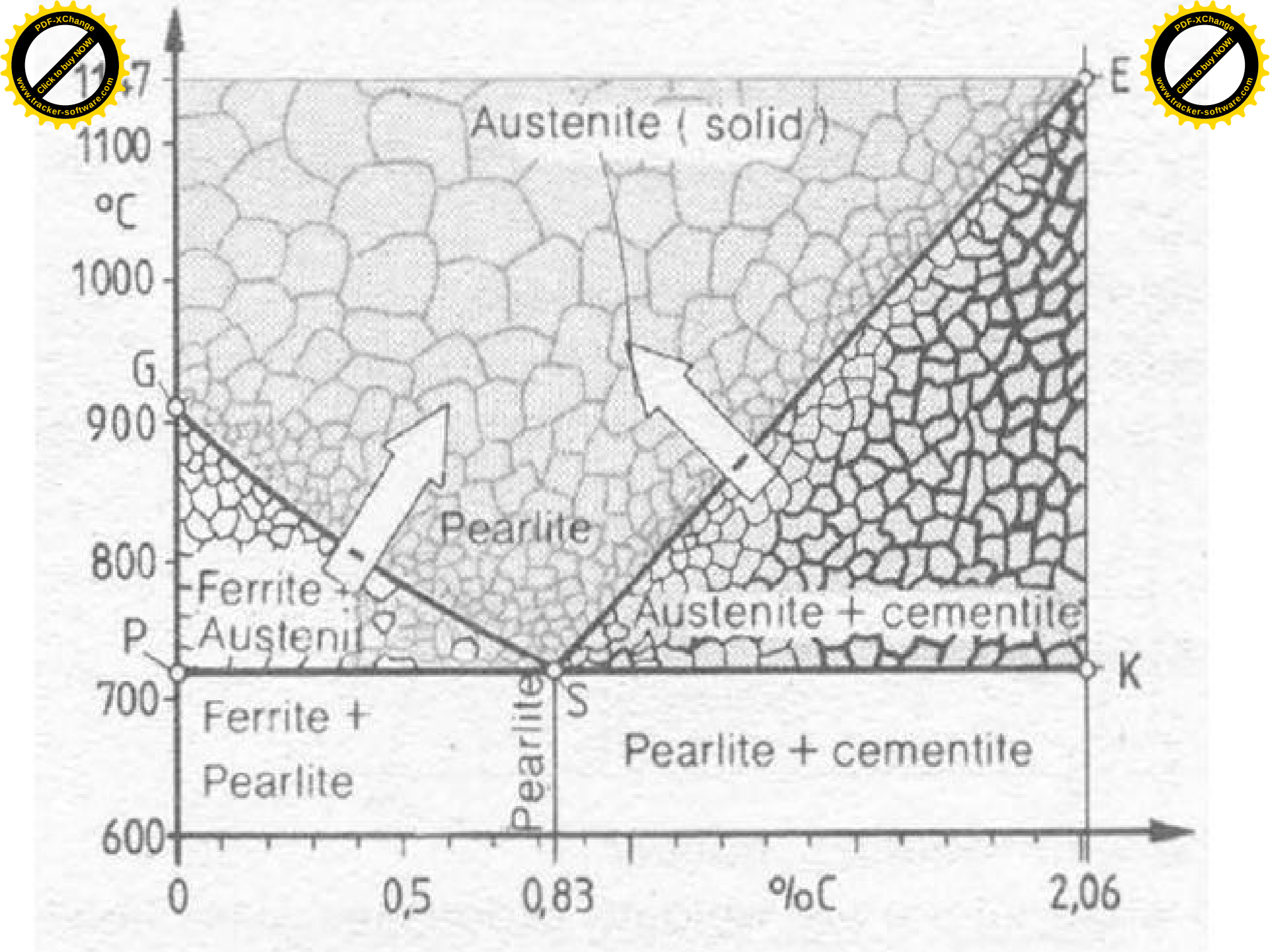
Iron Carbon Phase Diagram

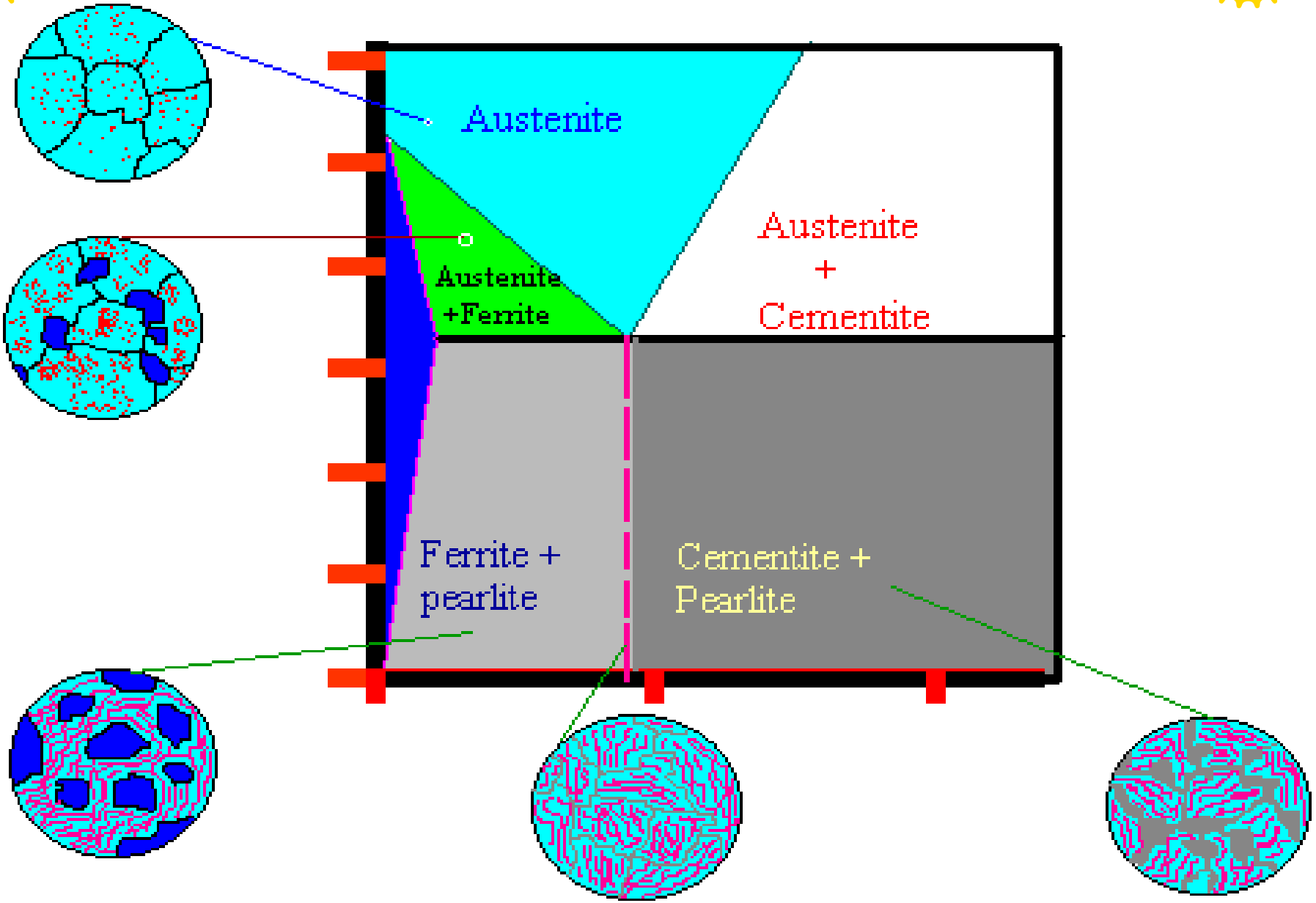
Material

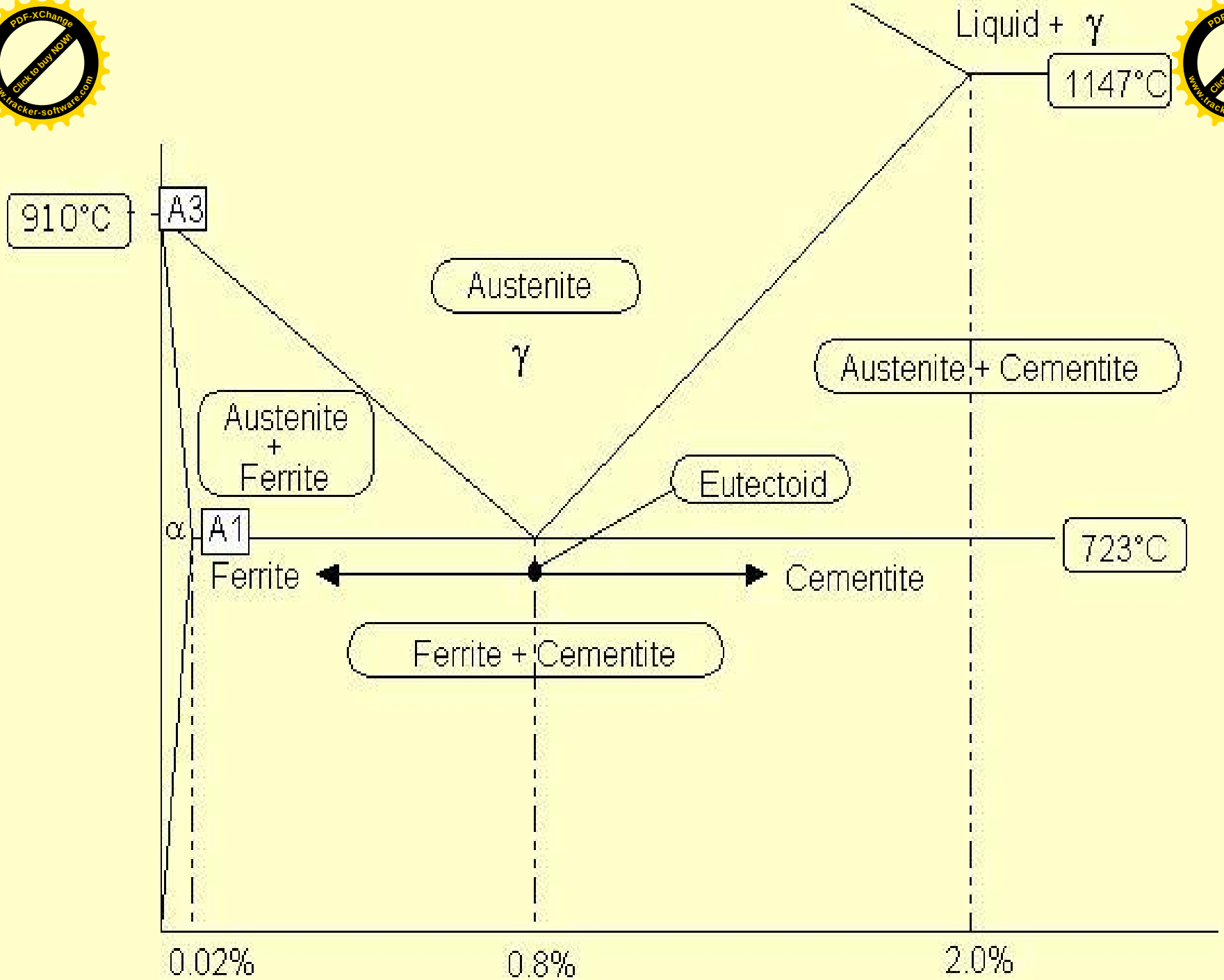
Prepared by:

Syed Fawwad


1147
1100
°C
1000
900
800
700
600
G
P
E
K
S
Austenite (solid)
Pearlite
Ferrite +
Austenit
Austenite + cementite
Ferrite +
Pearlite
Pearlite
Pearlite + cementite
0
0,5
0,83
%C
2,06

Variation in microstructure in steels





Formation of different structures w.r.t % age of Carbon

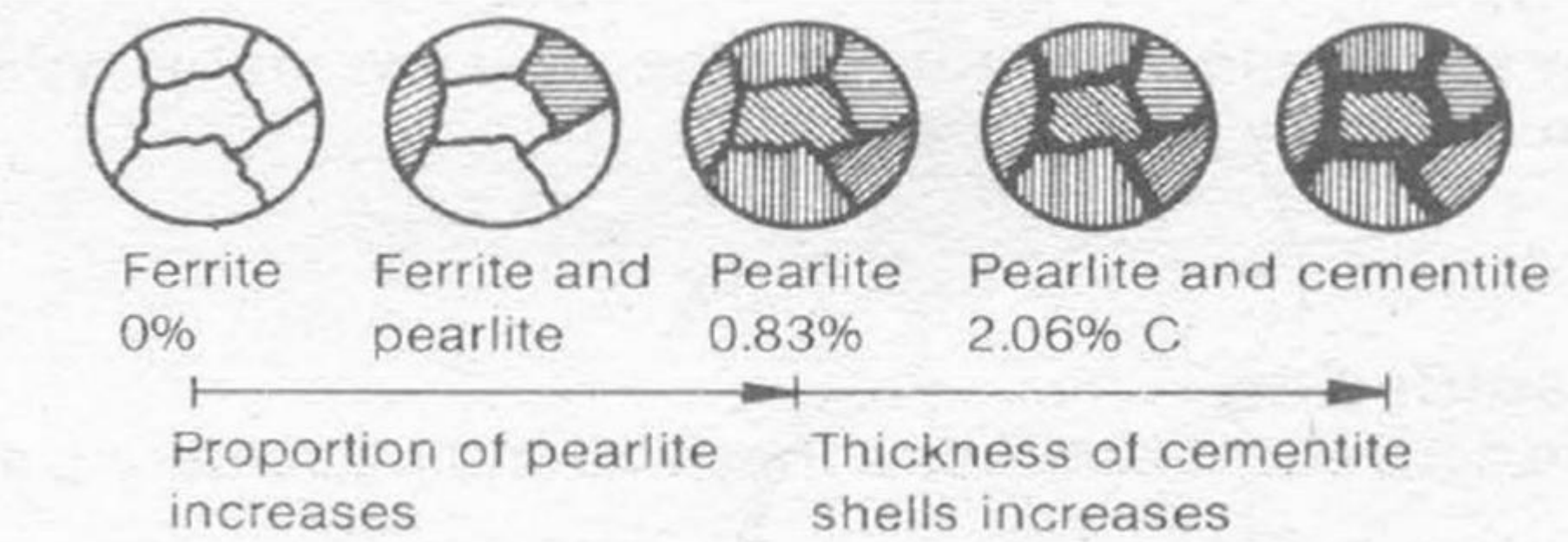


Fig. 3.634 Constituents of steel structure

Pearlite Grain Structure

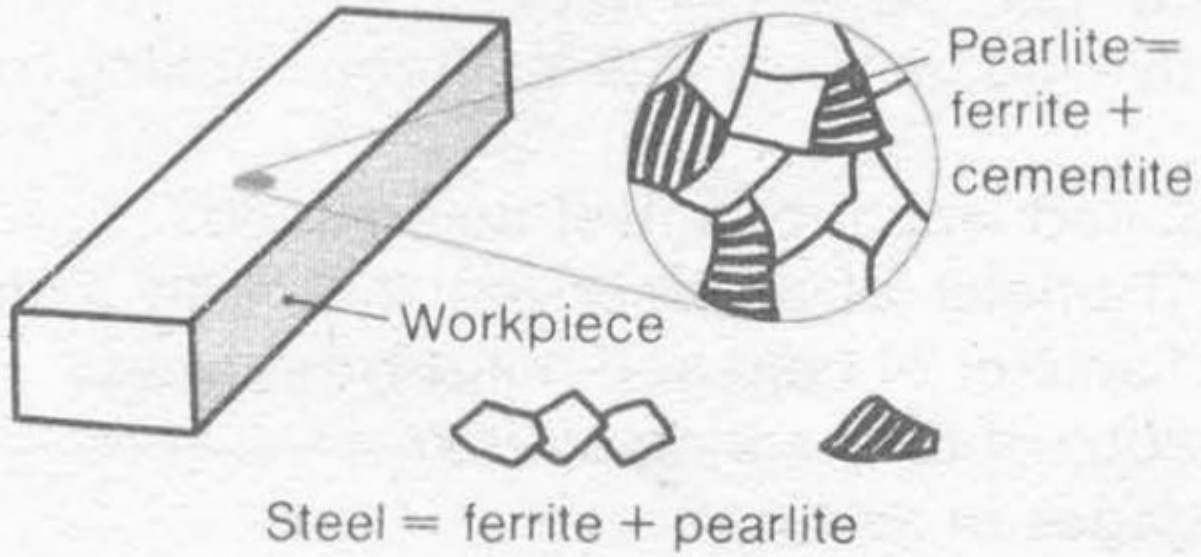


Fig. 3.631 The lattice structure of unhardened steel containing less than 0.83% by weight of carbon consists of ferrite and pearlite

Pearlite cementite grain structure

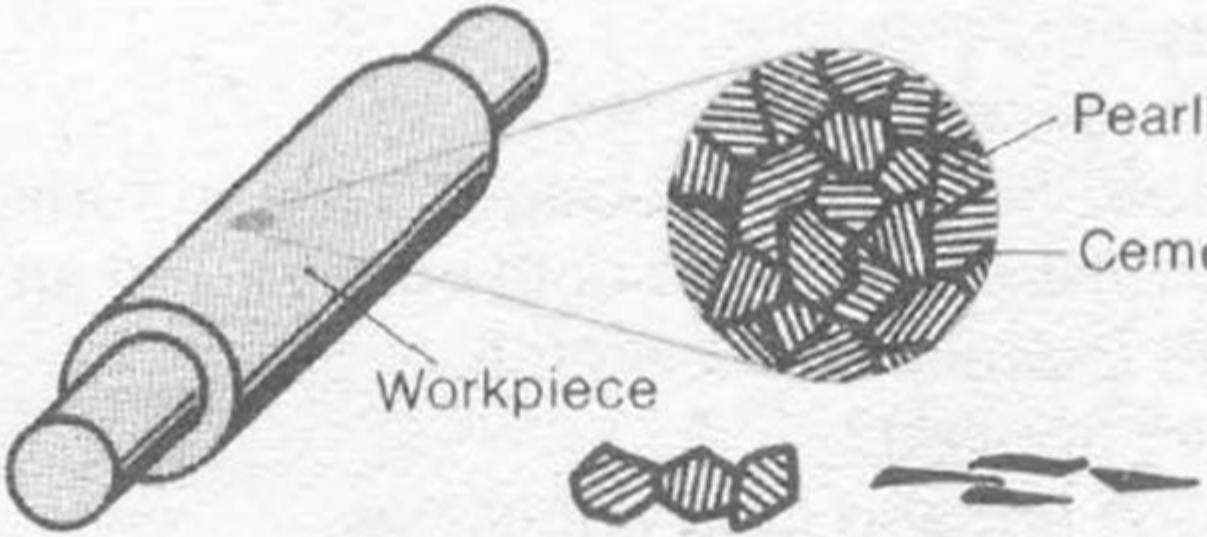


Fig. 3.633 The lattice structure of unhardened steel containing more than 0.83% by weight of carbon consists of pearlite and cementite

Transformation of structure

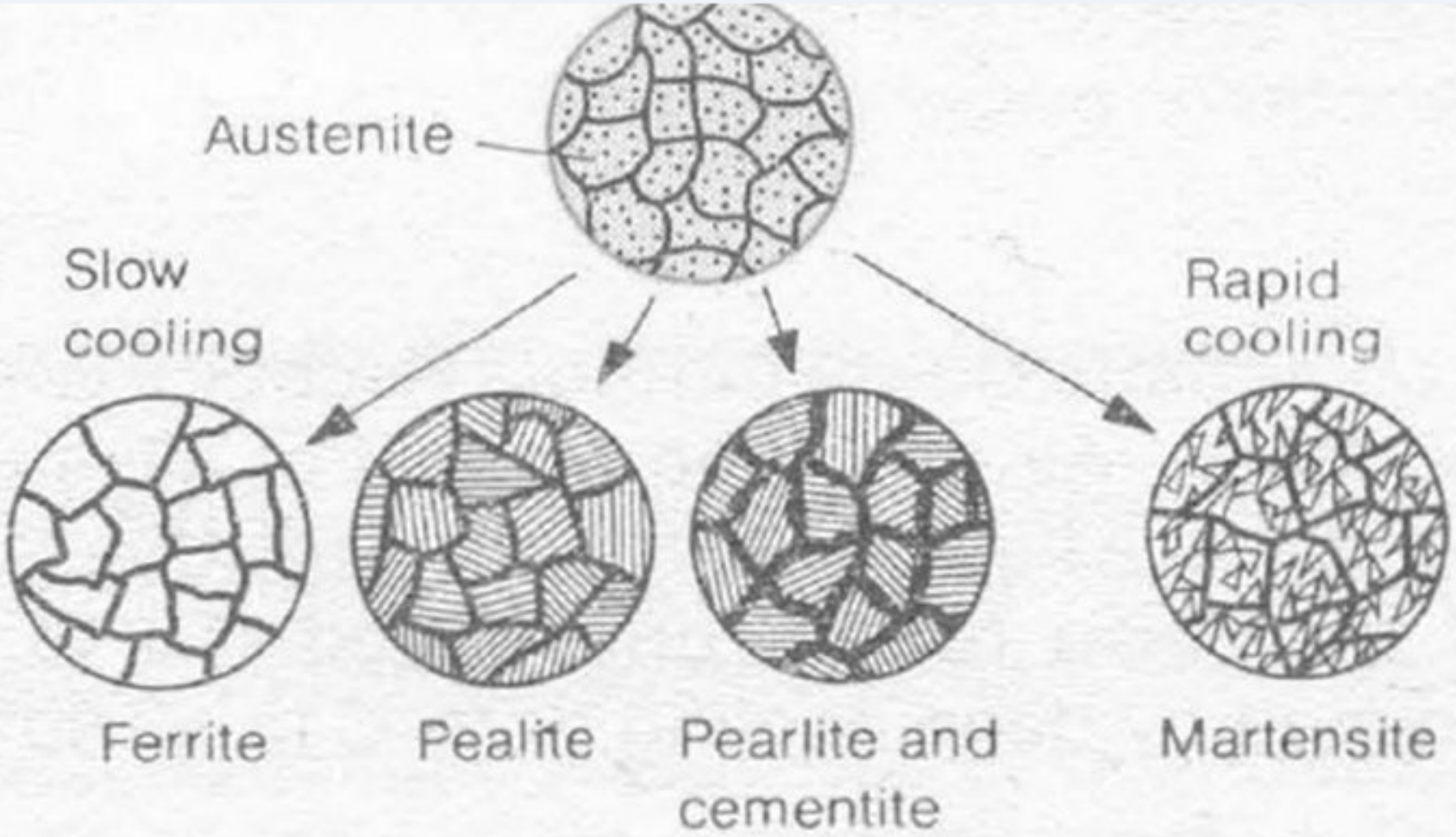


Fig. 3.637 Retransformation of the austenite structure.

Definitions related to heat treatment

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- Heat treatment
  - The controlled heating and cooling processes used to change the structure of a material and alter its physical and mechanical properties.
- Annealing
  - The steady heating of a metal at a certain temperature above the re crystallization phase followed by a gradual (inside furnance) cooling process

Full annealing

- An annealing process that soaks the metal above the austenite phase, followed by gradual cooling. A full anneal may take a day or longer.

- Process annealing
  - An annealing process that heats the metal below the austenite phase to restore ductility after cold working
- Normalizing
  - The steady heating of a metal above the re crystallization phase, followed by a cooling process at a moderate pace. Normalized metals are often cooled in open air at room temperature

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- Quenching
  - The soaking of a metal at a high temperature above the re crystallization phase, followed by a rapid cooling process. The quenching of steel creates martensite
- Quenching medium
  - The liquid or air substance used to cool a metal during quenching. Water, saltwater, air, and oil are common quenching mediums

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- Tempering
  - The steady heating of martensite steel at a temperature below the re crystallization phase, followed by a gradual cooling process
- Phase
  - A portion of material with a uniform crystal structure, consistent properties, and recognizable boundaries. At room temperature, steel consists of two or more phases

- Austenite phase
  - The phase at which solid steel re crystallizes and has a face-centered cubic crystal structure. This phase is only possible in carbon steel at high temperature.Austenite steel holds a greater amount of dissolved carbon and exhibits increased formability
- Ferrite phase
  - The phase at which solid steel has a body-centered cubic crystal structure. Ferrite steel can hold only a minimal amount of carbon, and it is relatively soft.

Pearlite

- A combination of ferrite and cementite. Pearlite grain structures resemble human fingerprints. Steel with exactly 0.77 percent carbon consists of uniform pearlite at room temperature

Cementite

- A compound of iron and carbon that is very hard and brittle. The presence of cementite hardens steel.

Bainite

- A combination of ferrite and cementite in ferrous metals that is harder than pearlite. Bainite contains needlelike grain structures, and it requires an initial rapid cooling followed by gradual cooling

- Martensite
  - A steel that consists of a distorted, body-centered tetragonal crystal structure. Martensite is very hard and brittle
- Eutectoid temperature
  - The lowest temperature at which austenite transforms into ferrite and cementite. Steel with 0.77 percent carbon transforms at this temperature
- Hypoeutectoid steel
  - Steel that contains less than 0.77 percent carbon. Hypoeutectoid steel consists of ferrite and pearlite at room temperature.

Hypereutectoid steel

- Steel that contains more than 0.77 percent carbon. Hypereutectoid steel consists of pearlite and cementite at room temperature.