UNIT IV FERROUS AND NON FERROUS METALS

Cu alloys -Aluminium and Al -Cu -Precipitation Strengthening Treatment

Engineering Materials and Metallurgy

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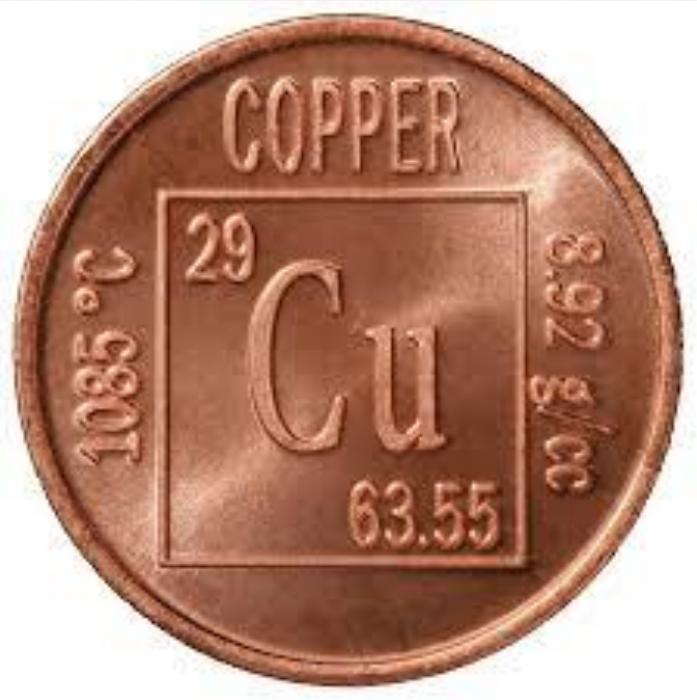
Copper

- Mostly used in Non Ferrous Metals.
- Melting Point : 1083 deg C
- Very Good Corrosion Resistance



Properties

- High Electrical Conductivity
- High Thermal Conductivity
- Good Corrosion resistance
- Soft, Ductile and Malleable.
- Can be hot worked and cold worked but can't be welded

Applications

- Power cables
- Telephone cables
- Circuit boards
- Connectors
- Domestic water tanks and utensils
- For manufacturing brass and bronze

Copper Alloys

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  - High Electrical Conductivity
  - High Thermal Conductivity
  - Good Corrosion resistance
  - Soft, Ductile and Malleable.
  - Can be hot worked and cold worked but can't be welded

Cu Alloys

- Brass (Cu – Zn Alloys)
- Bronze (Cu-Tin Alloys)
- Gun Metal (Cu – Tin – Zn Alloys)
- Cupro Nickel (Cu – Ni Alloys)
  - Tellurium → Very Good Machinability
  - Cadmium → Increase in Strength and little loss in Conductivity
  - Beryllium or Cr → High Strength alloys.

Brass

- Upto 36 % Zn → single phase solid solution → α brass.
- More 36% Zn → two phase solid solution → α β brass.
- α brass → soft, ductile and easily cooled worked.
- α β brass → stronger than α brass

Characteristics

- Stronger than Cu
- Low Thermal and Electrical Conductivity than Cu.
- Cast into moulds and drawn into wires and rolled into sheets.
- 1 – 3% of Pb increases Machining Properties.
- Color: Reddish to White depend upon Zinc %.

Types of Brass

- Gliding Brass → Jewellery works.
- Cartridge Brass → Mfg Cartridge and shell
- Std Brass → Screws, rivets, tubes.
- Muntz Brass → Extruding Rods, tubes, heat exchanger plates.
- Naval Brass → Marine Structural uses.
- Admirality Brass → Condensers, Pump impellers.

Bronze

- High strength with Good Corrosion than brass.
- Strength increase with Tin content.
- But Tin Content is below 12 % because it tends to be brittle.
- Rolled into wires, rods and sheets.

Types

- Bell Bronze → Making Bells
- Phosphor Bronze → Pumps parts, lining, springs.
- Si Bronze → Boiler parts, die cast parts, marine applications.
- Al Bronze → cams, rollers etc.
- Coinage bronze → making Cu coins
- Leaded Bronze → Bearing alloys.

Gun Metal

- Zinc acts as deoxidized to increase fluidity.
- Lead is added to improve castability and machinability.
- Cheaper.

Types

- Admirality Gun metal → Pumps, valves, castings.

- Leaded Gun Metal → Hydraulic gears, valves, etc.

Cupro Nickel

- Cu and Ni have unlimited Solubility.
- They are ductile and malleable.
- Better Corrosion resistance than any other in marine application.
- Hot or Cold worked.
- Shaped by forging, pressing, drawing, spinning.

Types

- Cupronickel → Salt water piping, condenser tubes and bullet envelope.
- Monel metal → pump fittings, sea water exposed parts, food handling plants.
- 'K' Monel → motor boat propeller shafts.

Aluminium Characteristics

- Light weight
- High Thermal and Electrical Conductivity
- Excellent Corrosion resistance
- Non Toxicity
- Low Sp.Gravity
- High Strength to Weight ratio.

Types

- **Heat Treatable Al Alloys:**
- Al – Cu Alloys

  Al – Cu – Ni Alloys

  Al – Mg – Si Alloys

  Al - Zn - Cu alloys

  Al – Li Alloys.

- **Non Heat Treatable Alloys:**
  - Al – Mn Alloys
  - Al – Mg Alloys
  - Al – Si Alloys.

➢ Al – Cu alloys

- Duralumin
- YAlloy.

Precipitation Strengthening

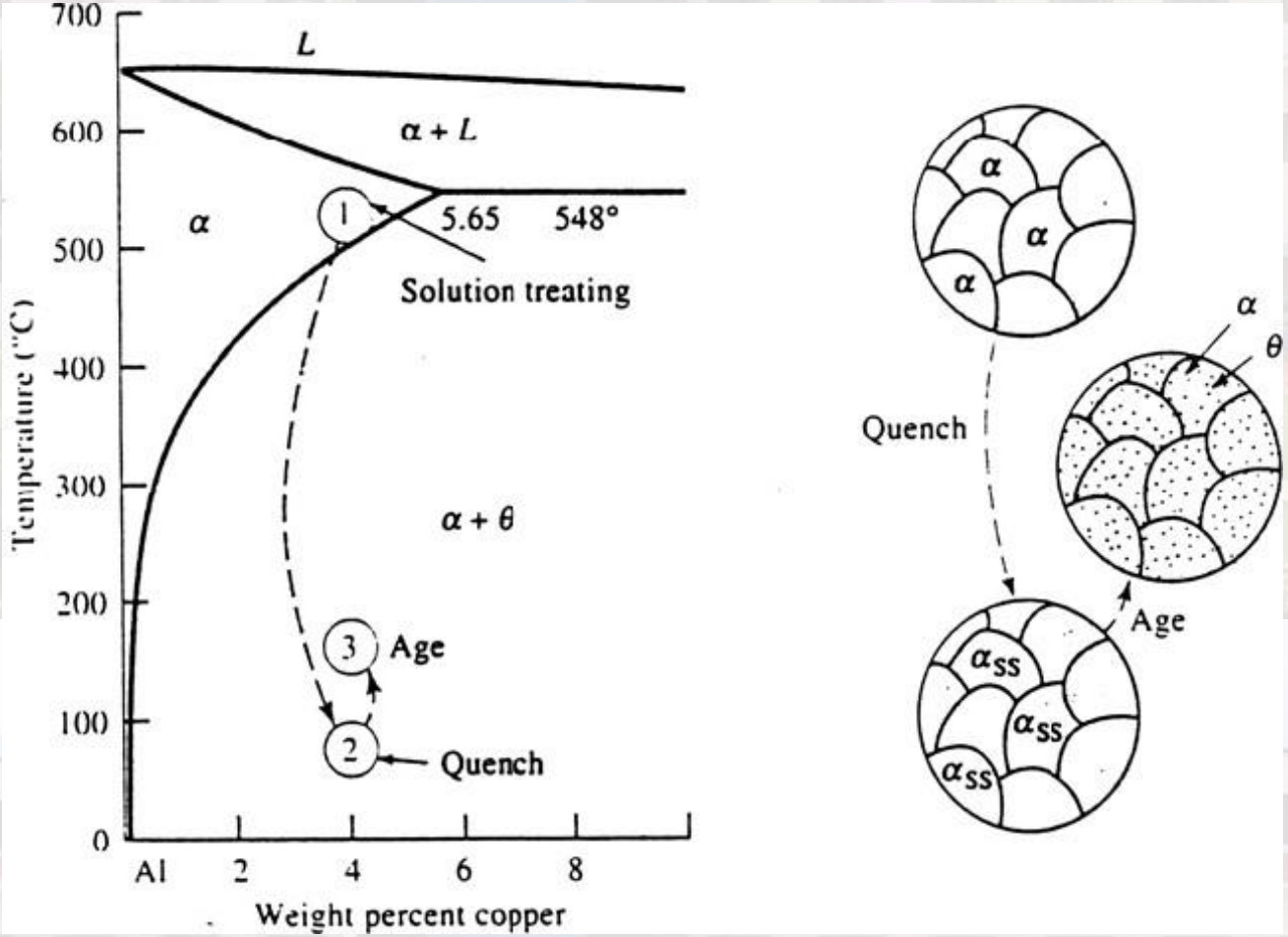
- Also Known as Age Hardening,
- It is used to improve the physical properties by solid state reaction.
- Most applicable for Al, Mg, Ni.
- Ex: Al - Cu, Cu – Be, Cu – Tin, Mg – Al.
- In this Process hardening takes place because the fine particles of the new phase are formed.

Process

- Its is explained with Al -4% Cu Alloy(Duralumin).

- Steps
  - Solution Treatment
  - Quenching
  - Ageing.

Al-Cu phase diagram showing three steps in Precipitation Hardening



Solution treatment

- Heating above the solvus temperature to obtain solid solution
- Hold until homogenous Solid solution
- This step dissolves the θ precipitate and reduces any segregation in original alloy.
- This treatment is done at the temperature range of 500°C and 548°C

Quenching

- After ST → Rapid Quenched.
- On rapid cooling, there is no sufficient time for diffusion of Cu atoms to form precipitate particles.
- Hence supersaturated αss (containing excess Cu) is obtained at RT.
- Supersaturated αss is unstable.

Ageing

- αss is heated below the solvus temperature.
- At this ageing temp diffusion of αss may takes place and precipitate particles are formed.
- By holding at this same temperature for a sufficient time α + $CuAl_2$ (θ) is formed.
- This $CuAl_2$ increases the hardness.

THANK YOU