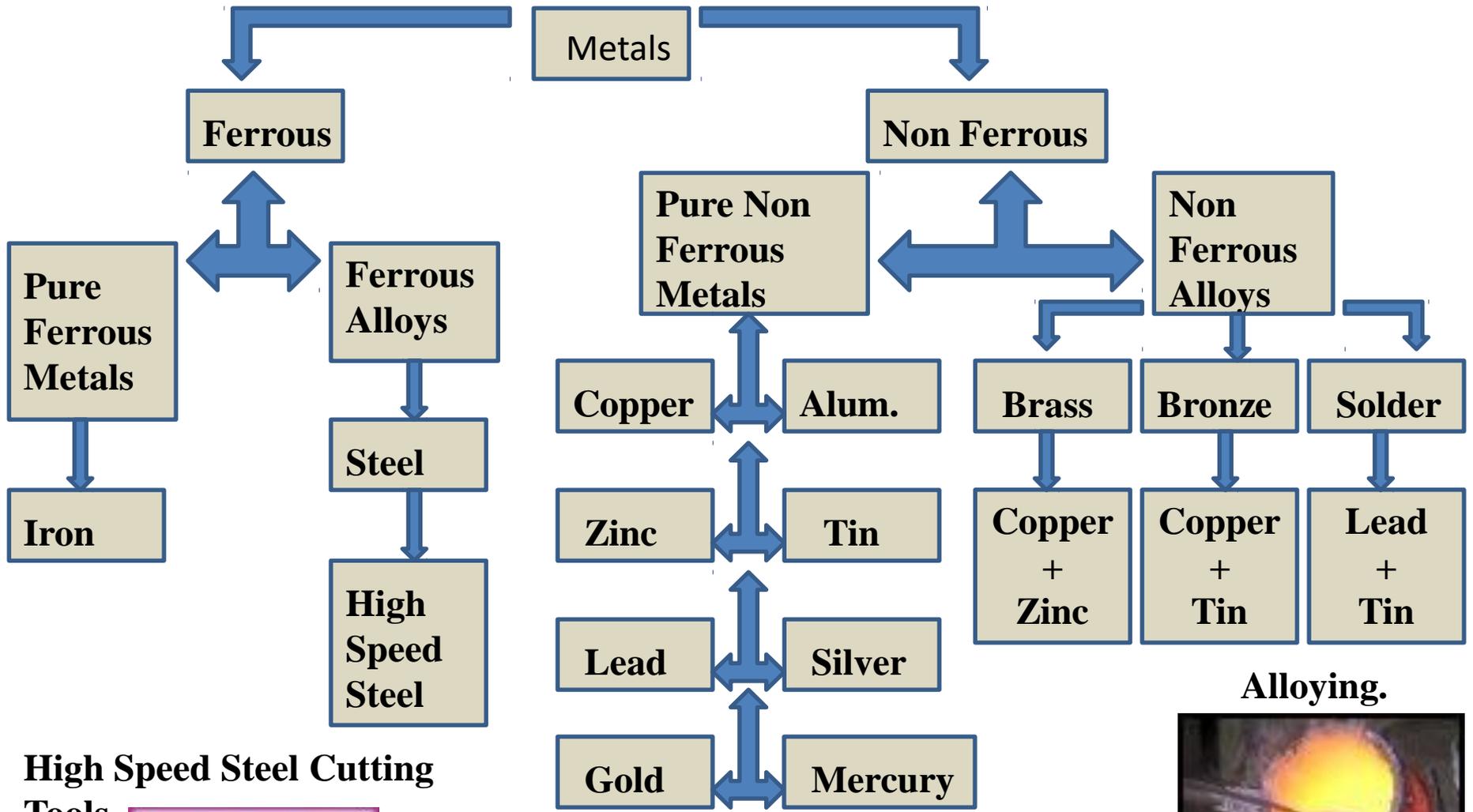


Non ferrous metals and Alloys

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High Speed Steel Cutting Tools



Mercury is the only non ferrous metal that is liquid at room temperature.

Alloying.



Non – Ferrous Metal.

Non-Ferrous Metals:

Non-ferrous metals are metals that do not have any iron in them at all. This means that Non-ferrous metals are not attracted to a magnet and they also do not rust in the same way when exposed to moisture. Typical Non-ferrous metals include copper, aluminium (coke cans), tin and zinc.

Examples:

1. Aluminium.
2. Copper.
3. Zinc.
4. Tin.
5. Lead.
6. Silver.
7. Gold.
8. Magnesium.



Non – Ferrous Metal.

Metal Type.

Aluminium.

It tends to be light in colour although it can be polished to a mirror like appearance. It is very light in weight.



Metal Uses.

Used for saucepans, cooking foil, window frames, ladders, expensive bicycles.



Melting Point.

660°C



Non – Ferrous Metal.

Metal Type.

Copper.

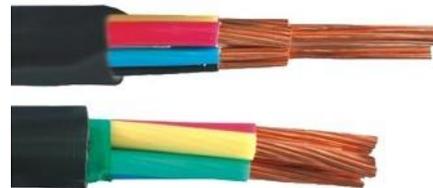
It is a ductile and malleable metal. It is often red / brown in colour. It is a very good conductor of heat and electricity.

Metal Uses.

Used for plumbing, electric components, cookware and roof coverings.

Melting Point.

1084°C



- **Copper:**

The main grades of raw copper used for cast copper base alloy are:

1. High conductivity copper having not less than 99.9% Cu. The oxygen content may be of the order 0.40% .Pb And Fe less than 0.005% each. Ag 0.002% and Bi less than 0.001%. Electrolytic copper is used for electrical purposes.
2. Deoxidized copper having not less than 99.85% Cu, less than 0.05% As, 0.03% Fe, and 0.003% Bi other elements may be of the order of 0.05% P, 0.01% Pb, 0.10% Ni, 0.003% and 0.005% Ag and Sb respectively.
3. Arsenical de-oxidized copper having 0.4% As, 0.04% P and remaining copper. It is used for welded vessels and tanks.
4. Arsenical touch pitch copper containing 0.4% As, 0.065% oxygen, 0.02% Pb, 0.15% Ni, 0.006% Ag, 0.01% Sb and less than 0.005% Bi, less than 0.020% fe, and remaining copper.
5. Oxygen free copper contains 0.005% Pb, 0.001% Ni, 0.001% Ag and less than 0.0005% and 0.001% Fe, and Bi respectively. It is melted and cast in non-oxidizing atmosphere.

- Copper possesses following properties:
 - Excellent resistance to corrosion.
 - Non-magnetic properties
 - Easy to work, it is ductile and malleable.
 - Moderate to high hardness and strength
 - High thermal and electrical conductivity.
 - It can be easily polished, plated and possesses a pleasing appearance.
 - Resistance to fatigue, abrasion, and corrosion.
 - It can be soldered, brazed or welded.
 - Very good machine ability.
 - Ease of forming alloys with other elements like zn, sn, al, ph, si, ni, etc.
- Copper is used for the following:
 - Electrical parts
 - Heat exchangers'
 - Screw machine products
 - For making various copper alloy, such as brass and bronze
 - Household utensils, etc.

Non – Ferrous Metal.

Metal Type.

Zinc.

It is very resistant to corrosion from moisture. However zinc is a very weak metal and is used mainly for coating

Metal Uses.

Used as a coating on screws, steel buckets etc It is also used to galvanize steel.

Melting Point.

419°C



Non – Ferrous Metal.

Metal Type.

Tin.

It is a very ductile and very malleable metal. It is resistant to corrosion from moisture. It is bright silver in appearance.

Tinplate is steel with a tin coating.

Metal Uses.

Used as a coating on food cans, beer cans.
Used as whistles, tin foil and soldering.

Melting Point.

231°C



dreamstime.com



Non – Ferrous Metal.

Metal Type.

Lead.

It is a soft, malleable metal. It is also counted as one of the heavy metals. Lead has a bluish-white color after being freshly cut, but it soon tarnishes to a dull grayish color when exposed to air.



Metal Uses.

Used for roof flashing. Also used for batteries and for X-ray protection. Lead is used for its weight in many ways.



Melting Point.

327°C



Assignment.

- (a) Name the non-ferrous metal used to make cooking pots.**
- (b) Name the metal used for plumbing.**
- (c) What metal is used to galvanize steel.**
- (d) A heavy metal used in batteries.**
- (e) What is tinplate.**



Non – Ferrous Metal Alloys.

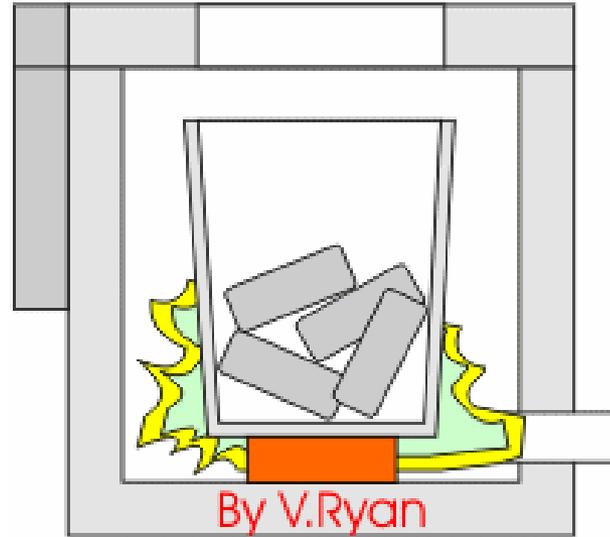
Non-Ferrous Metal Alloys:

Non-ferrous metal alloys are metals that are a mixture of two or more metals. The main ones in everyday use are,

Brass.

Bronze.

Solder.



Heating metals in a furnace to form an alloy.

- **Copper Alloys:**

- Copper normally possess excellent corrosion resistance electrical and thermal conductivities and formability.
- Some copper alloys combine high strength and corrosion resistance, a combination desirable for marine applications.
- Some copper alloys because of their wearing properties, high hardness or corrosion resistance are used as surfacing metals.
- Some copper alloys are selected for decorative applications because of appearance.
- Elements such as aluminum, zinc, tin, beryllium, nickel, silicon, lead etc. form alloys with copper.
- Copper alloys may be classified as:
 1. ***Brasses – Alloys of copper and zinc***
 2. ***Bronze – up to 12% of alloying element***
 3. ***Cupronickels – alloy of copper and nickel***
 4. ***Nickel silvers – alloy of copper, nickel and zinc.***

Non – Ferrous Metal Alloys.

Metal Type.

Brass.

Brass is a mixture of copper and zinc. Copper is the main component, and brass is usually classified as a copper alloy. The color of brass varies from a dark reddish brown to a light silvery yellow. Brass is stronger and harder than copper, but not as strong or hard as steel. It is easy to form into various shapes, a good conductor of heat, and generally resistant to corrosion from salt water.



Metal Uses.

Brass is used to make water fittings, screws, radiators, musical instruments, and cartridge casings for firearms.



Melting Point.

940°C



• BRASSES:

- Brasses contain zinc as the principle alloying element.
- Brasses are sub-divided into three groups.
 - cu-zn allos
 - cu, pb-zn alloys or leaded brass,
 - cu-zn-sn alloys or tin brass
- Brass has high resistance to corrosion and is easily machinable. It also acts as good bearing material.
- Zinc in the brass increases ductility along with strength.
- Brass possesses greater strength than copper however it has a lower thermal and electrical conductivity.
- Various types of brasses are discussed below.

(1) Gilding Metal

**(2) Cartridge
Brass**

(3) Admiralty Brass

**(4) Aluminum
Brass**

(5) Basis Brass

**(6) Muntz metal or
yellow metal**

(7) Leaded 60:40

(8) Naval brass

- **Gilding Metal:**
 - The gilding metals cover a range from 5% to 15% Zn. And possess shades of color from the red of copper to a brassy yellow.
- **Cartridge Brass:**
 - Normally contains 70% Cu and 30% Zn. In the fully annealed condition it has a tensile strength of over 300 N/mm²
- **Admiralty Brass:**
 - Admiralty brass contains Cu 71%, Zn 28% and Sn 1%. The small amount of tin added to brass improves its resistance to certain types of corrosion.
- **Aluminum Brass:**
 - It contains 76% Cu, 22% Zn and 2% Al a little arsenic is added to inhibit dezincification.
- **Basis Brass:**
 - It contains copper 61.5 – 64%, the remainder being Zinc.
 - Basis brass is used for press work where a relatively cheap material is required and the main commercial forms are sheet, strip, and wire.

- **Muntz metal or yellow metal:**
 - It contains 60% of copper and 40% of zinc and is essentially a hot working material.
 - It is manufactured in the form of hot rolled plate and hot rolled or extruded section in a great variety of shapes and sizes. Yellow metal is frequently used as a brazing alloy for steel.
- **Leaded 60:40 brass:**
 - It is the chief material fed to automatic lathes and similar machines. Usually in the form of extruded bar.
 - Lead is added to Cu-Zn alloy to promote machinability. The lead content ranges from about 0.5% to as much as 3.5%.
- **Naval brass:**
 - It contains Cu 60%, Zn 39.25% and Sn 0.75%. The purpose of tin is to improve the resistance to corrosion.

Non – Ferrous Metal Alloys.

Metal Type.

Bronze.

Bronze is a metal alloy consisting primarily of copper, usually with tin as the main additive. It is a hard and brittle metal. It has a very high resistance to corrosion.



Metal Uses.

Used for ship propellers and underwater fittings. Also used for statues and medals.



Melting Point.

950°C



• **Bronzes:**

- Bronze is a broad term defining an alloy of copper and elements other than nickel or Zinc.
- Bronze is basically an alloy of copper and tin. Bronze possesses superior mechanical properties and corrosion resistance than brass. Bronze is comparatively hard and it resists surface wear.
- Bronze can be shaped or rolled in to wire rod and sheets.
- Different types of bronze are:

(1) Phosphor bronze:

- The most important copper-tin alloys are those which have been deoxidized with phosphorus during the refining process and hence are known as phosphor bronze.
- The amount of residual phosphorus may range from a trace to about 0.35% or even higher in some special grades.

- The excess phosphorus, which exists in solid solution, materially increases the hardness and strength of the alloy, but it does so at the expense of ductility.
- In amounts greater than 1.0% phosphorus causes excessive brittleness and impairs surface appearance but affords a good bearing surface, as is evident by the use of high phosphorus bronze compositions for gears and other machine parts subject to wear.
- A phosphorus bronze containing approximately 4% each of tin, lead and zinc has excellent free cutting characteristics.
- Standard phosphor bronze for bearing applications contains 90% Cu, 10% Sn, and 0.5% P, in sand cast condition it has a tensile strength of 220-280 N/mm² and % elongation 3 to 8 %.
- Phosphor bronze for gears contains 88% Cu, 12% Sn, 0.3% Zn, 0.50% Pb and 0.15 P. in sand cast condition, it has a tensile strength of 220-310 N/mm² and 5-15% elongation. This alloy is also utilized for general bearings, where its rigidity of advantages.

(2) Aluminum bronze:

- Have the following compositions:

Cu	Al	Fe	Sn	Mn
89	7	3.5	0.35	0.11(max)
91	6.8	1.5-3.5		

- Aluminum bronzes possess the following properties good strength high corrosion resistance good heat resistance good cold working properties.
- Aluminum bronze finds the following uses:
- Bearings, gears, slide valves, imitations jewellery, valve seat, propellers, cams, pump part etc.

(3) Silicon bronze:

– Have the following compositions:

Si 1 – 4%

Fe 0.5 – 1.0%

Mn 0.25 – 1.25%

Cu Balance.

- Lead when added as 0.5% improves machinability.
- Silicon bronze possesses high strength and toughness as that of mild steel and corrosion resistance as that of copper.
- Silicon bronzes find the following uses.
- Bearings, roll mill sleepers, turntable bushing marine hardware, ways and gibs, screw down nuts, boiler parts, Die cast parts etc.

- **Gun Metal:**

- Gun metal is an alloy of copper, tin and Zinc.
- Zinc cleans the metal and increases its fluidity
- A small amount of lead may be added to improve castability and machinability.

(1) Admiralty gun-metal:

- It contains 10% Sn, 2% Zn, 1.5% max pb, 1.5% max Ni, and balance Cu, it has tensile strength of 260-340 N/mm². It is widely used for pumps, valves and miscellaneous casting and is also used for statuary.

(2) Nickel gun-metal:

- It contains 7% Sn, 2.25% Zn, 0.3% pb, 2% max Ni when sand cast it has a tensile strength of 200-270 N/mm². This is among the most widely used grades, particularly where pressure tightness is required.
- In general gun metal is used for Bearings, steam pipe fittings,

marine castings, Hydraulic valves and gears, etc

- **Bearing materials:**

- Bearings support moving parts, such as shaft and spindles, of a machine or

mechanism.

- Bearings may be classed as.

- Rolling contact bearings.

- Plain bearings.

- Rolling contact bearings are almost invariant by made of steel that can be hardened after machining both plain carbon and alloy steel are employed for different applications.

- For making plain bearings, an extremely wide range of materials is available and will be discussed below.

- **Properties of Bearings Materials:**

- A bearing material should:

- Possess low co-efficient of friction.

- Provide hard wear resistance surface with a tough core.

- Have high compressive strength.

- Have high fatigue strength.

- Be able to bear shocks and vibrations.

- Possess high thermal conductivity to dissipate heat generated due to friction between the bearing and the rotating shaft.

- Possess adequate strength at high temp.

- Be such that it can be easily fabricated.

• Aluminum and Aluminum Alloys

– Aluminum is a silvery white metal and it possesses the following characteristics.

1. It is a light metal, with a density about a third that of steel and brass(2.7 gm/cm³)
2. Its electrical conductivity is about 60% of that of copper.
3. It has high thermal conductivity.
4. It is ductile and malleable.
5. It has a non magnetic and
6. Easy formability and mach
7. It is good conductor of heat



• Types of Al Alloys

– Aluminum alloy Can be classified.

1. Wrought alloy
2. Cast alloy
3. Heat treatable alloy
4. Non-heat-treatable alloys.

– Aluminum alloy contain

1. Al-Mn
2. Al-Mg
3. Al-Mg-Mn
4. Al-Mg-Si
5. Al-Cu-Mg
6. Al-Cu-Si
7. Al-Cu-Mg- Pb
8. Al-Mg-Si- Pb
9. Al-Zn-Mg-Cu

- # 1. Percent composition of few wrought alloys are:
1. 4.4 Cu, 0.6 Mn, 1.5 Mg, Balance Al (**Duralumin**)
 2. 0.12 Cu, 1.2 Mn, Balance Al (**Magnalium**)
 3. 2.5 Mg, 0.25 Cr, Balance Al (**Kindalium**)
 4. 0.6 Si, 0.27 Cu, 1.0 Mg, 0.2 Cr, Balance Al

2. Percent composition of few cast alloys are:

- | | |
|-----------------------------------|----------------------------|
| 1. 12 Si, rest Al (LM-5) | 3. 4 Cu, 3 Si, rest Al |
| 2. 4.5 Cu, 5.5 Si, rest Al | 4. 3.8 Mg, 1.8 Zn, rest Al |

3. Percent composition of few heat treatable alloys are:

1. 3.9-5.0 Cu, 0.2-0.8 Mg, 0.5-1.0 Si, 0.5-1.0 Mn, rest Al
2. 0.5-1.2 Mg, 0.7-1.3 Si, 0.4-1.0 Mn, rest Al

3. 0.4-0.9 Mg, 0.3-0.7 Si, rest Al

4. Percent composition of few non heat treatable alloys are:

1. 0.8-1.5 Mn, Rest Al
2. 1.7-2.4 Mg, rest Al (**LM-10**)
3. 10-13 Si, rest Al
4. 5.0-5.5 Mg, 0.6-1.0 Mn, 0.05-0.20 Cr, rest Al

- **Use of Al and Al-alloys**

1. Transportation industry- Structural frame work, engine parts, decorative features, hardware, doors, window frame, furnishing and fitting.
2. Overhead conductor and heat exchanger parts.
3. In food industry, Al and its alloy find application as preparation equipment, refrigeration, storage containers, bakery equipment, shipping container.
4. Cryogenic application.
5. As heavy duty structure such as travelling Crain, hoists, conveyor support, bridges.
6. In process industry, handle organic chemical petrochemicals and drug.

- **Magnesium and Magnesium Alloys**

- Magnesium is a silvery white metal and has the lowest density of the common structural materials.
- Properties:
 1. High strength to weight ratio.
 2. Good fatigue strength.
 3. Good dimensional stability in service.
 4. Good damping capacity.
 5. Relative high electrical conductivity.
 6. High thermal conductivity.

• Magnesium and Magnesium Alloys

• Uses:

1. For making parts such as airframes, engines, gear boxes, flooring, seating etc. for the helicopters, aero planes, missiles.
2. For material handling equipment such as hand trucks, conveyors, foundry equipment.
3. For storage tank electric drills, chain saws, power hammer etc.
4. Moving parts of textile machines and printing equipment.
5. Binocular and camera bodies.
6. In the production of uranium, beryllium, zirconium, titanium etc.
7. Typewriters, dictating machine, calculator etc.

• Types of magnesium alloys:

1. Dow metal

- It contains 90% magnesium, 10% Aluminium and a small addition of manganese
- It used in air craft industries and automobile industries
- It is extremely hard and can be welded and machined

2. Cast alloys of magnesium

- Al 8, Zn 0.5, Mn 0.3 and Mg balance
- Al 8, Zn 0.5, Mn 0.3, Be 0.0015 and Mg balance

3. Wrought alloys of magnesium

- Zn 3.0, Zr (Zirconium) 0.6 and Mg balance
- Th 0.8, Zn 0.6, Zr 0.6 and Mg balance

- **Titanium and its Alloys**
- Characteristics:
 - They are 40% lighter than steel and 60% heavier than aluminum. The combination of moderate weight and high strength give titanium alloys the highest strength to weight ratio of any structural metal.
 - Melting point of titanium is higher than iron.
 - It has low thermal conductivity.
 - Titanium has good corrosion resistance.
 - Its thermal coefficient of expansion is low.
 - Its electrical resistivity is also high.
- Types of titanium alloys
 1. Alpha alloys (alloying elements Al, Sn, Zr, V, Mo)
 2. Beta alloys
 3. Alpha and beta alloys

- **Lead and its alloys**
- **Properties of lead:**
 - Resistance to corrosion and low melting point
 - It is poisonous
 - Heavy weight, high density, softness, malleability
 - High coefficient of expansion and low electrical conductivity
- **Application:**
 - For radiation shielding and production of paints
 - For weight in counter weights
 - It is used in copper alloys for good machinability
- **Lead based alloys:**
 - It is applied where cheap and corrosion resistance material is required. An alloy contains 8 to 10% Pb are used as bearing metals.

Thank You