UNIT III

HEAT TREATMENT

Engineering Materials and Metallurgy

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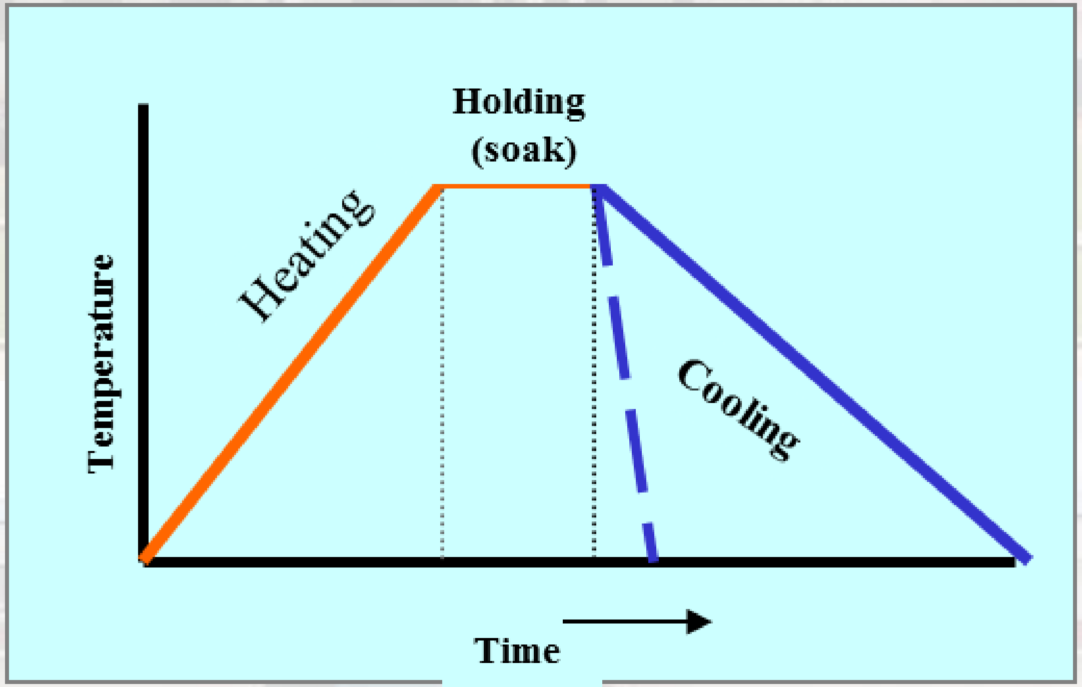
Heat Treatment

Heat Treatment

Defined as the controlled heating and cooling of metals for the primary purpose of altering their properties (strength, ductility, hardness, toughness, machinability).



Purpose of Heat Treatment

- To relieve internal stress
- To improve machinability
- To refine grain size
- To soften the metal
- To improve mechanical properties
- To increase resistance to wear, heat and corrosion.
- To change the chemical composition.

Who uses Heat Treating ?

- Aircraft Industry
- Automobile Manufacturing
- Defense Sector
- Forging
- Foundry
- Heavy Machinery Manufacturing
- Powder Metal Industries

Steps in Heat Treating Operation

Loading

- Cleaning
- Pre-wash with coalescence
- De-phosphate system
- Spray rinse

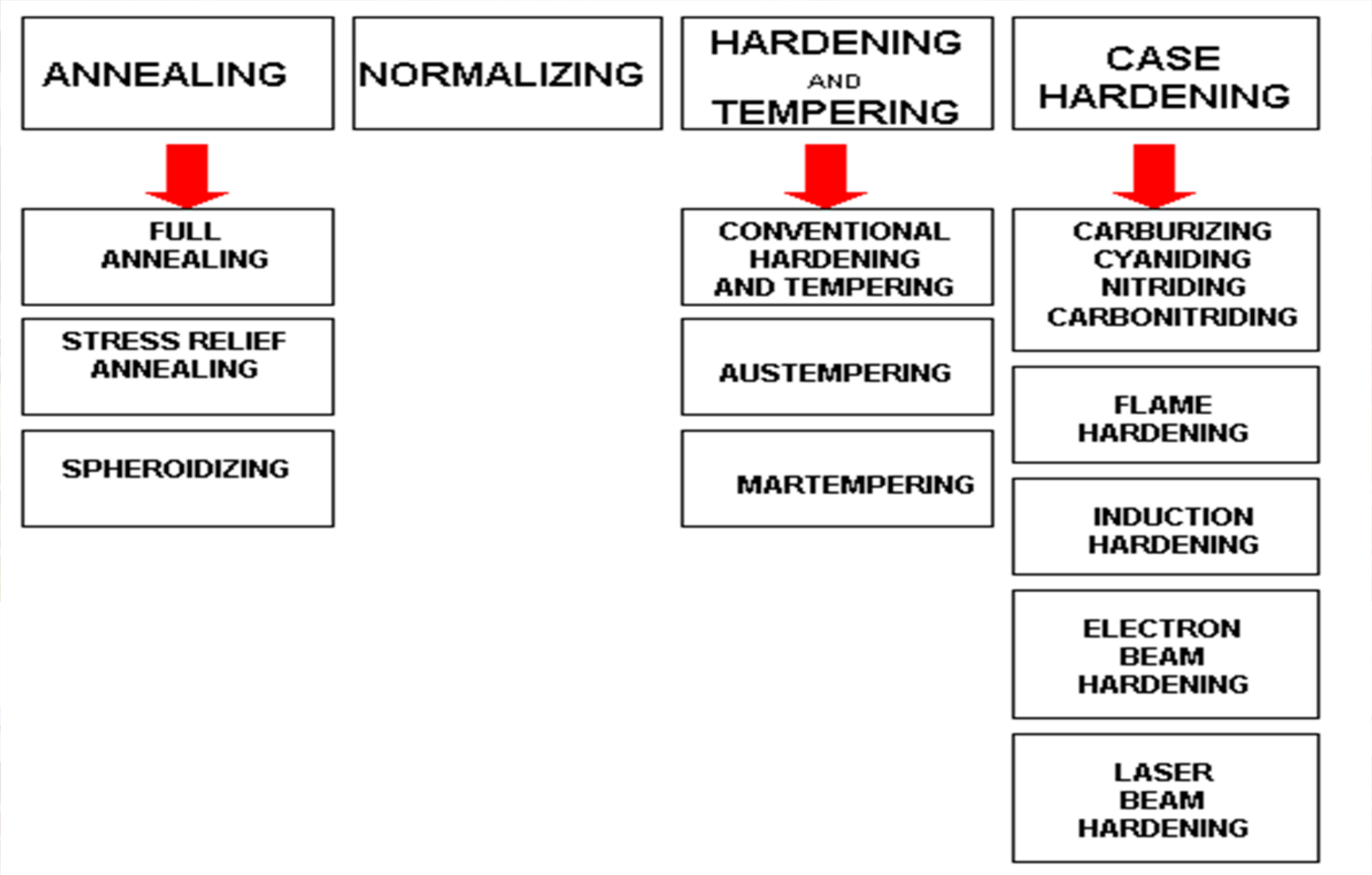
- Heating
  - Preheating
  - Heating
  - Soak & diffusion
  - Pre-cooling

- Quenching (Cooling)
- Post-wash

- Tempering
- Surface coating

- **Unloading**

Heat Treating Processes



Annealing

- It refers to a heat treatment in which the material is exposed to an elevated temperature for an extended time period and then slowly cooled.
- When an annealed part is allowed to cool in the furnace, it is called a "full anneal" heat treatment.

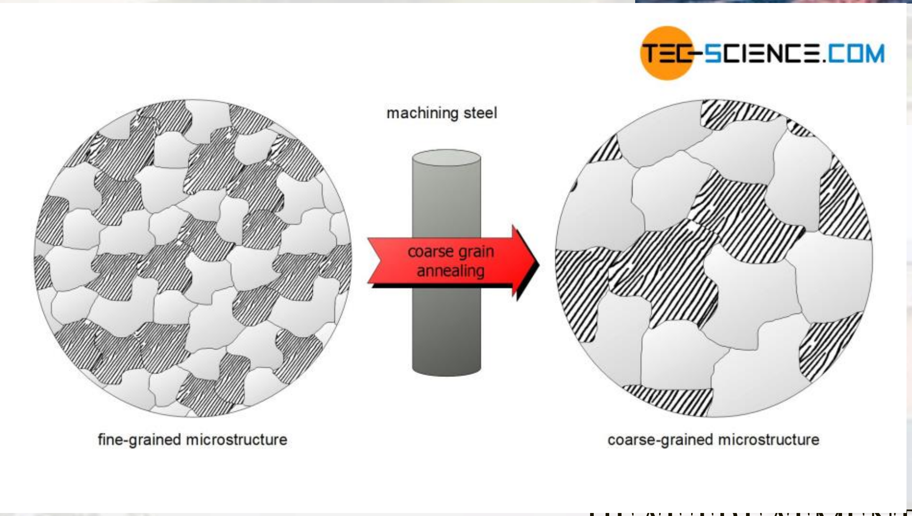
Types of Annealing

- Full Annealing
- Process Annealing
- Stress Relief Annealing
- Recrystallization Annealing
- Spheroidise Annealing

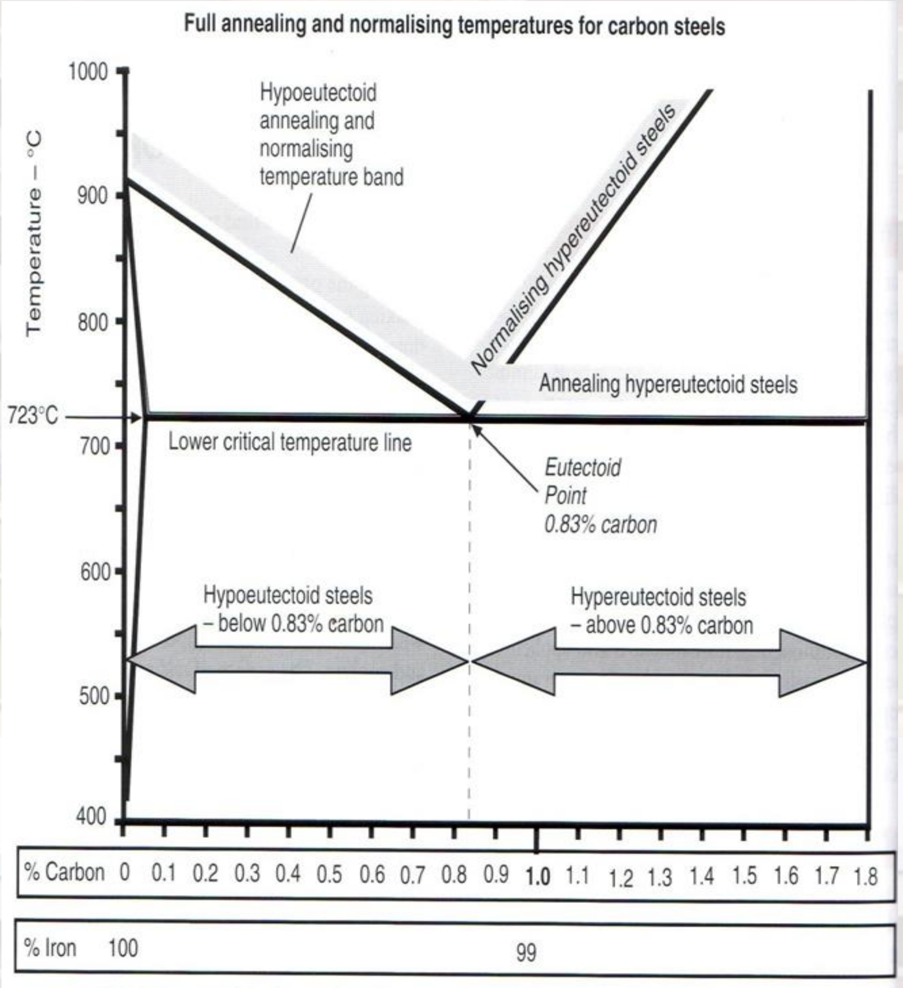
Full Annealing

Main Objective:

- Soften the metal
- Relieve the stress
- Refine the structure.

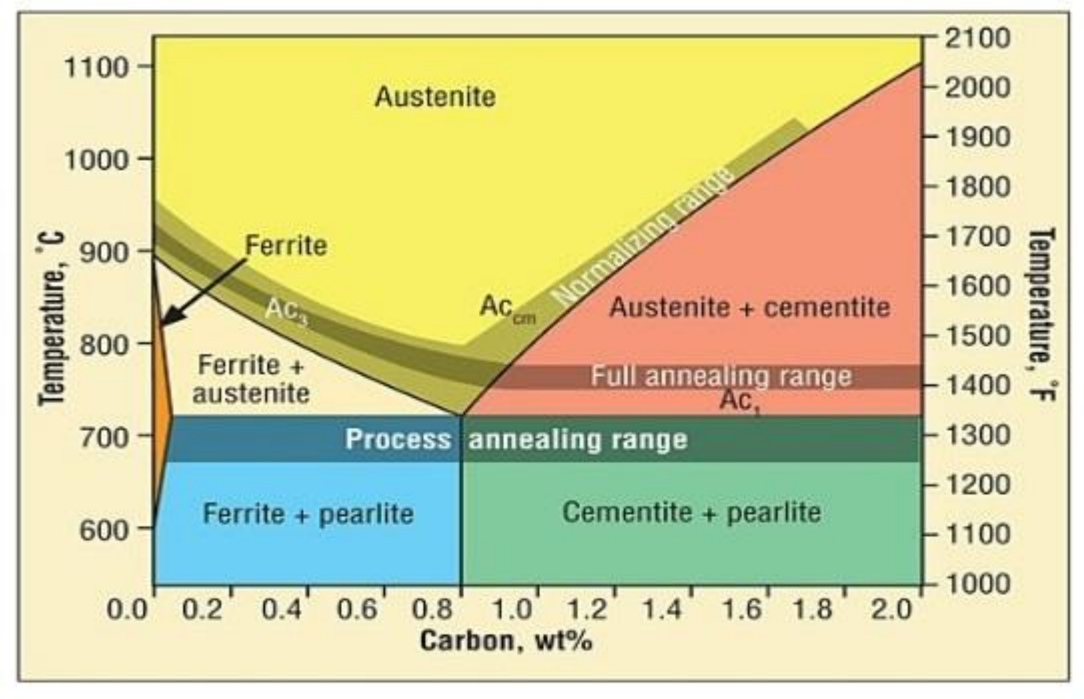


Full Annealing



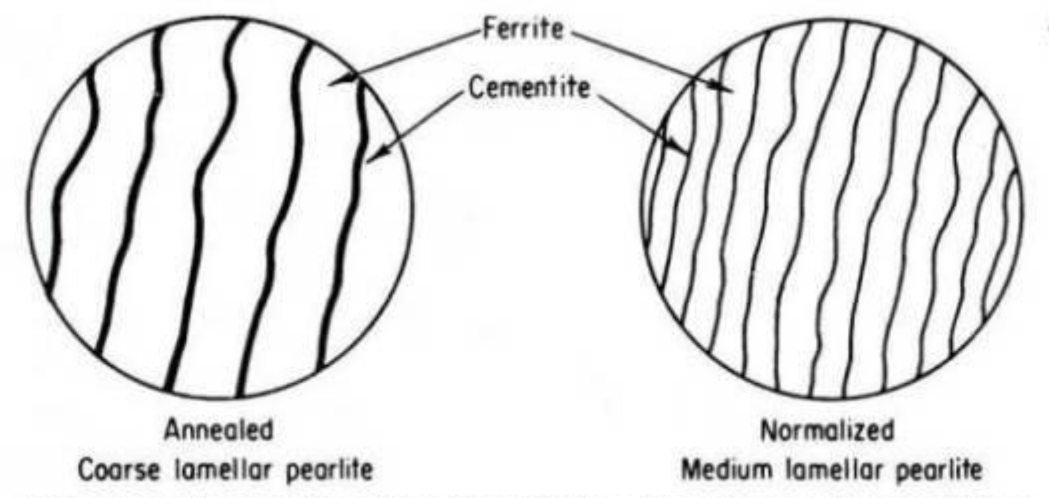
Full Annealing

- Temp is 30 - 50° C above the upper critical temp for hypo eutectoid steel.
- 30 - 50° C above the lower critical temp for eutectoid steel.
- Cooling is done at the furnace at the rate of 10-30°C per hour.
- For hypo eutectoid steel the resulting microstructure is coarse pearlite and ferrite.



Full Annealing

- For hypereutectoid steel annealing temp is 30-50°C above the lower critical temp.
- For hyper eutectoid steel the resulting microstructure is coarse pearlite and cementite.
- This process provides high ductility and toughness.

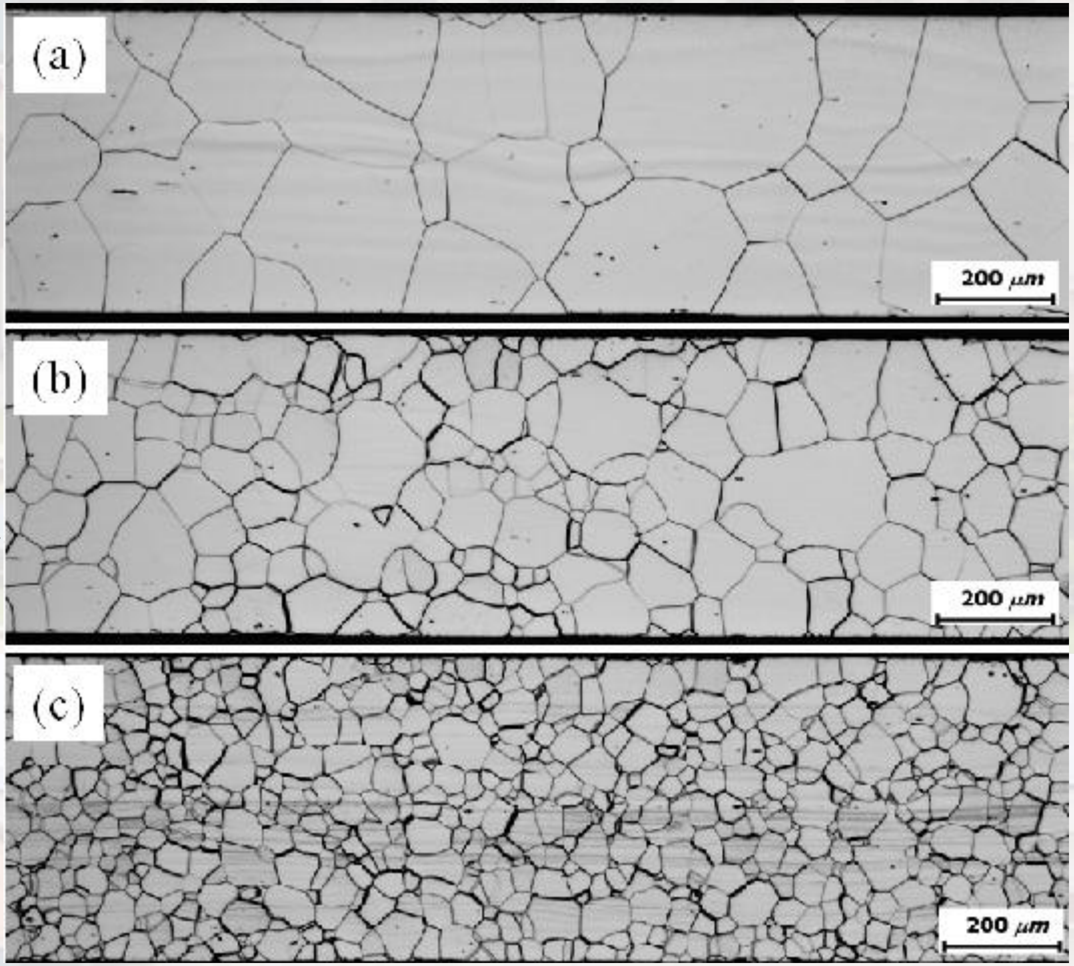


Difference in pearlitic structure due to annealing and normalizing

Stress Relief Annealing

- Stress relief or recovery annealing.
- Annealing temp is at the range of 550-700°C.
- Uniform cooling is mandatory.
- It eliminates the stress formed during

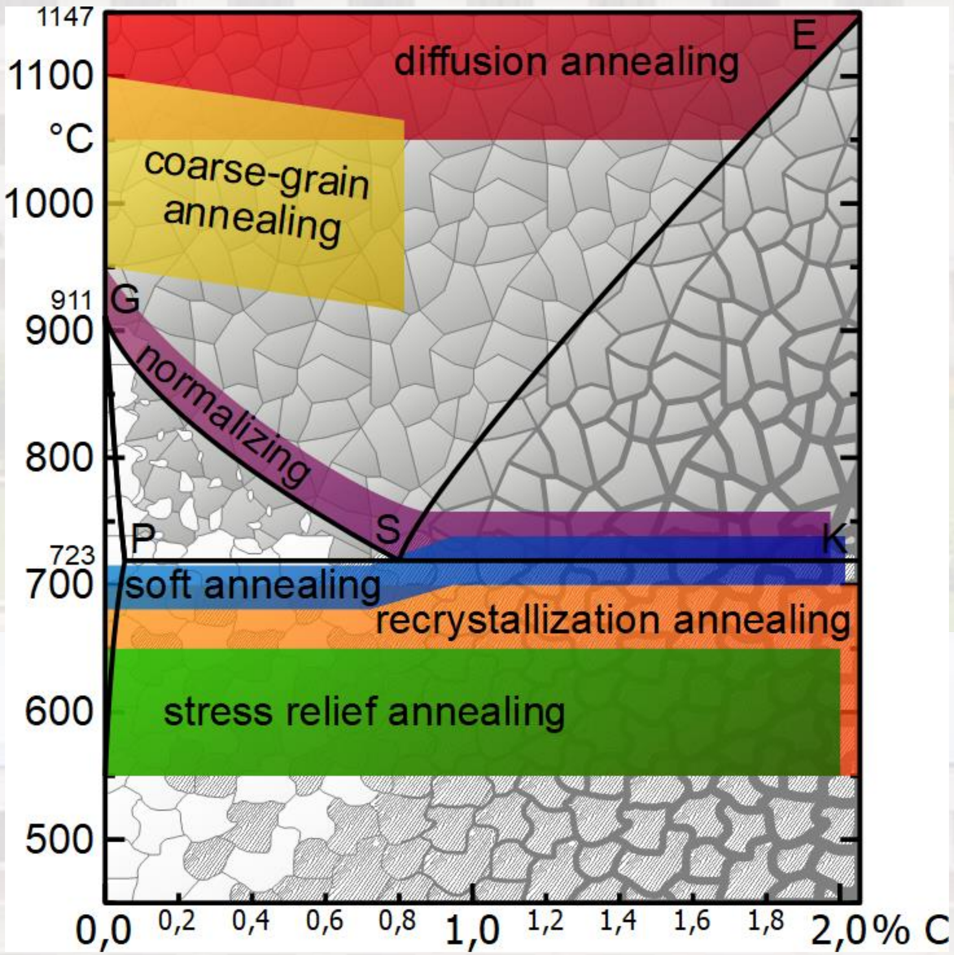
welding, cold working, casting, quenching, machining.



Need for SR Annealing

❖**Causes for stress:**

- Plastic deformation during machining
- Non-uniform cooling
- Phase transformations between phases with different densities.



❖**Effect of Stress**

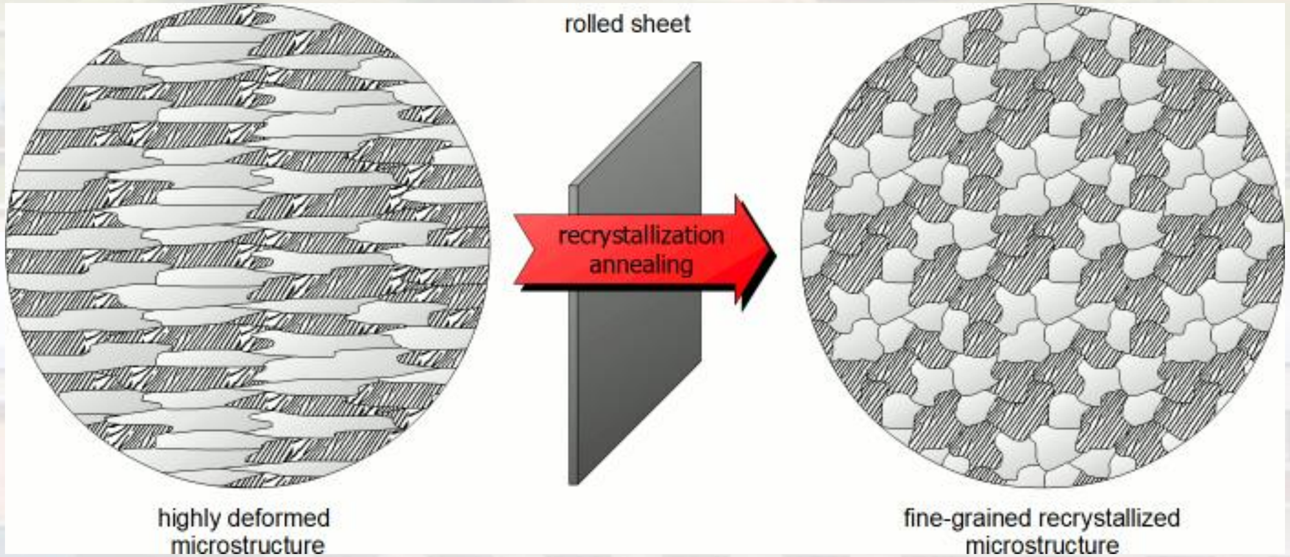
✓War page

✓Crack

✓Distortion

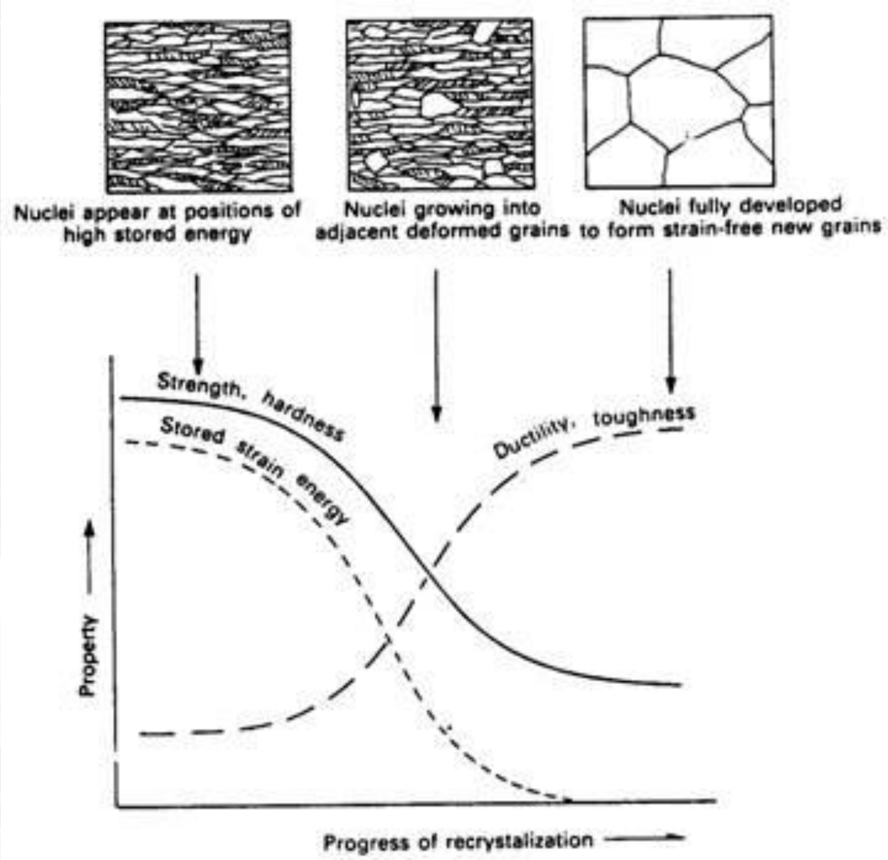
Recrystallization Annealing

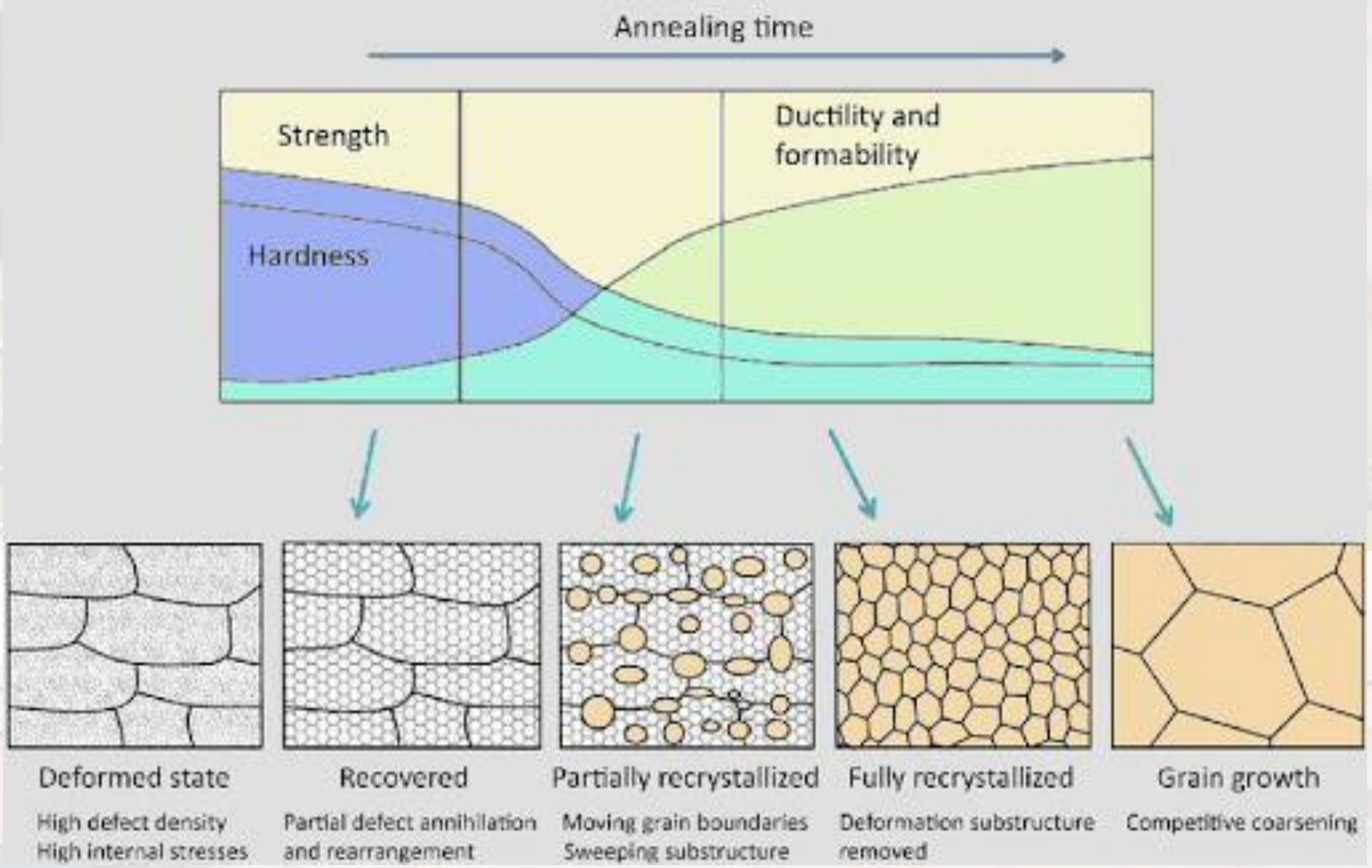
- It is a process in which distorted grains of cool worked material are replaced by strain free new grains.
- Recrystallization annealing is an annealing process at temperatures above the recrystallization temperature of the cold-worked material, **without phase transformation**
- The recrystallization temperature is not a constant for a material but depends on the amount of cold work, the annealing time, and other factors.
- $T_{(recrystallization)} = 0.4\ T_{(melting)}$



Recrystallization Annealing

It reduces the Dislocation density and converts elongated grains to equaxied .

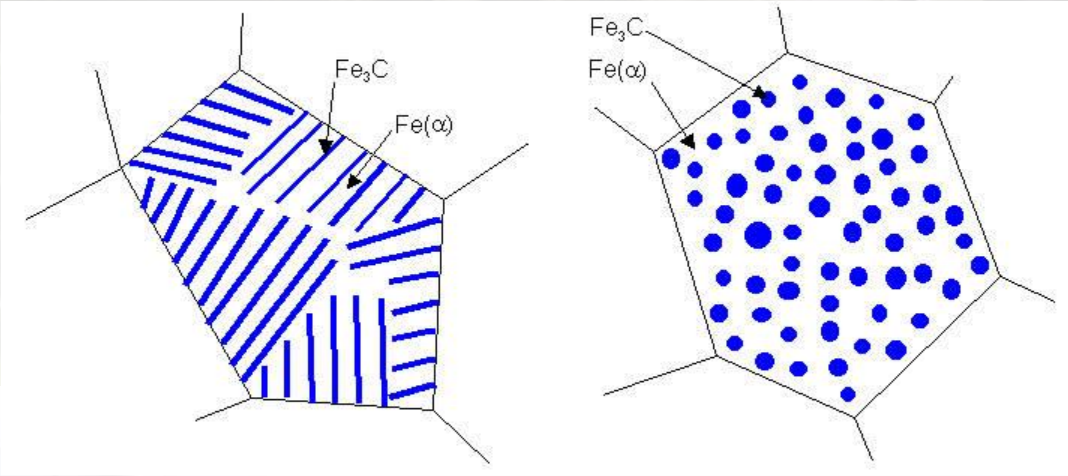


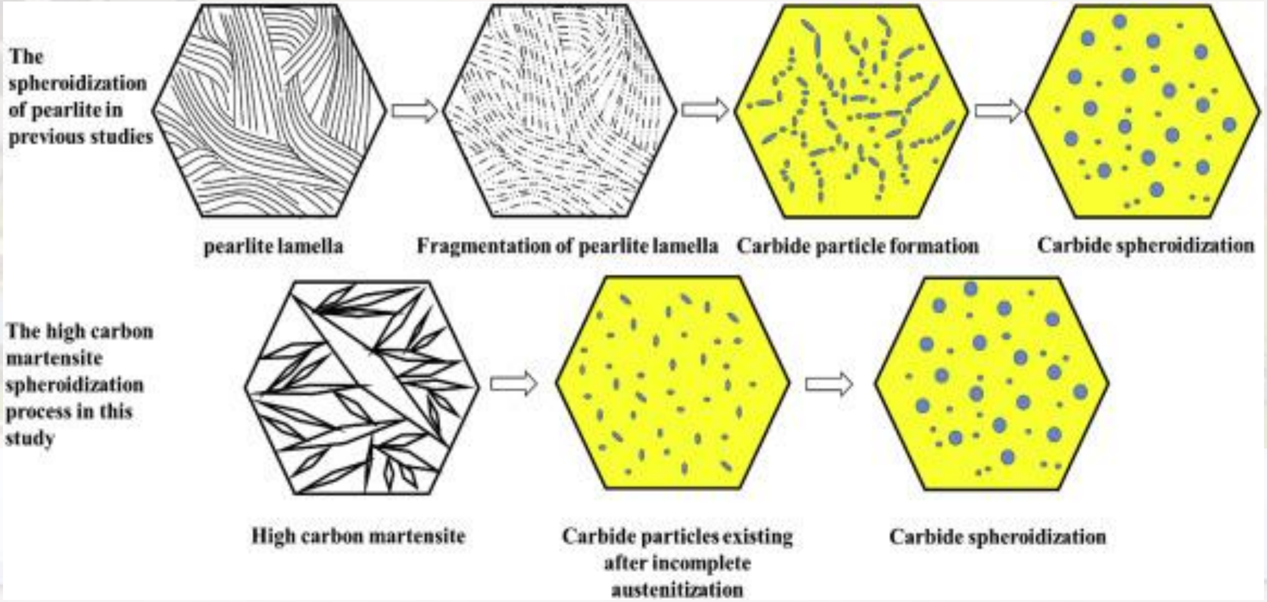


Spheroidizing

❖ Converts

- ➢ Lamellar Pearlite → Globular Pearlite
- ➢ Plates of Cementite → Spheriods of Cementite

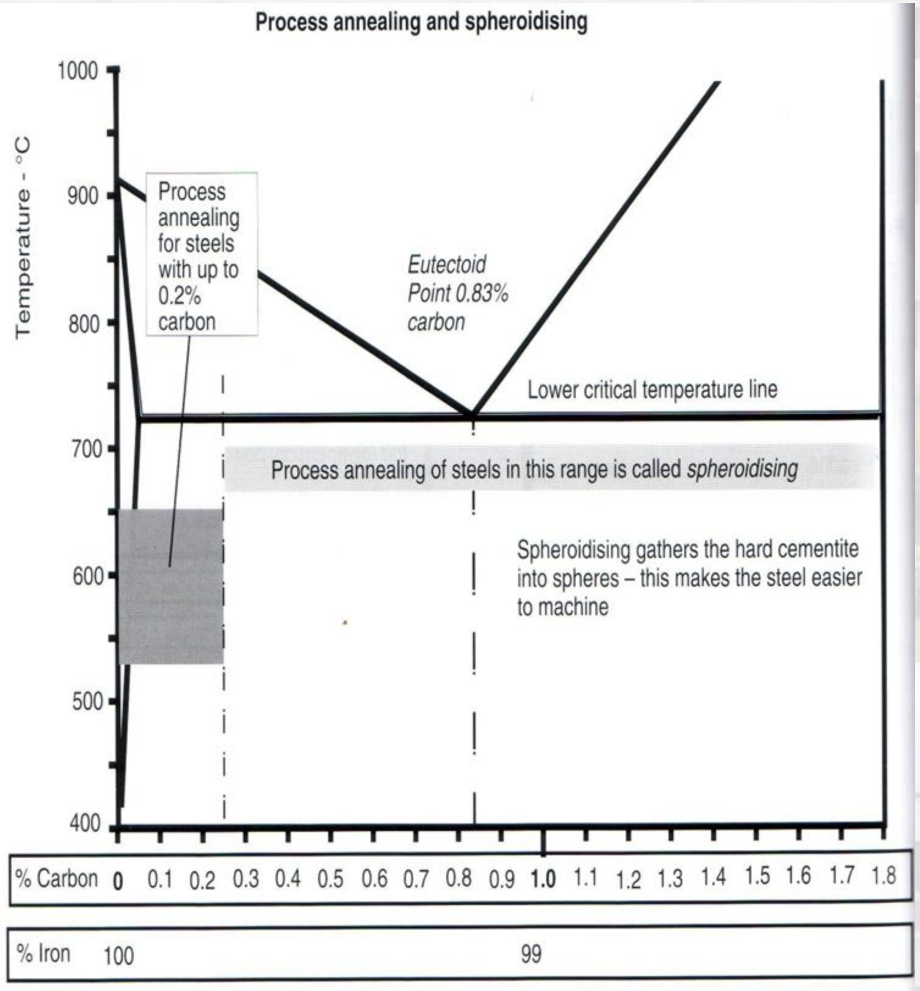




Spheroidizing

❖**Main objectives of Spheriodising:**

- To soften the steel
- Increase ductility and toughness
- Improves machinability and formability
- Reduces hardness, strength and wear resistance.



❖Materials mainly concentrated

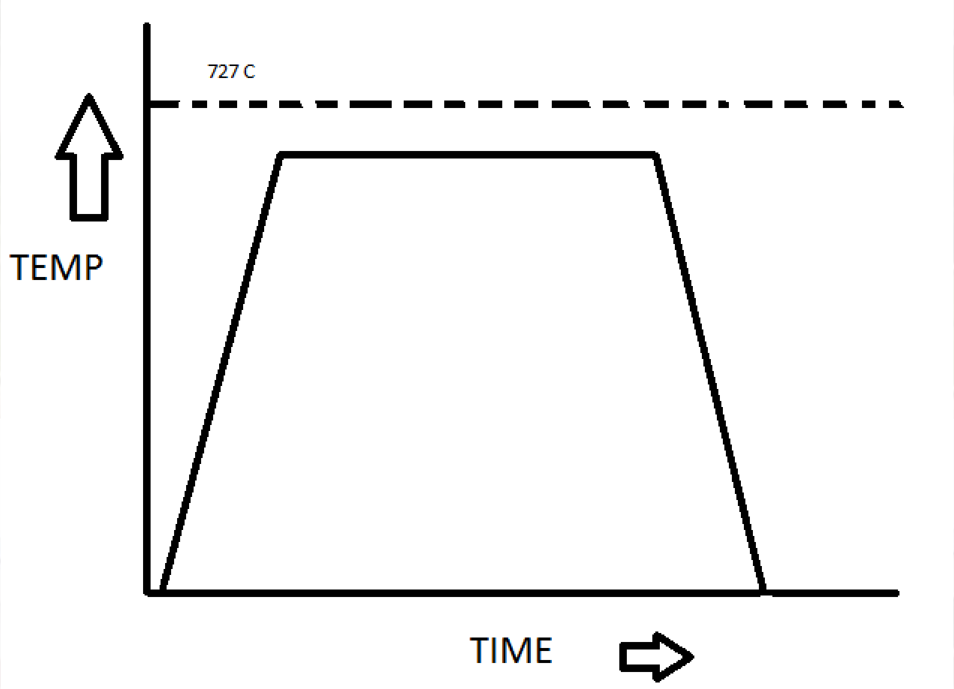
- Medium carbon steel
- High carbon (tool steel)

Not used for Low carbon Steel

Spheroidizing

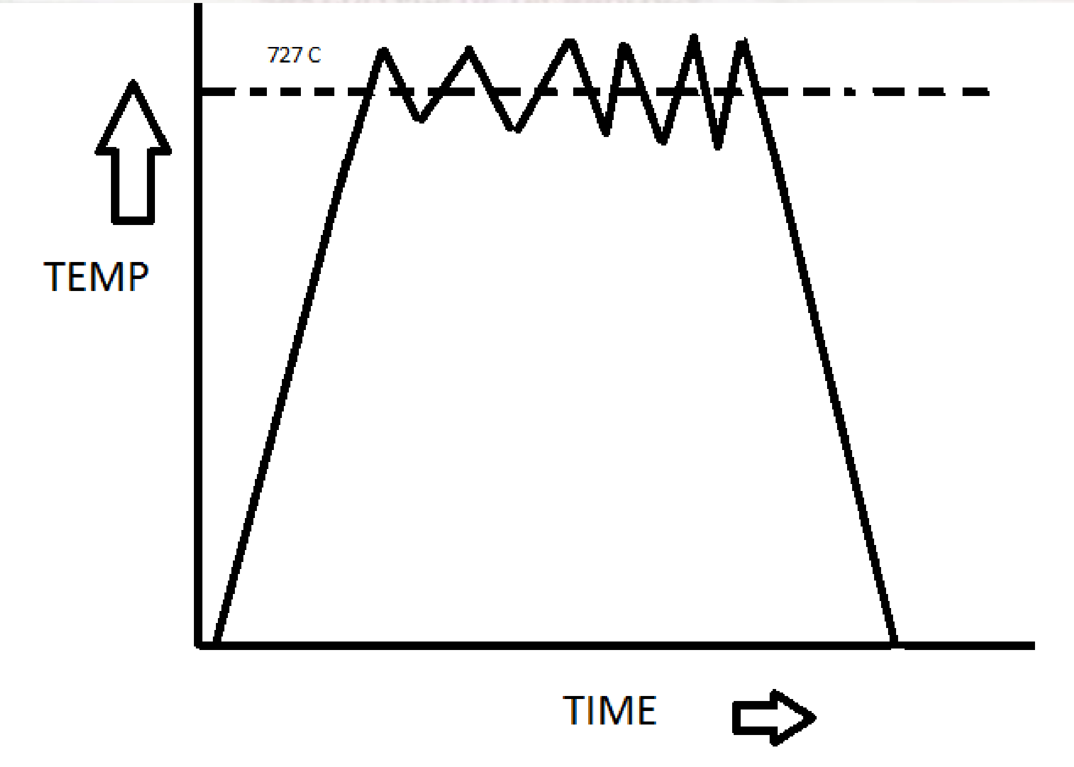
Three ways of Spheriodising

- Prolong heating below Lower critical temperature and slow cooling.



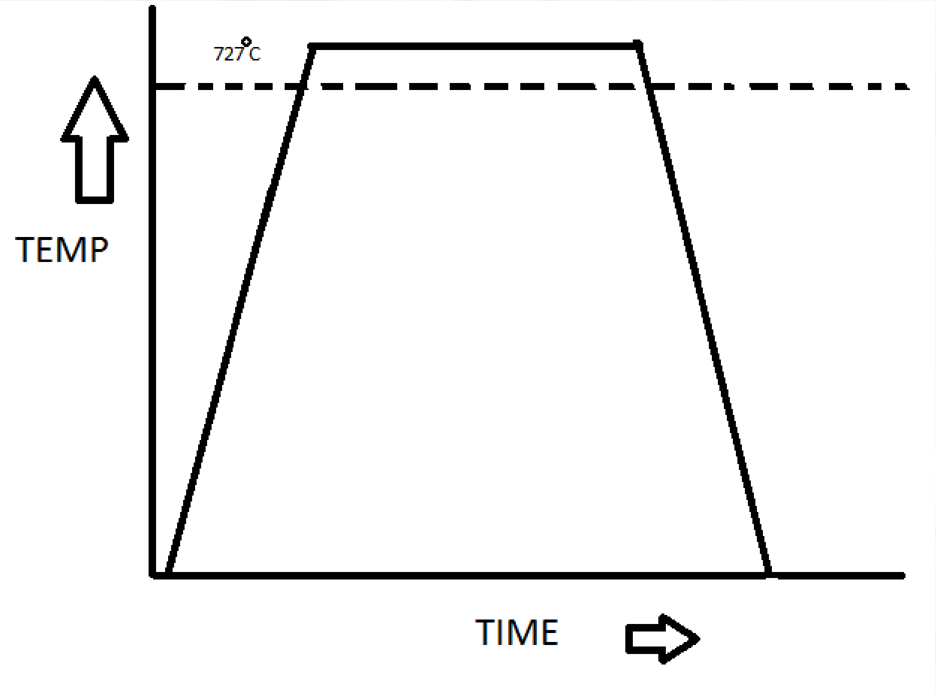
Spheroidizing

- Cycling between temperature and then relatively slow cooling.



Spheroidizing

- For tool and high speed steel heating at the temperature range between 750° - 800°C then hold at this temperature and then slow cooling.



THANK YOU

Assessment https://play.kahoot.it/v2/?quizId=250c11af-904f-48bf-902f-148509a5835a