



UNIT III

HEAT TREATMENT

Engineering Materials and Metallurgy

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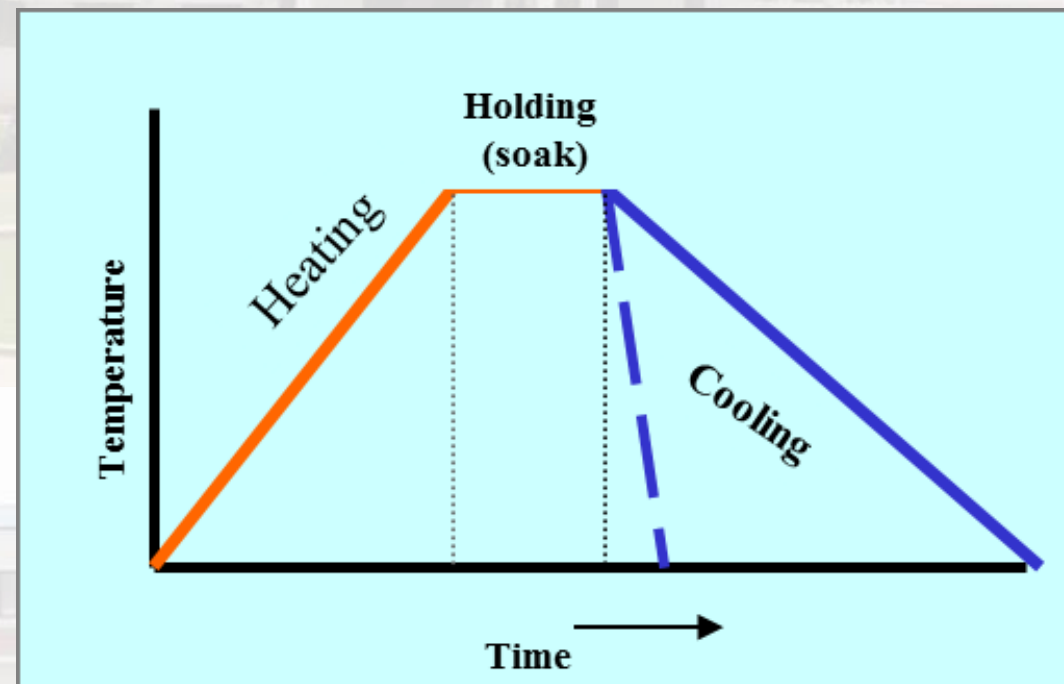
Heat Treatment





Heat Treatment

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



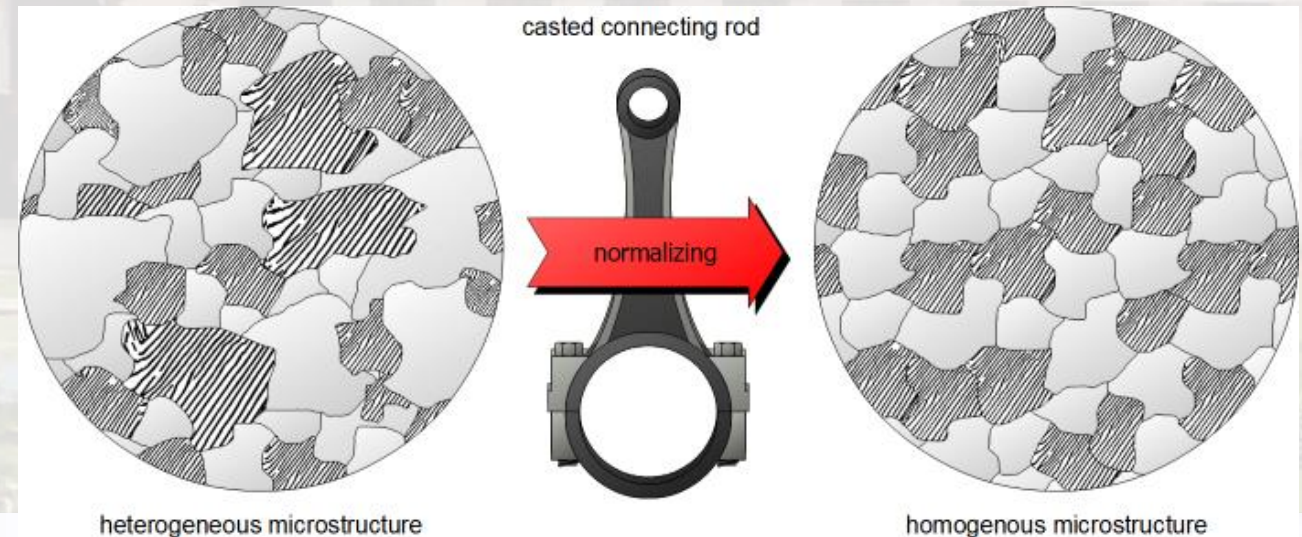


Normalizing

- When an annealed part is removed from the furnace and allowed to cool *in air*, it is called a "*normalizing*" heat treatment.

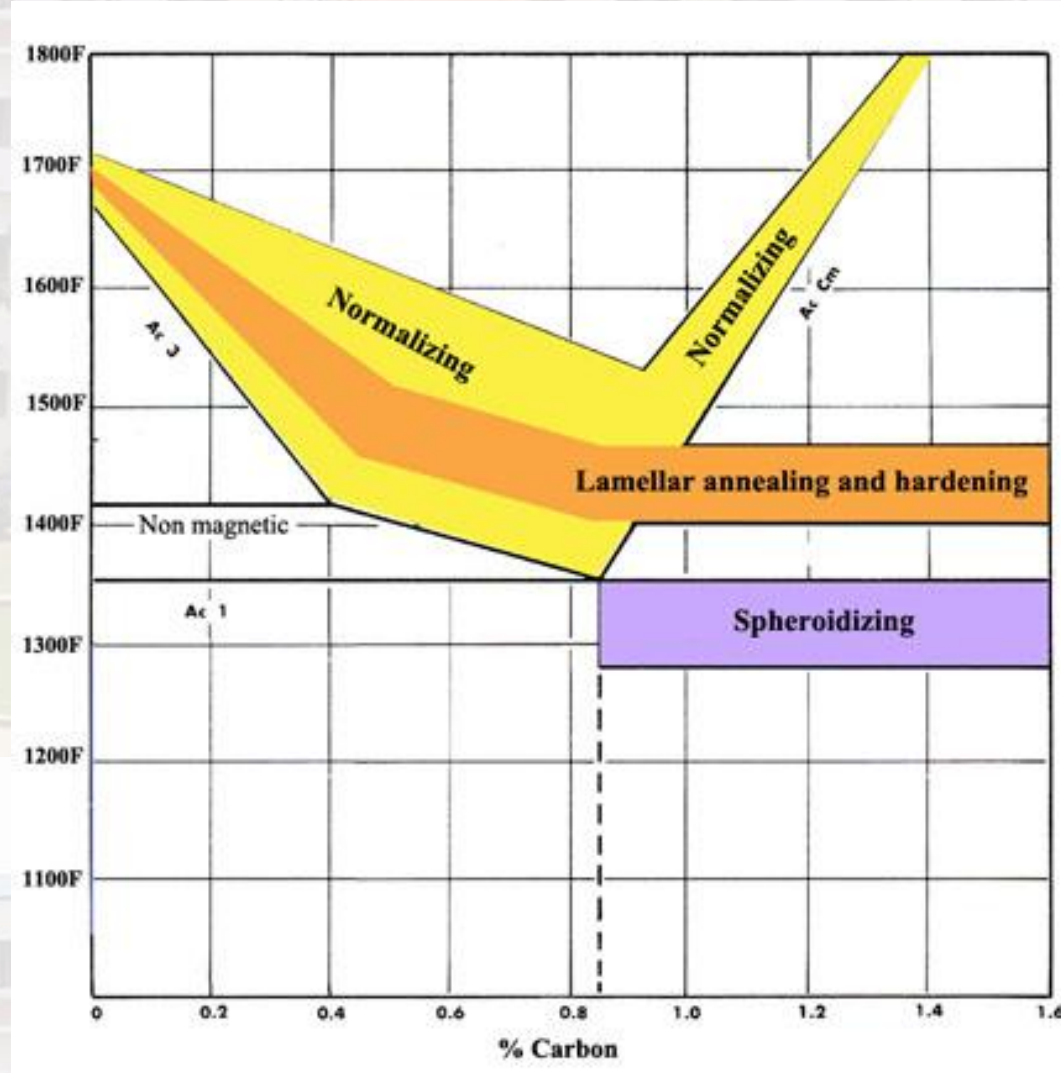
Main Objectives:

- ✓ To refine grain structure.
- ✓ To remove strains
- ✓ To remove internal stress
- ✓ To remove dislocations
- ✓ To improve mechanical properties(strength, hardness and toughness)
- ✓ To improve machinability of low carbon steels.





Normalizing





Hardening

- Increases the hardness
- Heat treatment which is used to produce **Martensite** predominately.

Objective:

- To improve hardness
- To improve wear resistance



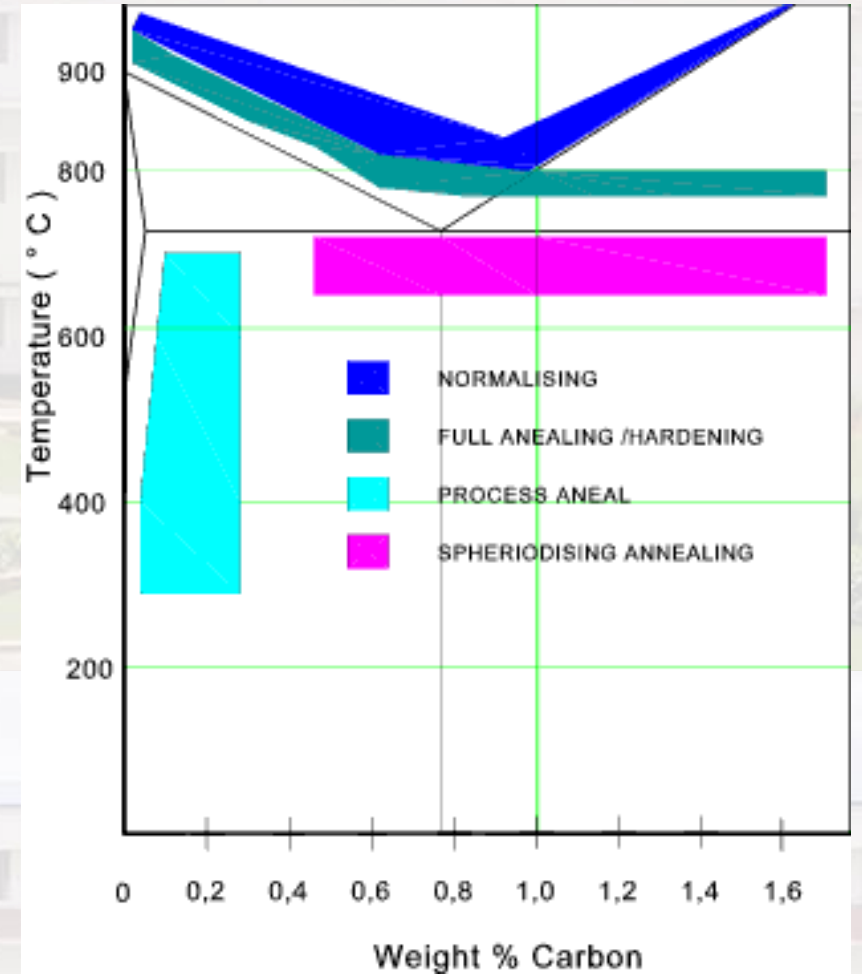


Hardening



Steps:

- Heating
- Soaking → Complete γ
- Cooling.





Factors Affecting Hardness



- **Carbon Content**

- ✓ Increasing Carbon → Increasing Hardness

- **Quenching Medium**

- ✓ Faster the cooling → Greater the hardness.

- **Specimen Size**

- ✓ Increase the specimen size → Decreases the hardness.

- **Other Factors**

- ❖ Geometry

- ❖ Quenching medium

- ❖ Degree of agitation

- ❖ Surface conditions

- ❖ Alloy elements

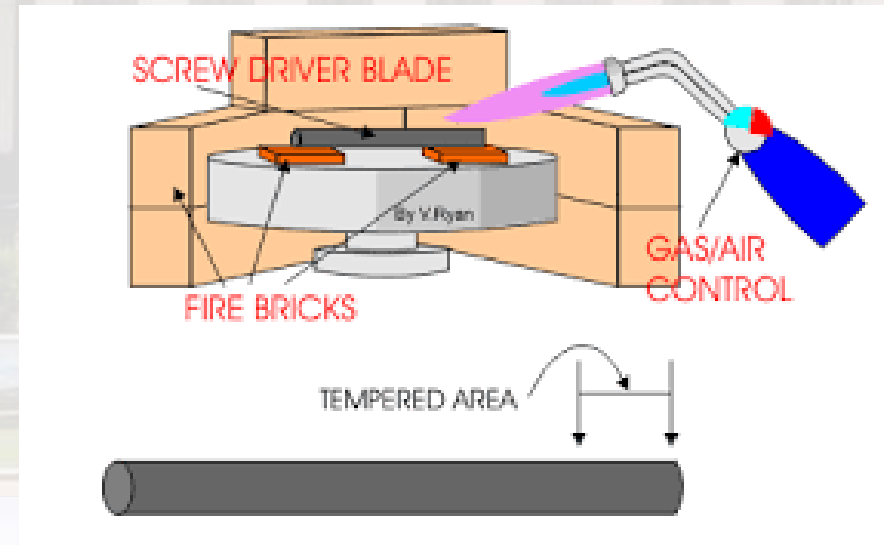


Tempering

- Martensite formed in the hardening process is converted to **TEMPERED MARTENSITE**
- To improve **ductility and toughness**.

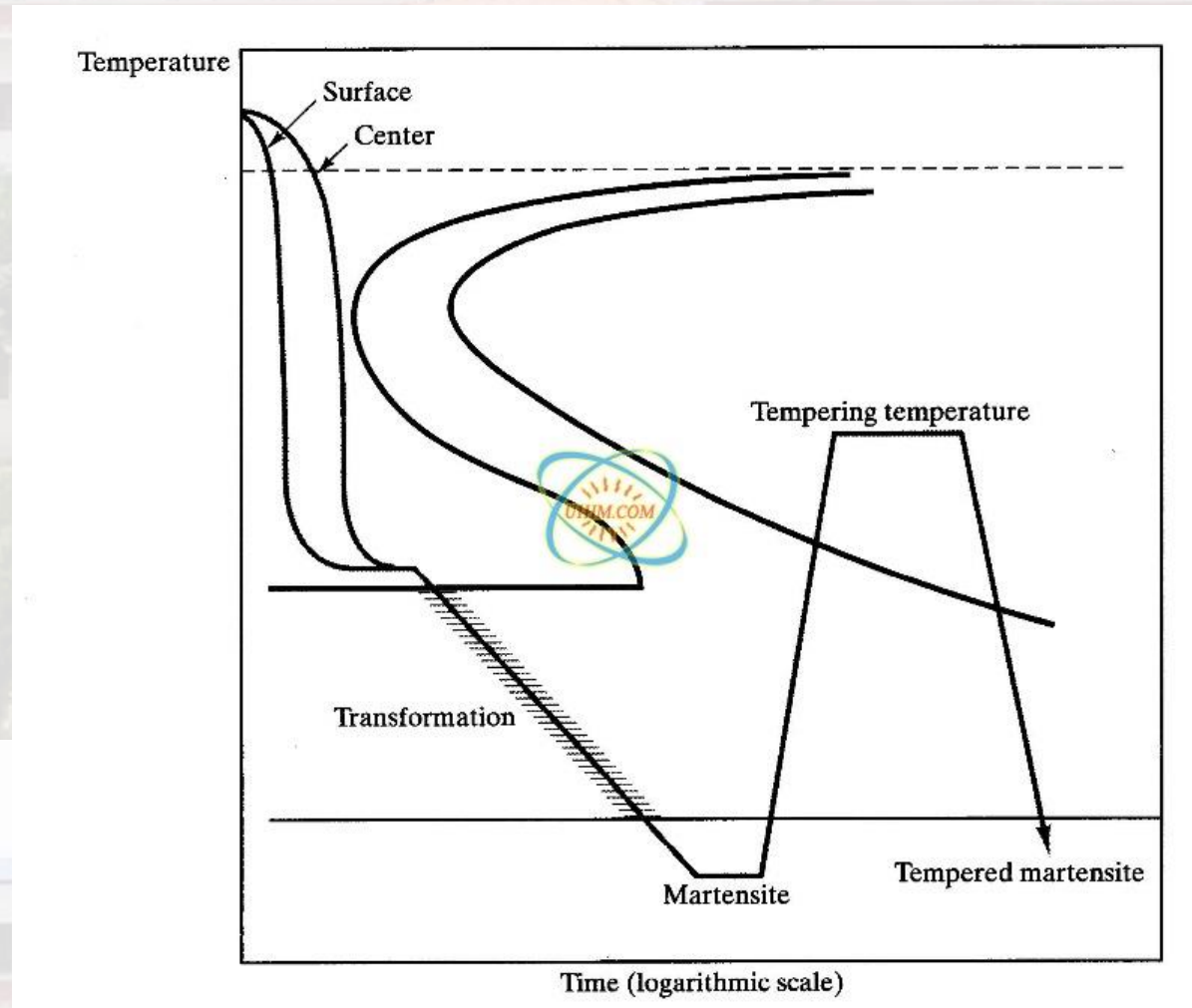
Objective

- To improve ductility
- To improve toughness
- To reduce hardness
- To remove internal stress (rapid cooling)
- To impart wear resistance.



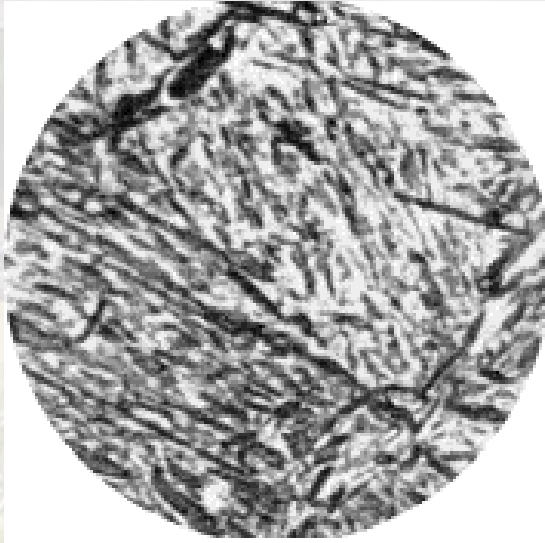


Tempering

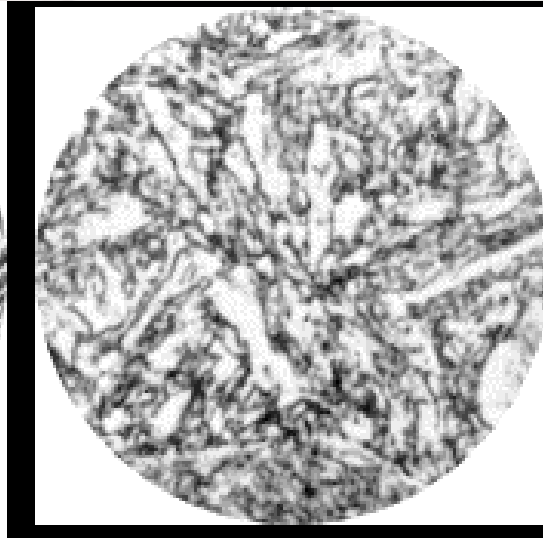




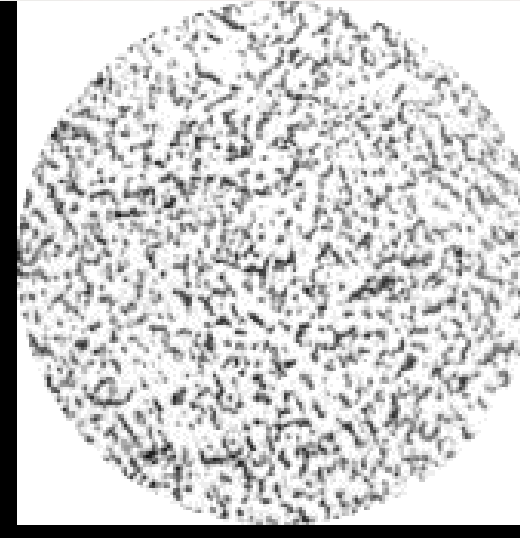
Tempering



Martensite



Tempered Martensite



Heavily Tempered Martensite



Tempering

- Heated to 250° - 650°C and cooled slowly to room temp
- This is also done to relieve internal stress.
- **Martensite(BCT) \rightarrow Tempered Martensite**
- BCT \rightarrow supersaturated carbon
- TM \rightarrow stable ferrite and cementite
- Hardness decreases with increasing in tempering time.



Types of Tempering



- **Low temp Tempering**

- 150-250°C

- Retain hard martensite

- Relieve internal stress

- **Medium Temp Tempering**

- ❖ 350-450°C

- ❖ Increases endurance limit and elastic limit

- ❖ For spring steel

- **High temp Tempering**

- ✓ 500-650°C

- ✓ Relieve internal stress

- ✓ On structural steel



THANK YOU

Assessment <https://play.kahoot.it/v2/?quizId=06fac555-3e18-4560-b9b5-4085f379adb3>