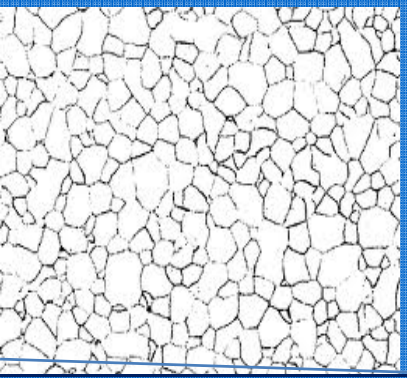
Modern Metallic Materials

Dual phase alloy

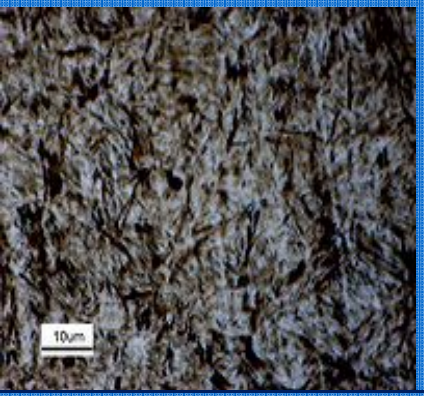
- **Dual-phase Alloy** (**DPA**) is a high-strength steel that has a ferrite and martensitic microstructure.

Ferrite

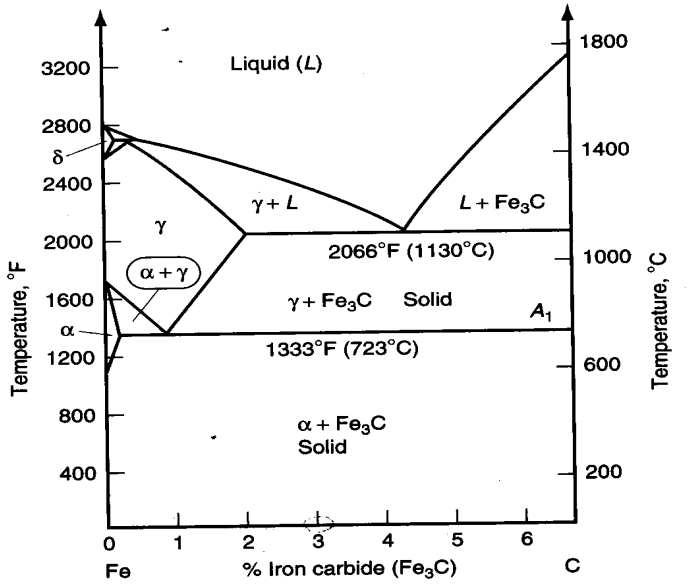


***It is BCC iron phase with very limited solubility For Carbon. The maximum solubility is 0.025% carbon Till 910 C and it dissolves only 0.008% carbon at room Temp.**

Martensite



Martensite possesses an Acicular or needle-like structure,.



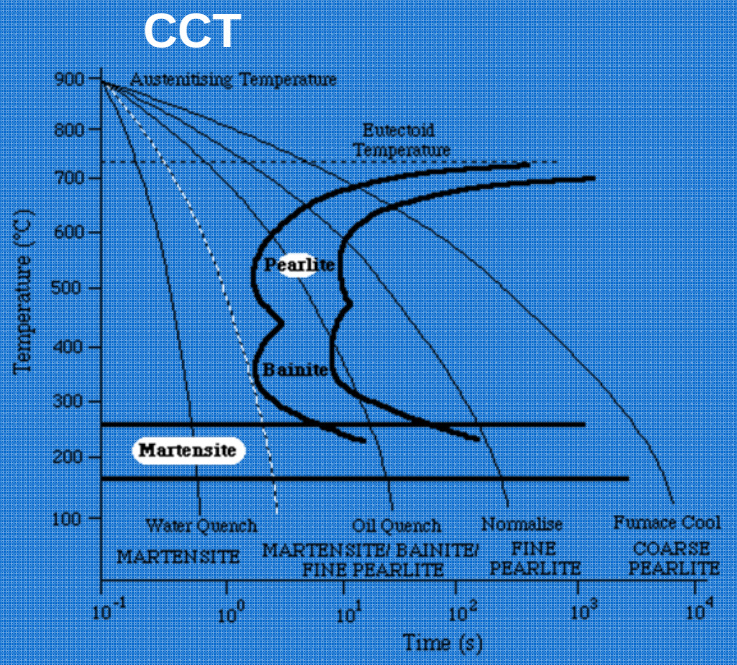
Dual phase alloys continued

- DPA starts as a low or medium carbon steel and is quenched from a temperature above A1 but below A3 on a continuous cooling transformation diagram.

- This results in a microstructure consisting of a soft ferrite matrix containing islands of martensite as the secondary phase (martensite increases the tensile strength).

Advantages

- **Low yield to tensile strength ratio (yield strength / tensile strength = 0.5)**
- **High initial strain hardening rates**
- **Good uniform elongation**
- **A high strain rate sensitivity (the faster it is crushed the more energy it absorbs)**
- **Good fatigue resistance**
- **Due to these properties DPS(dual phase steel) is often used for automotive body panels, wheels, and bumpers**



Micro-alloyed steel

- **Microalloyed steel** is a type of alloy steel that contains small amounts of alloying elements (0.05 to 0.15%). Standard alloying elements include: niobium, vanadium, titanium, molybdenum, zirconium, boron, and rare-earth metals. They are used to refine the grain microstructure and/or facilitate precipitation hardening.

- Hot worked microalloyed steels can be used from the air cooled state.. Machinability is better because of their more uniform hardness and their ferrite-pearlite microstructure.

Advantages:

❖These steels performance is better than carbon steel and low alloy steel and Yield strength is also better (500 and 750 MPa) without heat treatment.

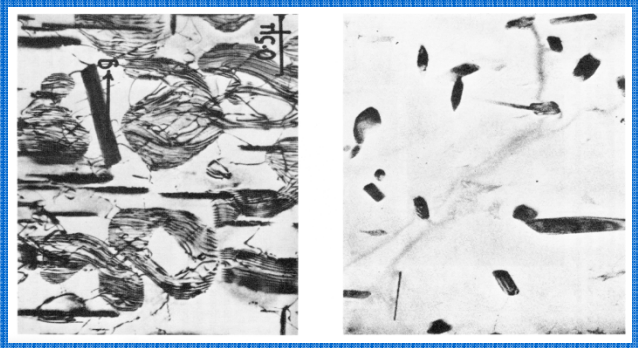
❖Weldability is good, and can even be improved by reducing carbon content while maintaining strength.

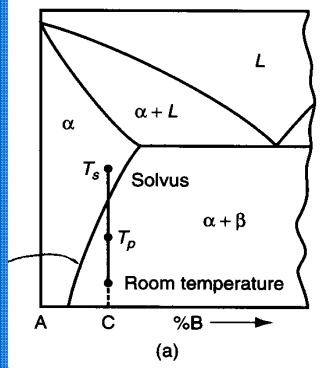
❖ Fatigue life and wear resistance are superior to similar heat treated steels.

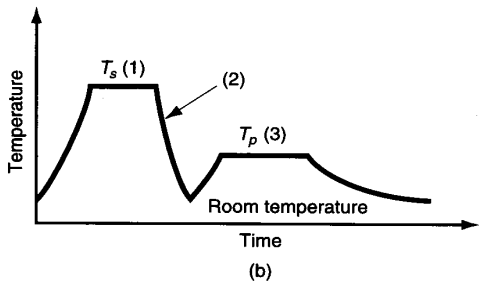
Disadvantages:

❖Ductility and toughness are not that good. They must also be heated hot enough for the all of the alloys to be in solution; after forming the material must be quickly cooled to 540 to 600 °C.

Precipitation Hardening microstructure







High-strength low-alloy(HSLA)

- **High-strength low-alloy** (**HSLA**) **steel** is a type of alloy steel that provides better mechanical properties or greater resistance to corrosion than carbon steel.

- HSLA steels vary from other steels in that they aren't made to meet a specific chemical composition, but rather to specific mechanical properties. They have a carbon content between 0.05–0.25% to retain formability and weldability.

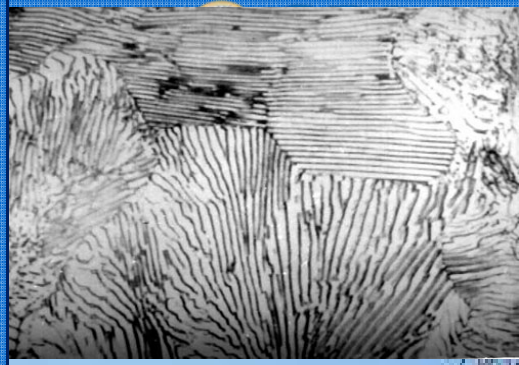
- HSLA steels are also more resistant to rust than most carbon steels, due to their lack of pearlite – the fine layers of ferrite (almost pure iron) and cementite in pearlite.

APPLICATIONS:

- Cars, trucks, cranes, bridges, roller coasters and other structures.
- Reasons for above Application:

HSLA are designed to handle large amounts of stress or need a good strength-to-weight ratio. HSLA steels are usually 20 to 30% lighter than a carbon steel with the same strength.

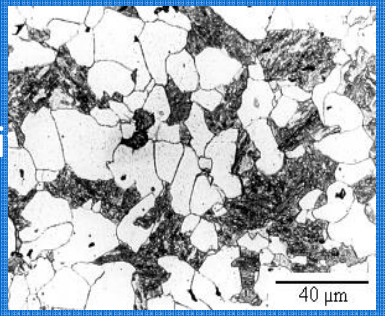
PEARLITE



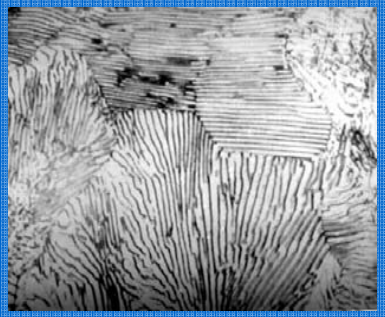
Transformation induced plasticity steel(TRIP)

- **TRIP steel** is a high-strength steel typically used in the automoti industry.
- TRIP steel has a triple phase microstructure consisting of ferrite, bainite, and retained austenite.
- During plastic deformation and straining, the metastable austenite phase is transformed into martensite.
- This transformation allows for enhanced strength and ductility.

BAINITE



PEARLITE



MARTENSITE