

## Classification of Alloy steels:

Alloy steels can be divided into two main groups: Low alloy steels and high alloy steels

### a) Low alloy steels:

- contain up to 3 to 4% of alloying elements.
- Have better mechanical properties that prevent corrosion,
- Have high temperature performance.

### Applications:

- Pipes
- Automotive & aerospace bodies
- Railway lines, off shore & onshore structured engineering plates.

### b) High Alloy steels:

- more than 5% of one or more alloying elements.
- The room temperature structures after normalizing may be austenitic, martensitic or contain precipitated carbides.

### Applications

- Automobiles
- Ship building
- Railways, aircrafts
- Finds use in low temperature applications due to its high toughness.

(Explain the cast iron micro structure, properties and application in detail.)

## Micro structure of cast iron

Cast iron, an alloy of iron that contains 2 to 4 percent carbon, along with varying amounts of silicon and manganese and traces of impurities such as sulfur and phosphorus.

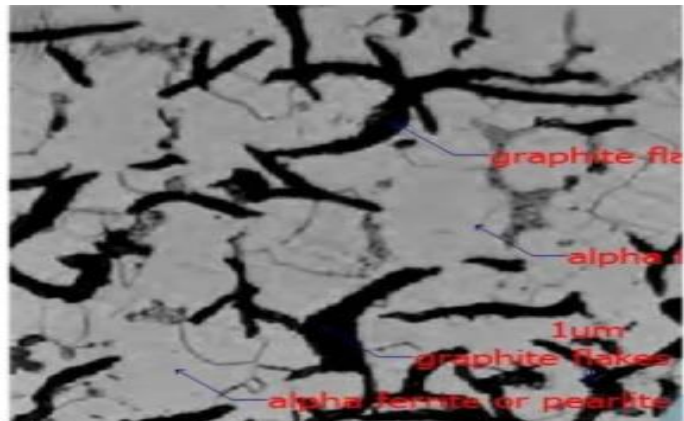
### Types of cast iron

1. Grey cast iron
2. White cast iron
3. Malleable cast iron
4. Spheroidal graphite cast iron or nodular cast iron
5. Alloy cast iron

### 1. Gray cast iron

- It is the most common type of cast iron.
- It has graphite microstructure consisting of many small fractures giving gray colour.
- When gray cast iron is produced, the fractures open up to reveal the gray-colored graphite underneath the surface.
- Gray cast iron is not as strong as steel, nor is it able to absorb the same shock as steel.
- gray cast iron offers similar compressive strength as steel.

## Micro structure of gray cast iron



### Composition

C - 2.5 – 4%, Si - 1 – 3%, Mn - 0.4 – 1%, P - 0.15 – 1%, S- 0.02 – 0.15%, Remaining – iron

### Properties:

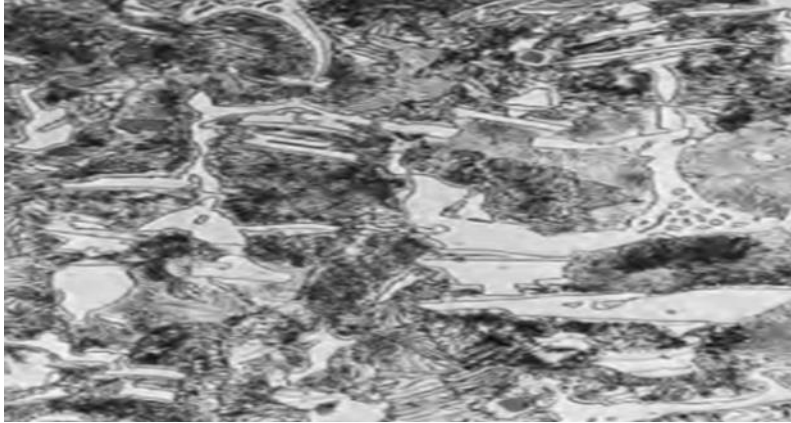
- Good wear resistance.
- Good corrosion resistance.
- Good Mach inability.
- High tensional, shear strength.
- High hardness.

### Application:

Machine tool bodies, engine cylinders, brake drums, camshaft, pipe Fitting, rolling mills, agriculture equipment.

## 2.White Cast Iron

- It is as common as gray cast iron.
- It receives its name from its off-white color, from iron compound cementite.
- Like gray cast iron, white cast iron features many small fractures.
- The difference is that white cast iron features cementite below its surface, whereas gray cast iron features graphite below its surface.
- The graphite creates the appearance of a gray color, while the cementite creates the appearance of a white color.
- White cast iron is hard and offers excellent resistance against abrasions.



**Micro structure of white cast iron**

**Composition:**

C - 1.8 to 3%, Si - 0.5 to 1.9%, Mn -0.25 to 0.8%, P - 0.05 to 0.2%, S - 0.1 to 0.3%,  
remaining – iron

**Properties:**

- Very hard and brittle.
- High wear resistance.
- High tensile strength.
- Low compressive strength.
- High hardness.
- Difficult to Machine.

**Applications:**

- Wearing plates.
- Road roller surface.
- Pump liners.
- Grinding balls.
- Dies.
- Nozzles.
- For production of Malleable castings.

**3.Malleable cast iron:**

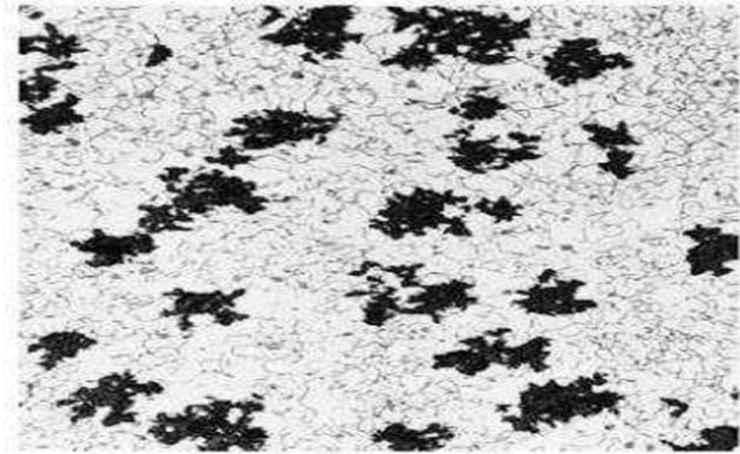
Malleable iron is an iron that has been heat treated so that it has significant ductility and malleability. On heat treatment Cementite in white cast iron micro structure breaks down into ferrite and graphite.

**Composition:**

- Carbon – 2.0% to 3.0%
- Manganese- 0.2% to 0.6%
- Silicon – 0.6% to 1.3%
- Phosphorus-0.15%
- sulphur-0.10%
- remaining – iron

### **Micro structure of malleable cast iron**

- Malleable iron is produced by heat treating white iron.
- During the heat treatment process, the cementite in the white cast iron structure breaks down into ferrite and graphite clumps (or) nodules.
- This graphite nodule, also called tempered carbon, appears like popcorn.
- This graphite shape permits a good combination of strength and ductility in the pearlite matrix.
- The irons so produced are called pearlite.



**Microstructure of malleable cast iron**

### **Characteristic of malleable cast iron:**

- The malleable cast iron possesses good ductility and malleability properties than grey cast iron.
- It exhibits high yield strength and tensile strength.
- It is not brittle as grey cast iron.
- It has high young's modulus and low co-efficient of thermal expansion.
- It has good wear resistance and vibration damping capacity.

### **Application of malleable cast iron:**

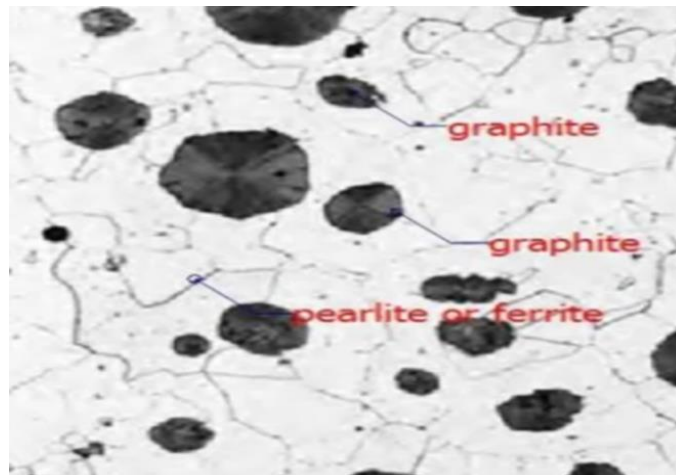
- Brake-shoes,
- pedals,
- levers,
- wheel hubs,
- axle housing,
- connecting rods,
- gears and
- door hinges.

#### 4.Spheroidal graphite cast iron or nodular cast iron

- graphite forms as nodules (spherical) instead of flakes as in normal cast iron.
- Nodulizing elements, typically magnesium, are used to allow the solidification of the graphite into nodules.

#### Micro structure of Spheroidal graphite cast iron or nodular cast iron

- The nodular cast iron is produced by adding magnesium and or cerium to molten cast iron.
- The magnesium converts the graphite of cast iron from flake form into spheroidal or nodular form.
- The resulting alloy is called spheroidal or nodular cast iron.
- The presence of spheroidal graphite improves the ductility strength, fracture toughness, and other mechanical properties.
- Ductility cast iron derives its name from the fact its ductility is increased by 20%.
- Addition of magnesium gives good results and hence it is widely used.



#### Micro structure of Spheroidal graphite cast iron or nodular cast iron

##### Composition:

C - 3.2 to 4%, Si - 1.8 to 3%, Mn - 0.2 to 0.5%, P - 0.08% Max, S - 0.1% Max, Remaining – iron.

##### Properties:

- Good ductility.
- Good tensile and yield strength.
- Good toughness.
- Good fatigue.
- Good impact strength.
- Good hardness.
- High modulus of elasticity.
- Good Mach inability.
- High Hardness.

**Applications:**

- Crank shafts.
- Gears.
- Sheet metal dies.
- Furnace doors.
- Cylinder blocks.
- Bearing blocks.
- Pipes.

**5. ALLOY CAST IRON:**

- Alloying element like Ni, Cr, Mo, Si, Mn are added to improve the properties like refining the grain size, stabilizing hard carbides and producing cast irons with martensitic and austenitic structure.

**Composition:**

Ni - 14 – 36 %, Cr - 1.5 %, Cu - 5 – 8 %, C - 2 to 2.3 %, Si - 5 to 6%.

**Properties:**

- High tensile strength.
- More brittle.
- Good corrosion resistance.
- High wear resistance.

**Applications:**

- Generator, Motor covers, gas turbine, furnace, impellers, cylinder liners.