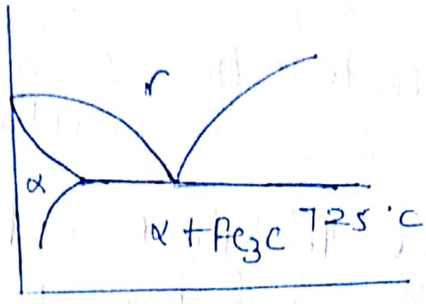
TTT diagram :- (Time - Temp. - Transformation curve)

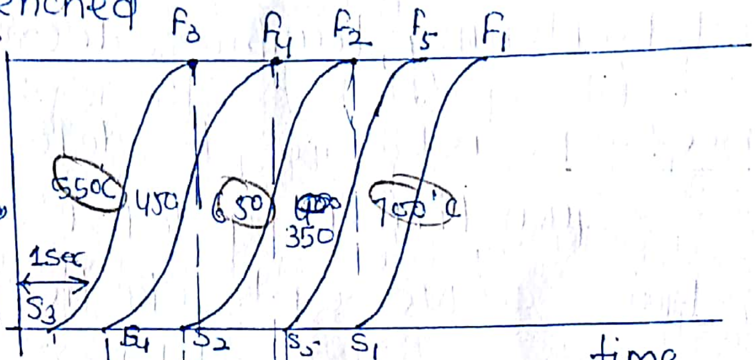
Bains



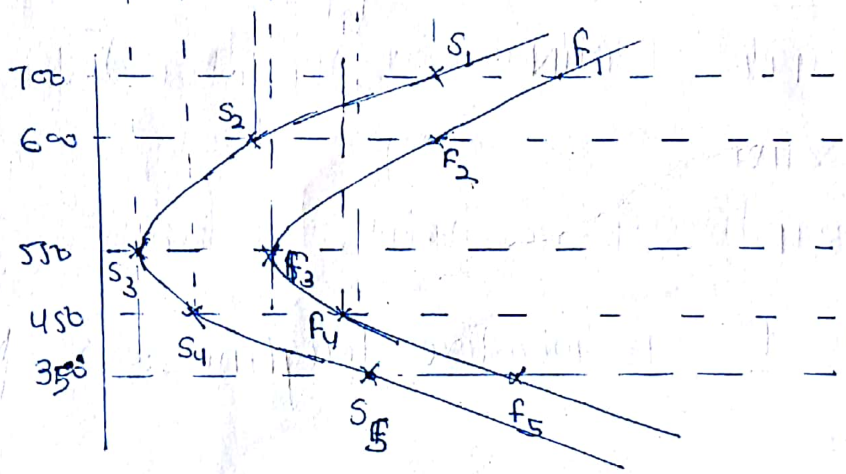
S - Start point
F - Final state of point

eutectoid Composion
750° then quenched

1. 700 °C
2. 600 °C
3. 550 °C
4. 450 °C
5. 350 °C



TTT Curve
Bain's Curve
C Curve
S Curve

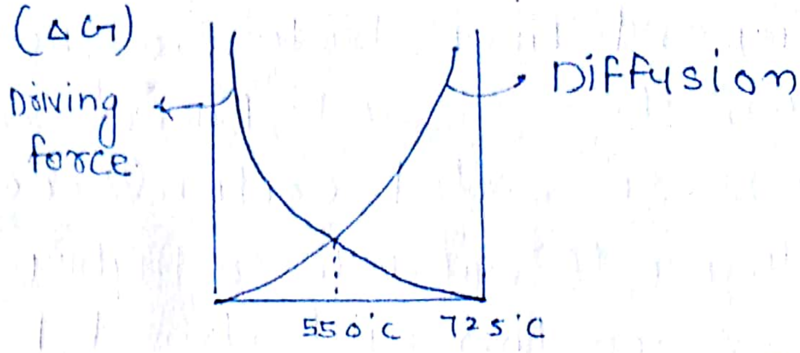


Austenite can't be stable below 725 °C, but upon quenching austenite below 725 °C it was observed that for certain period of time there was no change in microstructure this period is called incubation ~~period~~ time.

Upon decreasing quanching temp. there was a decrease in incubation time and at 550 °C it is 1 sec only.

Upon decreasing quanching temp. further incubation period again start ↑.

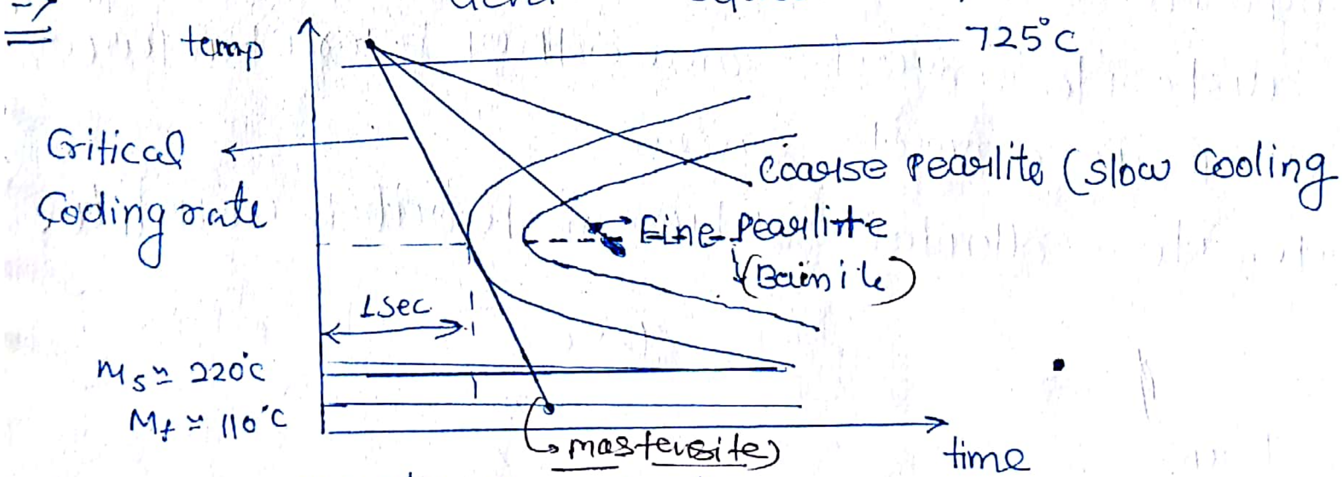
① Driving force (ΔG)
② Diffusion



when quenching temp is close to 725°C driving force is very low so incubation period is high. At 550°C driving force and diffusion both are optimum so incubation time is only 1 sec. when quenching temp. is below 550°C, although driving force is quite high but carbon atoms does not have enthsiasm to jump from one interstitial site to another, this increase incubation period

Driving force:- external force on iron atoms to achieve equilibrium.

⇒



220°C Ms start of martensite
110°C Mf finish of martensite

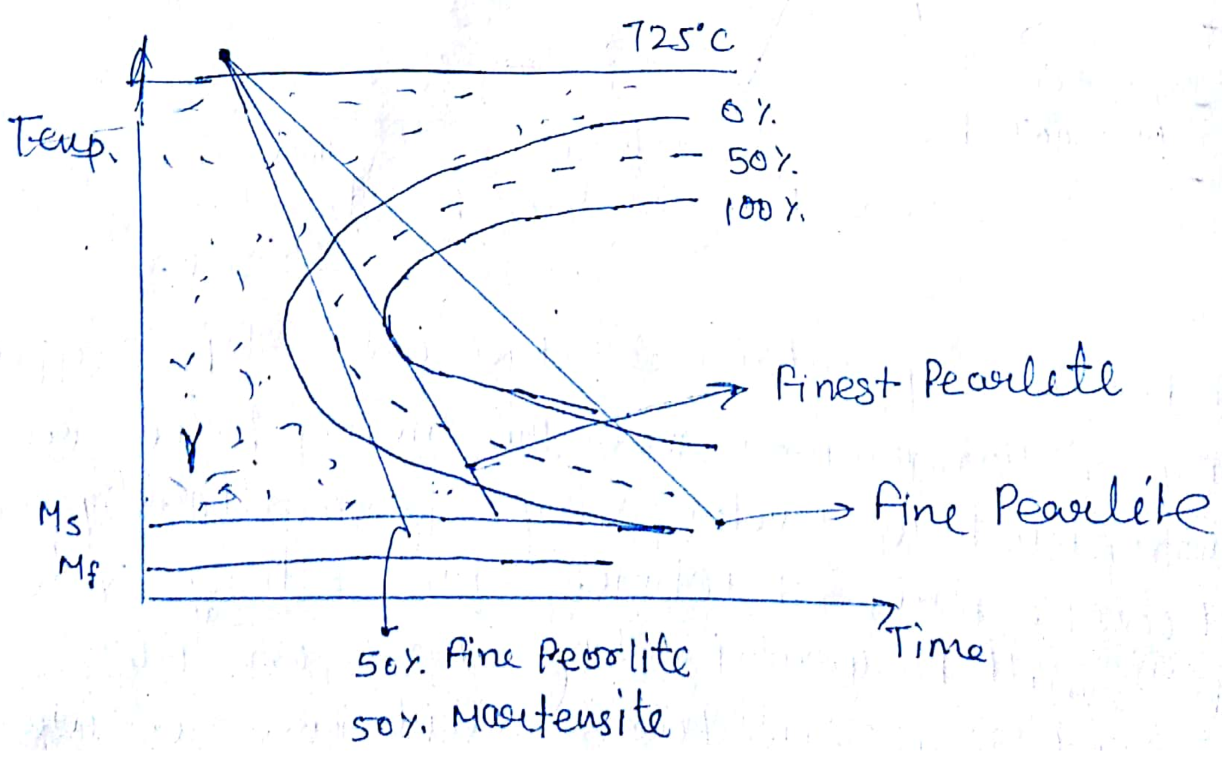
when cooling rates are slow, we enter in upper region of TTT diagram and since the driving force are low, microstructure develops very systematically so we get coarse grain structure. when cooling rate is there will be greater external force on iron atom to quickly achieve the equilibrium so we will get finer and finer structure. When cooling rate are such that it just touches nose of TTT diagram, are called critical cooling time. Any cooling rate equal to or higher the critical cooling rate carbon will almost freeze at its location and microstructure appears like mechanical mixture of cementite and ferrite or a submicroscopic cementite (smaller than microscopic) in structure of ferrite. This microstructure is called 'Martensite'. It is bct (body centred Tetragonal) structure and it is hardest metastable phase of iron.

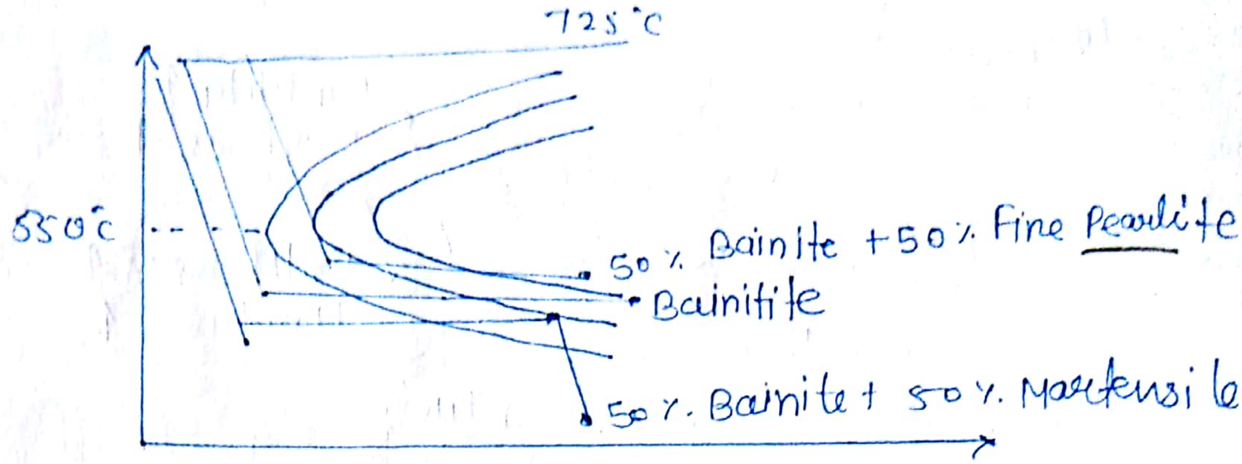
⇒ These TTT diagram are not equilibrium diagrams

⇒ All the lines on TTT diagram are that of decomposition austenite into some other microstructure, once austenite converts some other microstructure it never reconverts again

* martensite - Colloidal solution of ferrite & cementite.

⇒





Austempering - Formation of Bainite

Ausforming

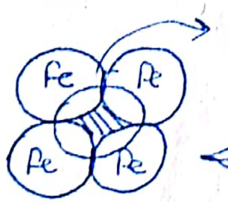
> Austenite is cooled at a rate equal to or greater than critical cooling rate to a temp below nose but above martensite start line. This temp is maintained for substantial period of time so that cooling curve enters into TTT diagram. This produces Bainite.

- Bainite cannot be produced by continuous cooling
- During this period if material is formed the process is called 'Ausforming'.

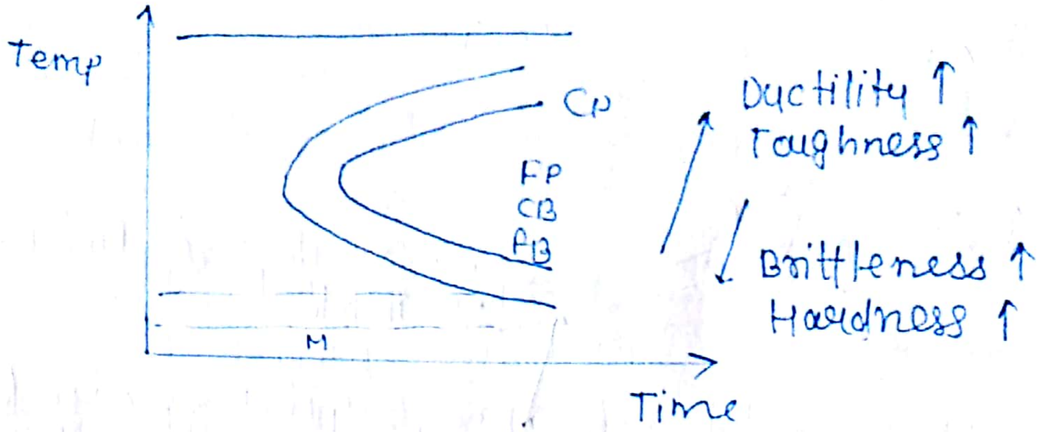
Pearlite - Diffusional

Martensite - Athermal (Non diffusion)

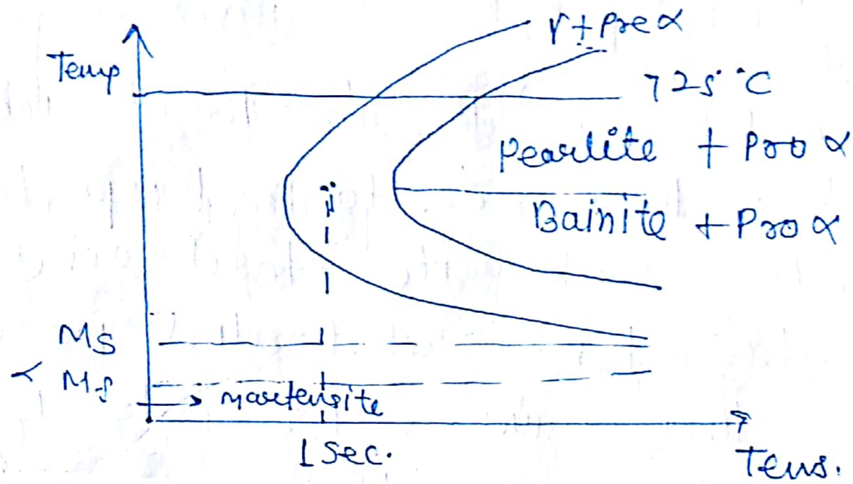
Bainite - Diffusion + shear



Due to high driving Force, there is slip b/w Fe-atom which forces carbon atom to diffuse. This is known as shear. Bainite is formed by this mechanism (Partly by diffusion tendency of carbon).



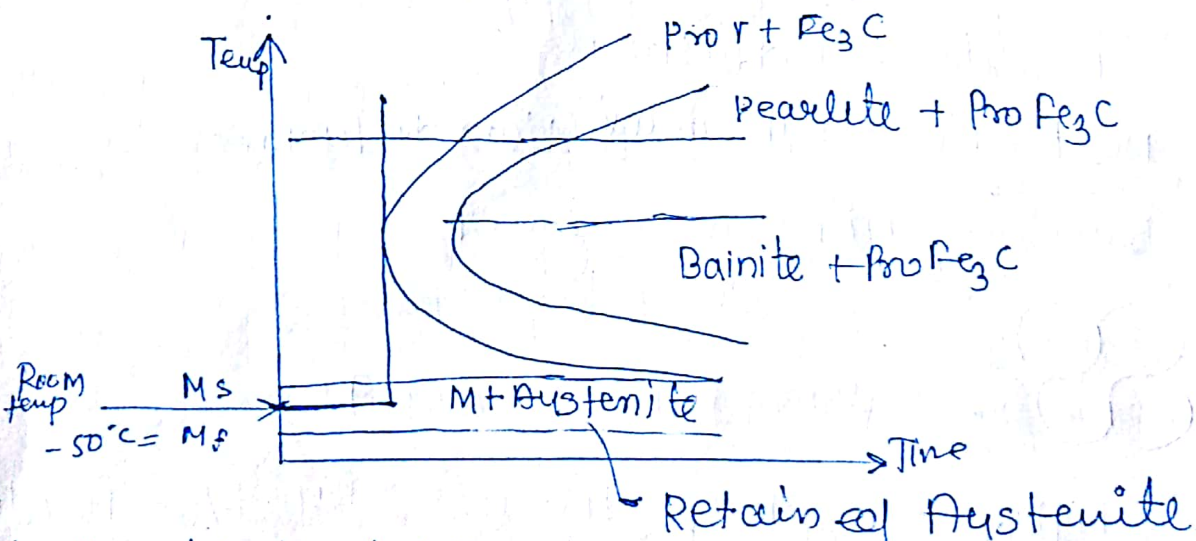
TTT diagram for Hypoeutectoid steel.



Austenite - most ductile

Martensite - most brittle

Hypereutectoid steels.



Austenitic stainless steel (ASS)
304, 316 - -
18% Cr → ~~8~~ 10% Ni
(stabilizes austenite phase)
→ Restricts diffusion of carbon)

⇒ To remove this dip in liquid N_2 at (77 K)

⇒ Cryogenic treatment of Material

In case of hypereutectoid steel when austenite is quenched to room temp, a portion of austenite will remain in ~~microstructure~~ microstructure called retained austenite. so austenite is quenched into liquid N_2 to ensure that there is complete conversion of austenite into martensite. It is called Cryogenic treatment of material. Position of M_s and M_f depends upon % of C in material.