



# SNS COLLEGE OF TECHNOLOGY

Coimbatore-35  
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## 23MET203 & Engineering Materials and Metallurgy

II YEAR / III SEM

### UNIT – 3

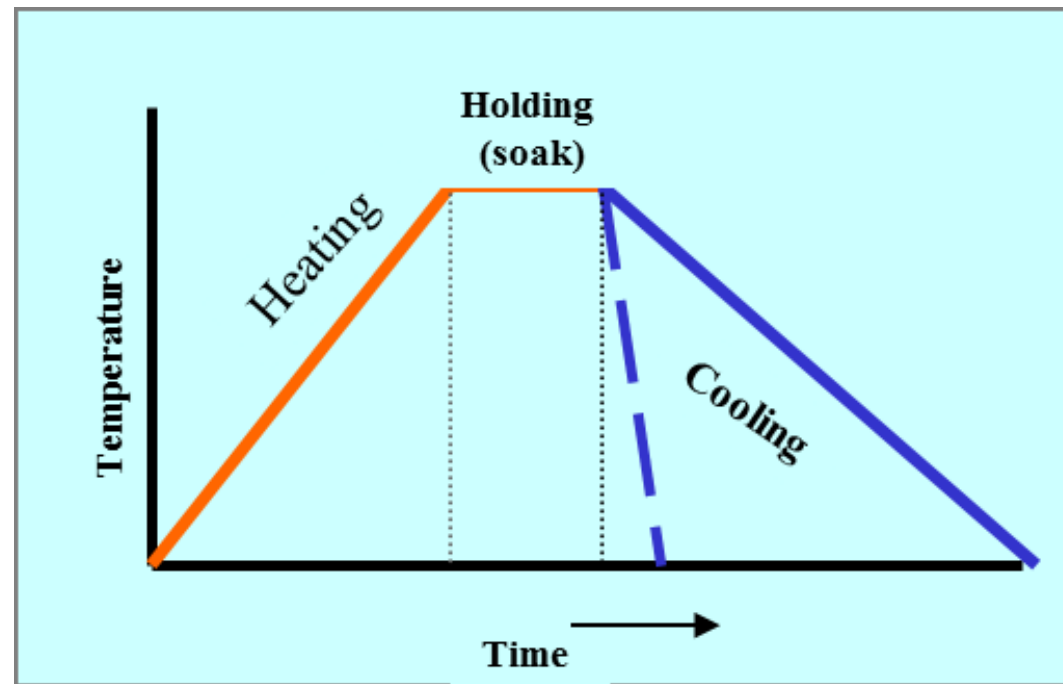
## HEAT TREATMENT



# 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.

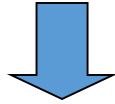
# Who uses Heat Treating ?

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



# Steps in Heat Treating Operation

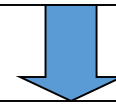
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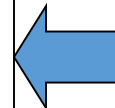
- Cleaning
- Pre-wash with coalescence
- De-phosphate system
- Spray rinse



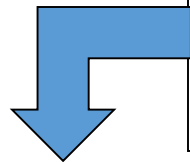
- Heating
  - Preheating
  - Heating
  - Soak & diffusion
  - Pre-cooling



- Quenching (Cooling)
- Post-wash

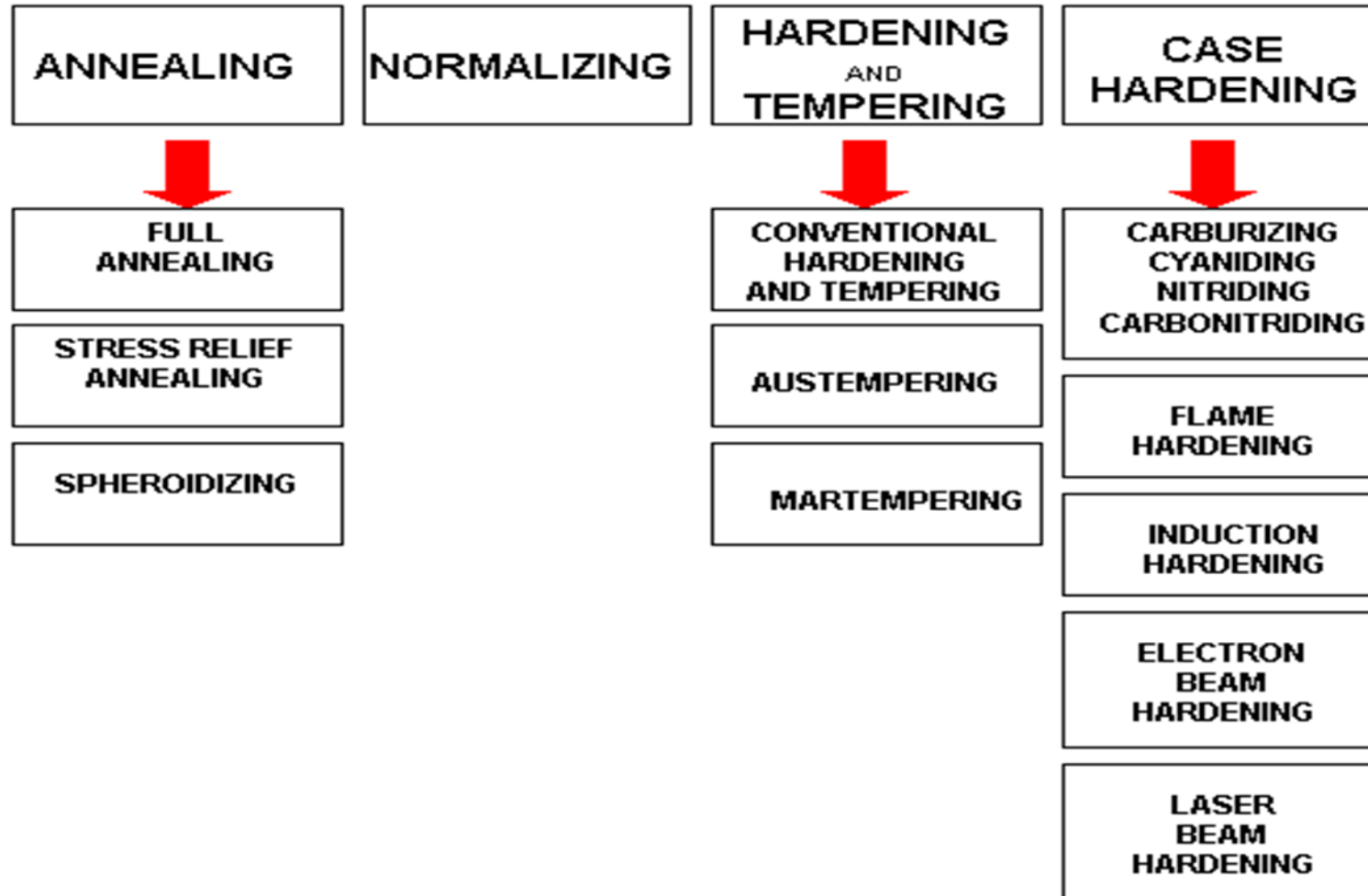


- Tempering
- Surface coating



- 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



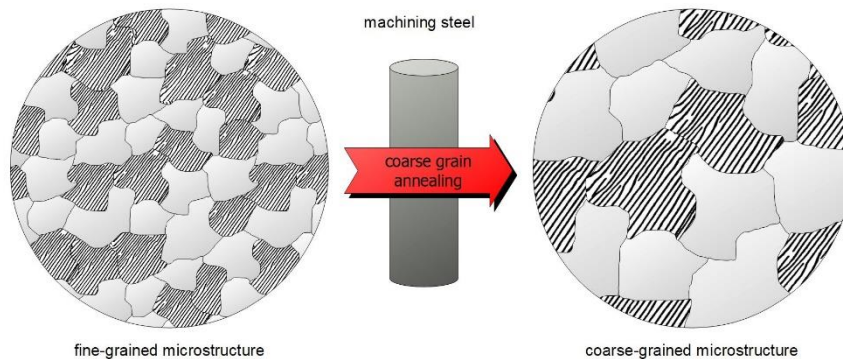
# Full Annealing

## Main Objective:

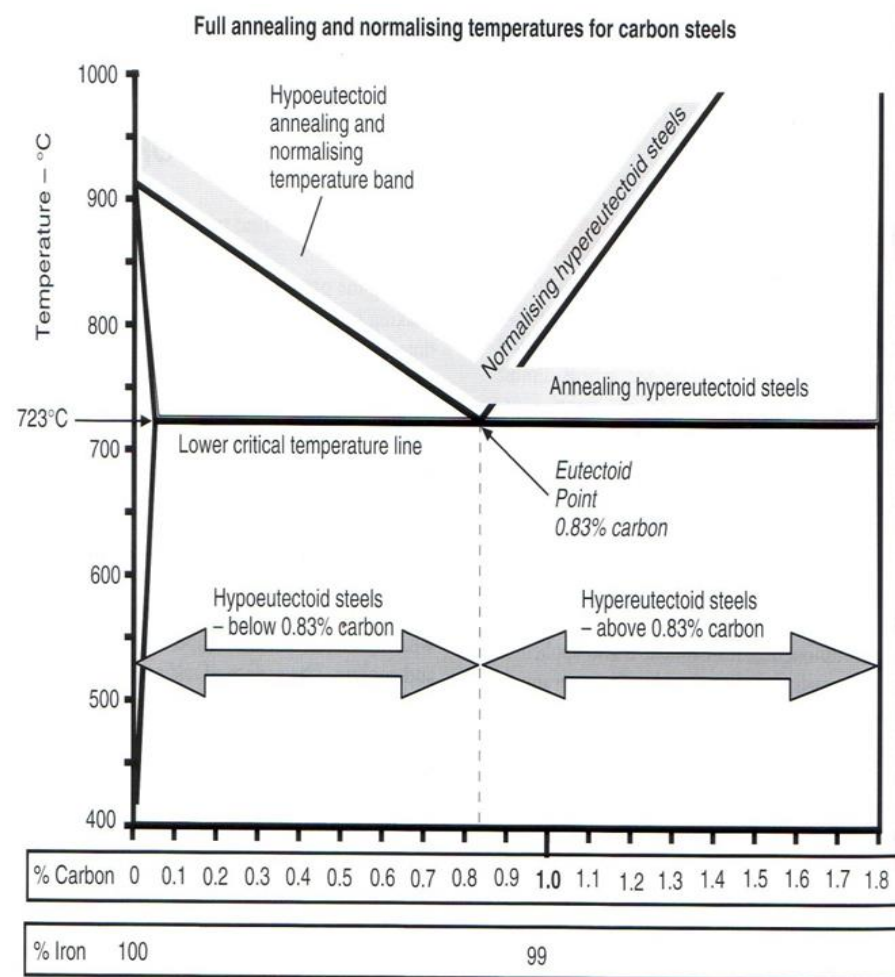
- Soften the metal
- Relieve the stress
- Refine the structure.



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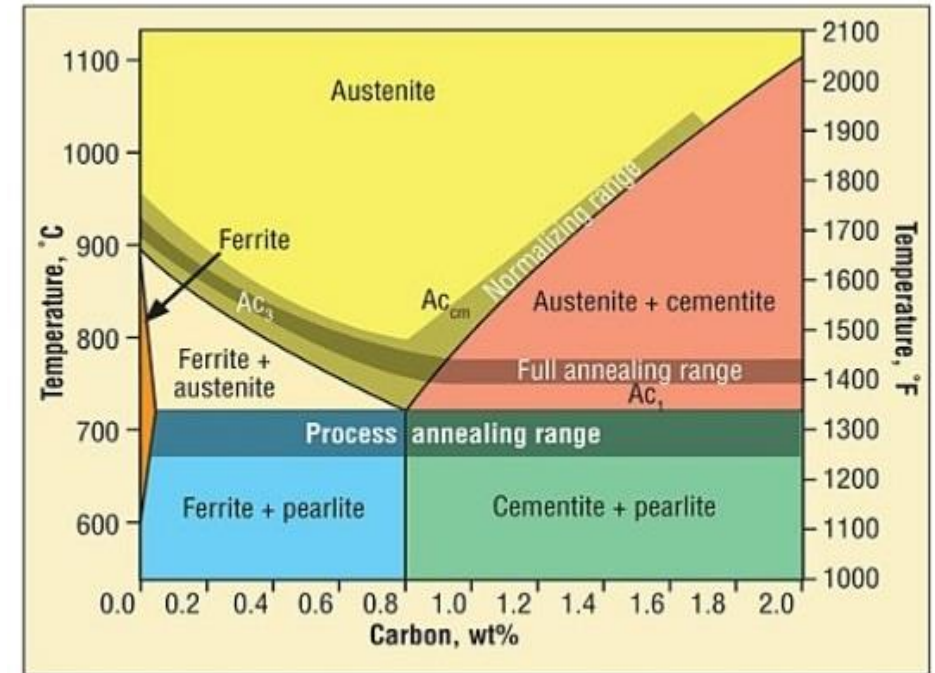


# Full Annealing



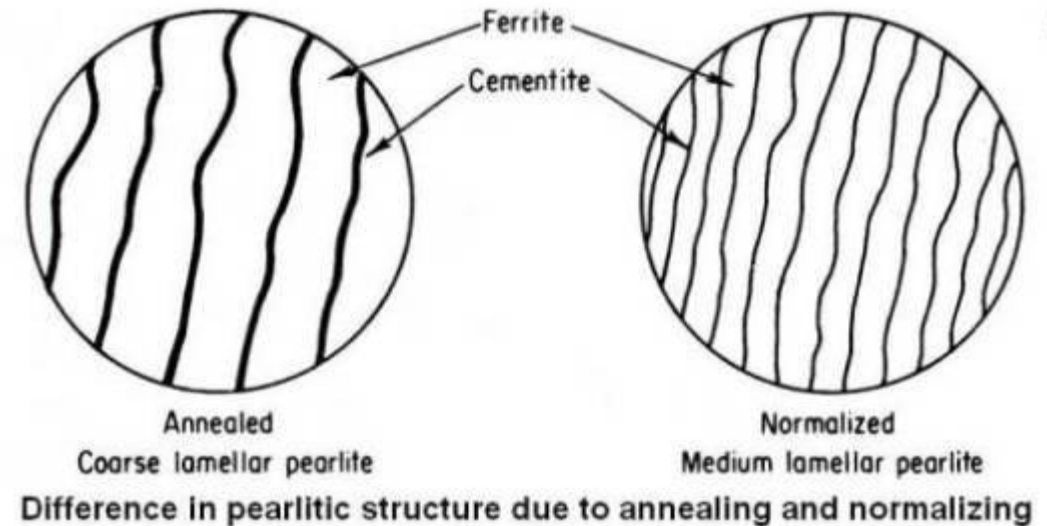
# Full Annealing

- 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.



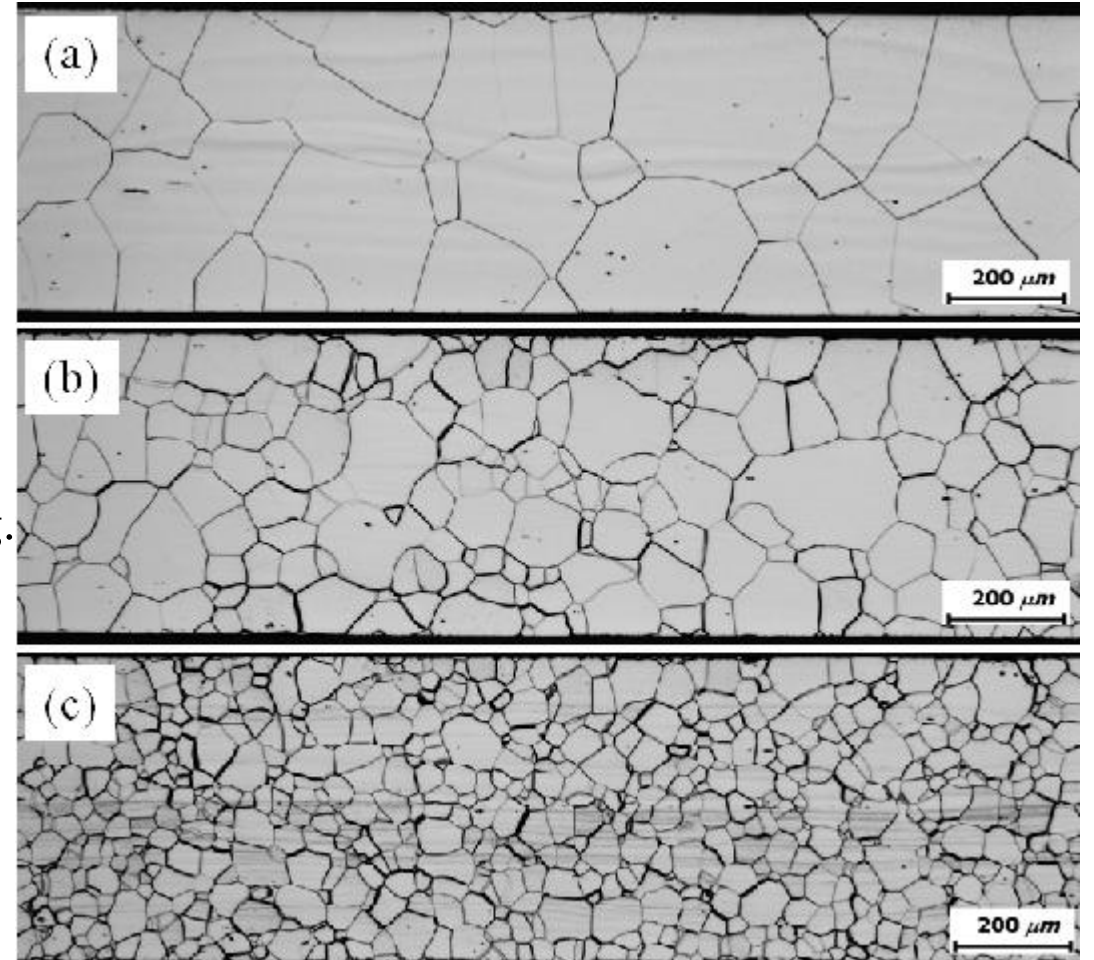
# Full Annealing

- 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.



# 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.



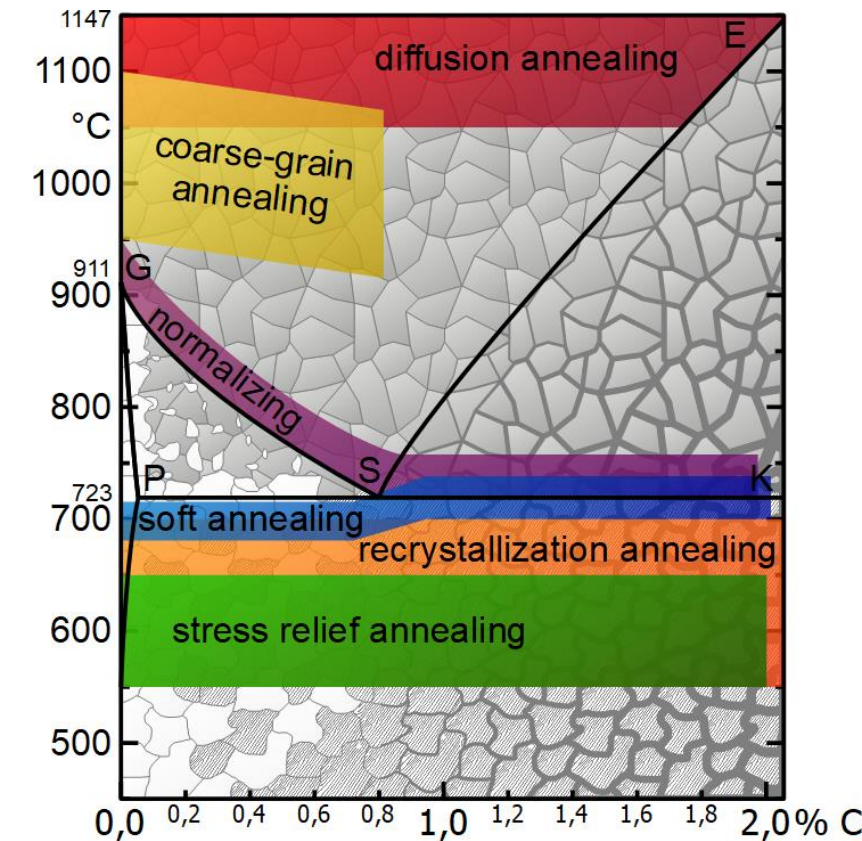
# Need for SR Annealing

## ❖ Causes for stress:

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

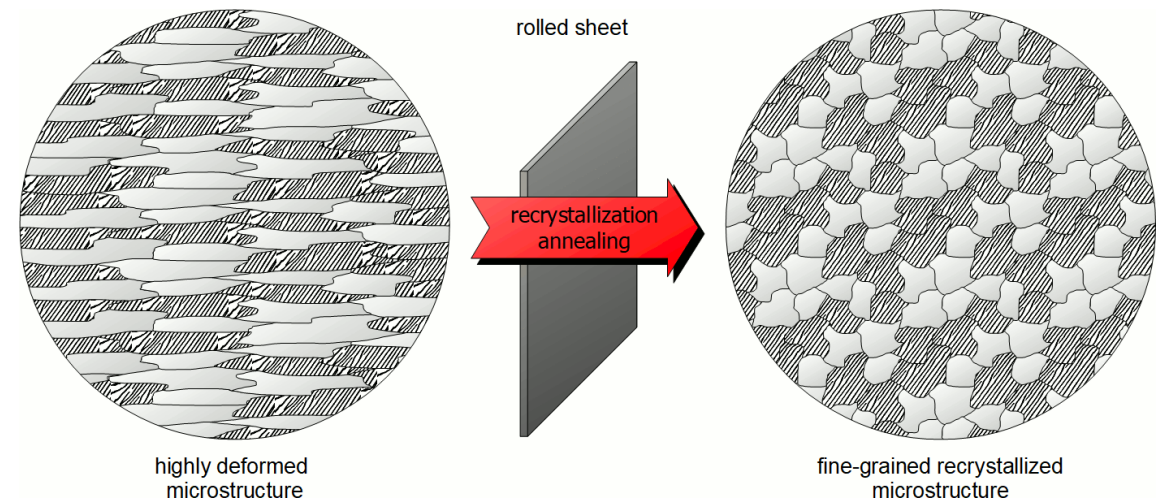
## ❖ Effect of Stress

- ✓ War page
- ✓ Crack
- ✓ Distortion



# Recrystallization Annealing

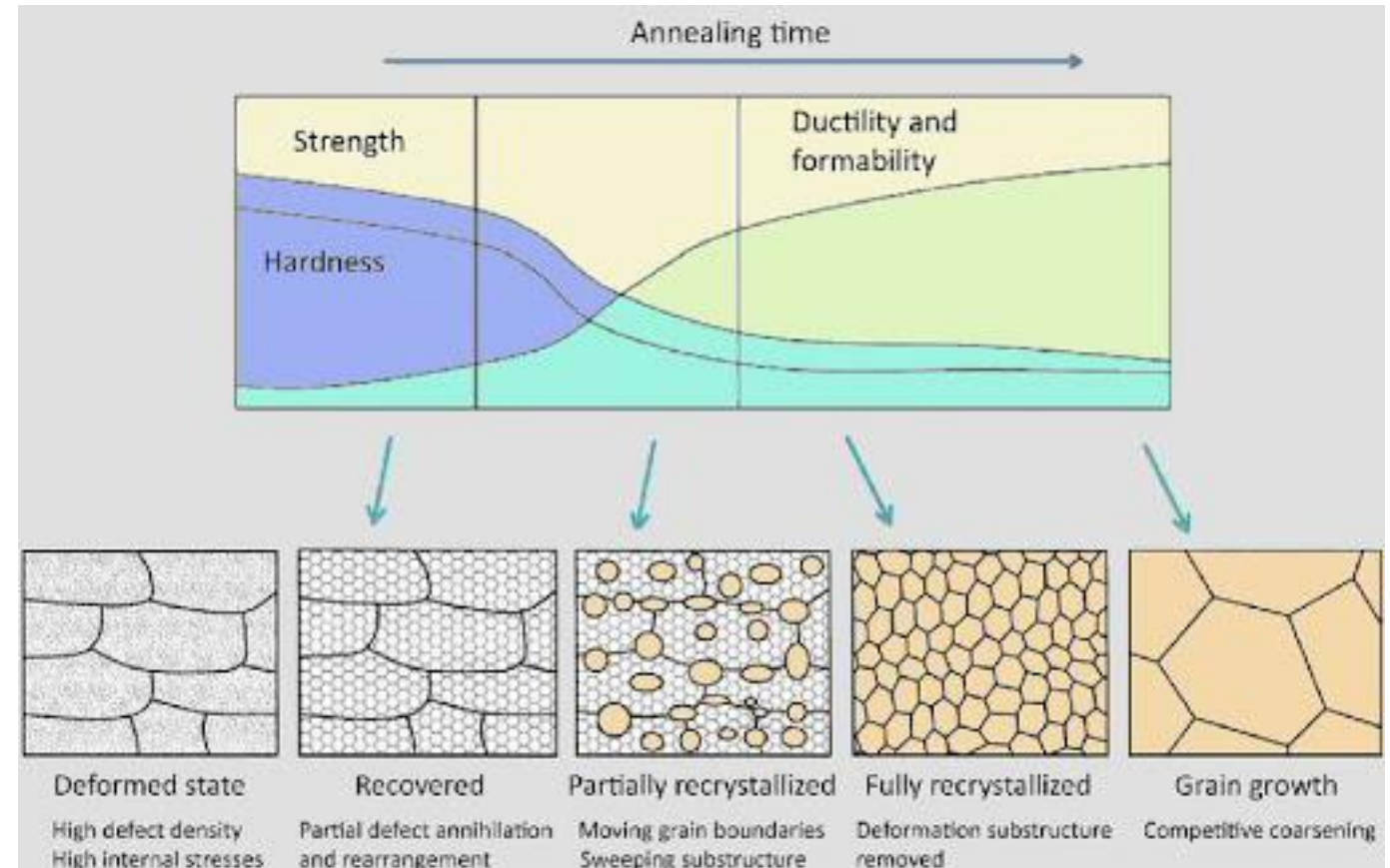
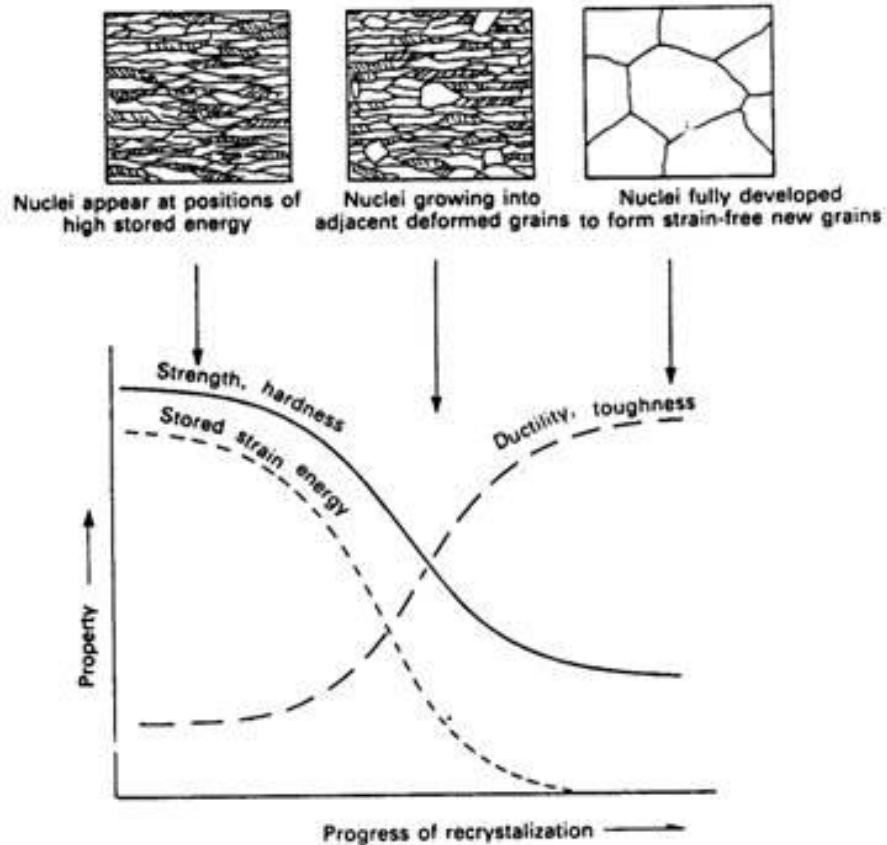
- It is a process in which distorted grains of cold worked material are **replaced by strain free new grains**.
- Recrystallization annealing is an annealing process at temperatures above the recrystallization temperature of the cold-worked material, **without phase transformation**
- The recrystallization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





# Recrystallization Annealing

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

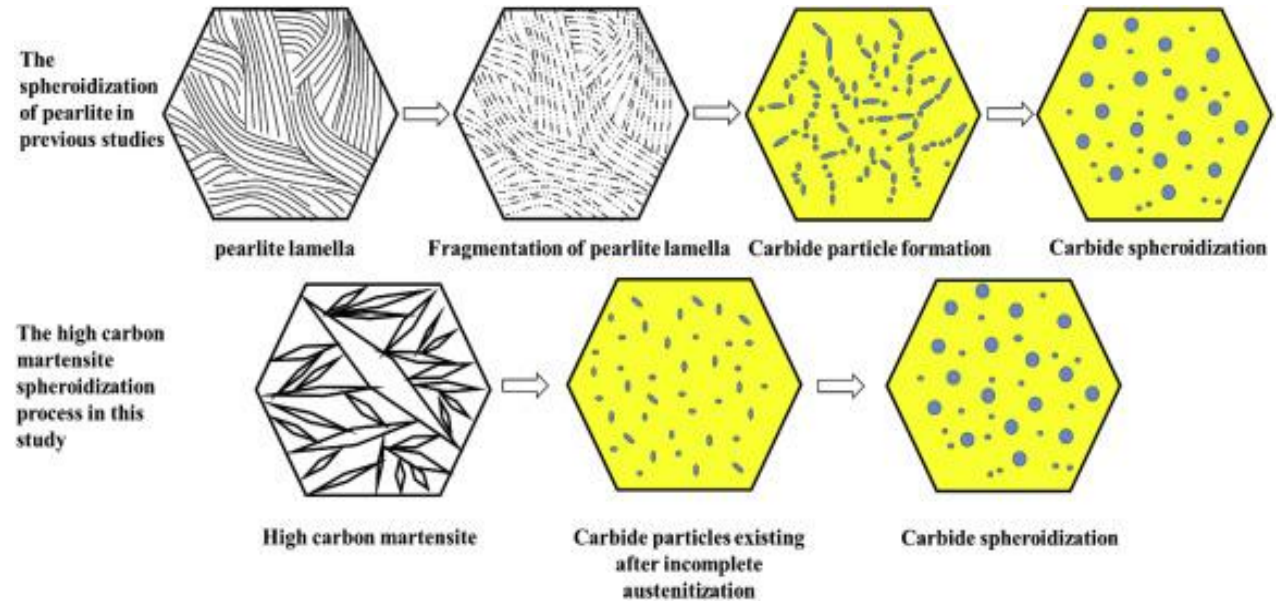
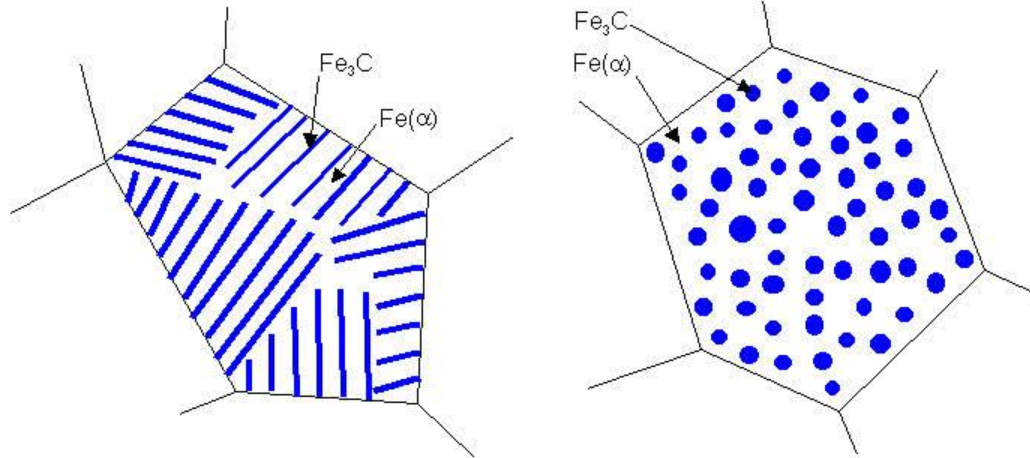


# Spheroidizing

❖ Converts

➤ Lamellar Pearlite → **Globular Pearlite**

➤ Plates of Cementite → **Spheroids of Cementite**



# Spheroidizing

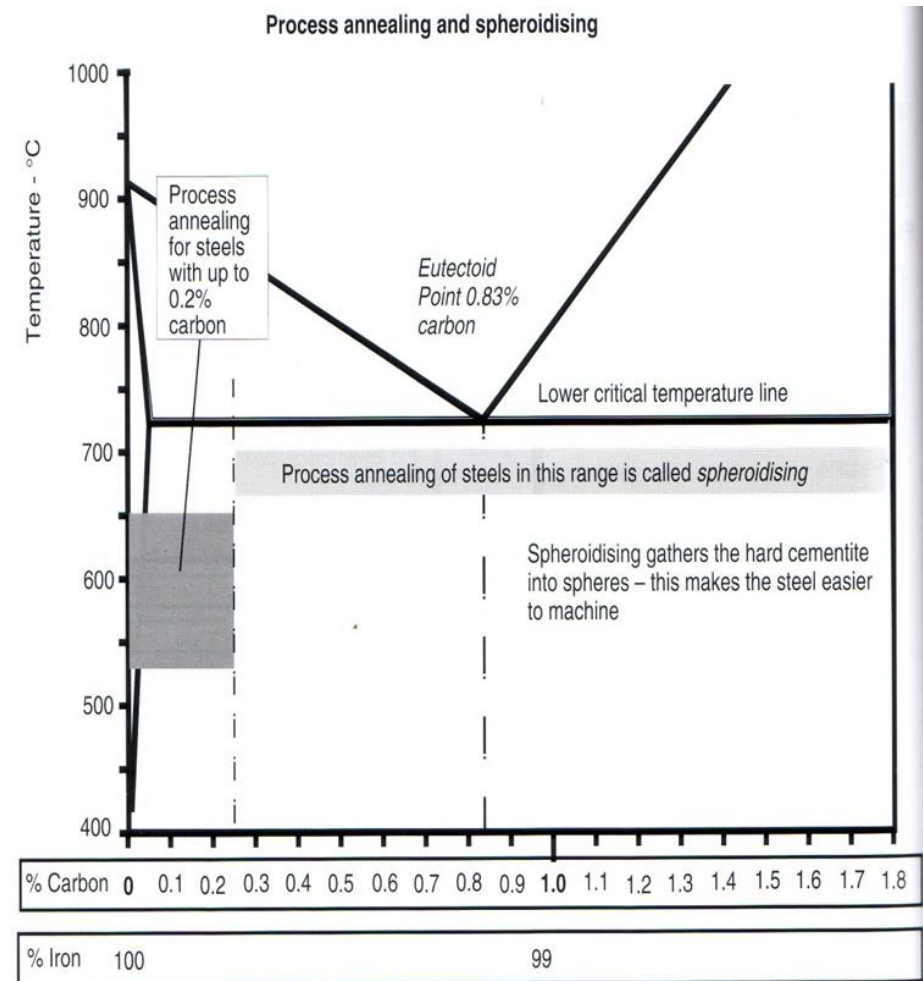
## ❖ Main objectives of Spheroidising:

- 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)

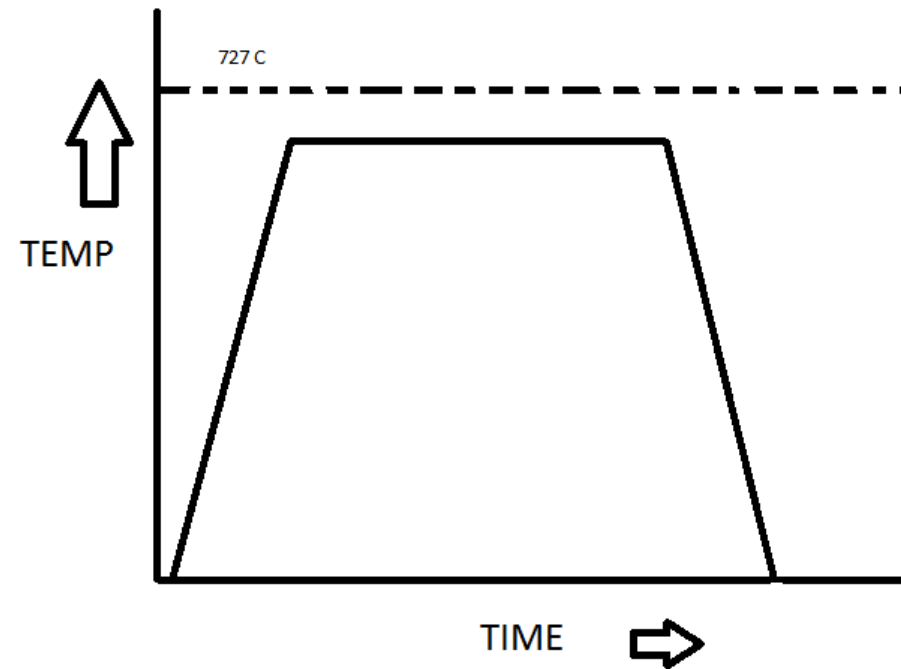
**Not used for Low carbon Steel**



# Spheroidizing

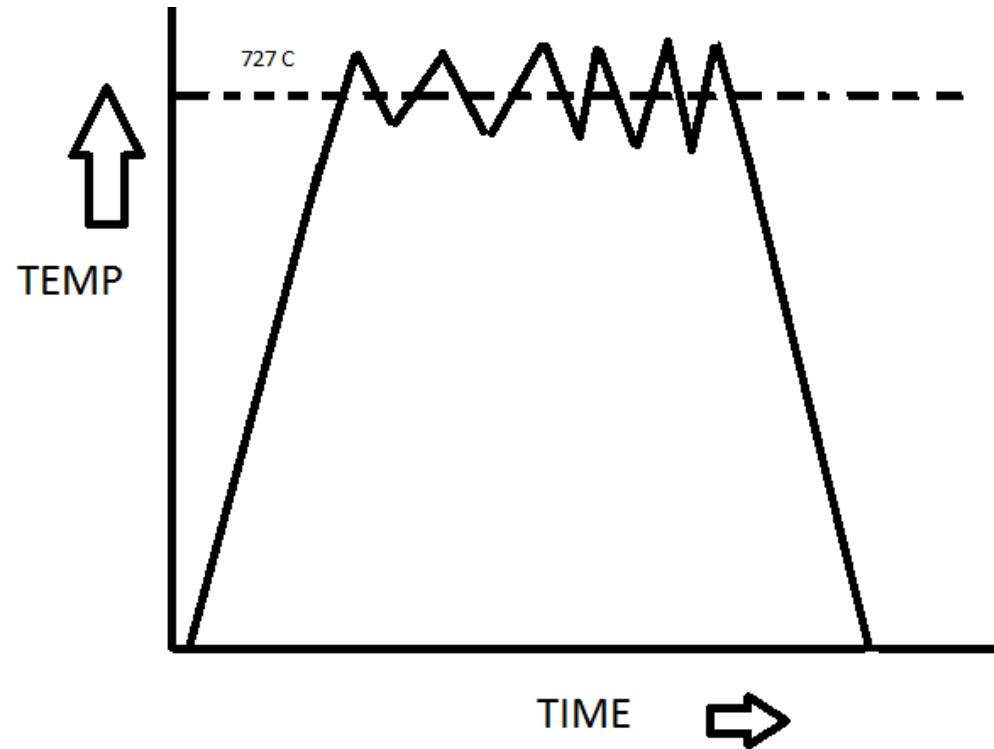
## Three ways of Spheroidising

- Prolong heating below Lower critical temperature and slow cooling.



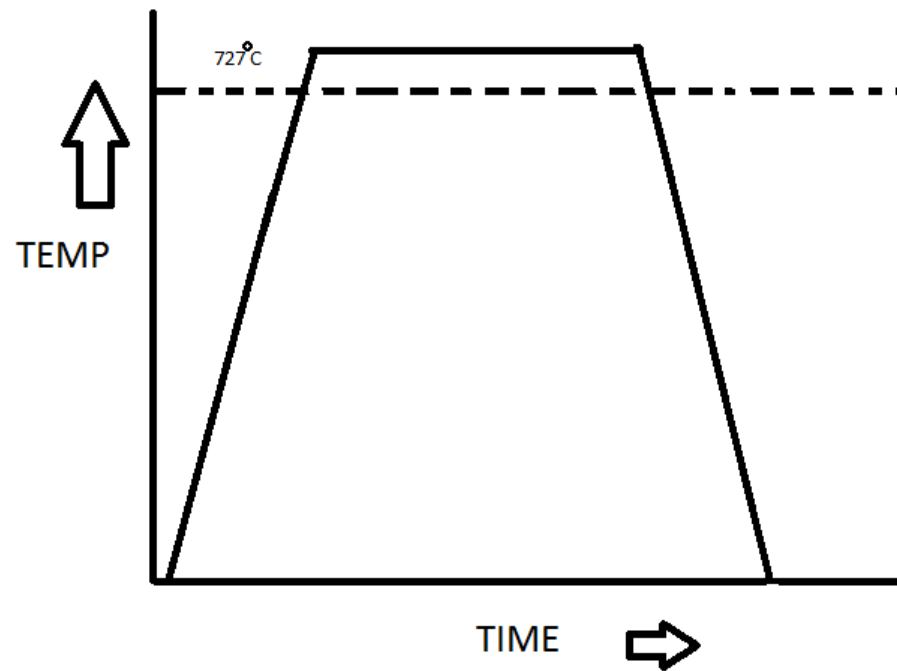
# Spheroidizing

- Cycling between temperature and then relatively slow cooling.



# Spheroidizing

- For tool and high speed steel heating at the temperature range between  $750^{\circ}$  -  $800^{\circ}\text{C}$  then hold at this temperature and then slow cooling.



# THANK YOU

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