

Applied Science (chemistry)  
22211 /EE /AO  
**METALS , ALLOYS AND INSULATORS**

Teaching Hours :08

Marks :09

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## **SYLLABUS**

- 6.1 Properties of Metals like Copper ,Aluminium,Tungsten,Platinum,Nickel
- 6.2 Thermocouple alloy: Composition and characteristics of nickel alloy, platinum/rhodium, tungsten rhenium, chromel-gold/iron
- 6.3Electrical insulators: Classification. Solid - ceramics, mica, asbestos, urea formaldehyde resin and glass. Liquid-silicone fluid, Gaseous-inert gases, hydrogen and nitrogen gas
- 6.4 Types of rubber : Natural and synthetic, processing of natural rubber. Synthetic rubber : Properties and applications of Buna-N, Thiokol, Neoprene
- 6.5 Process industry unit operations: Evaporation, condensation, Distillation, Energy balance and mass balance for above processes.
- 6.6 Nanomaterials: Applications of Fullerene, Graphene
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### **Mechanical Properties of Metal**

**Hardness:** To resist abrasion or penetration.

**Ductility :** Ability to be drawn into thin wires

**Malleability :**Ability to be beaten into thin sheets.

**Tensile strength:**Ability to carry load without breaking.

*Metals have a high Melting point (M.P) & Boiling point (B. P)*

<b>METAL</b>	<b>MELTING POINT</b>	<b>BOILING POINT</b>	<b>SPECIFIC GRAVITY</b>
Copper [Cu]	1089	2350 °C	8.93
Aluminium [Al]	658 °C	2470 °C	2.7
Tungsten [W]	3370 °C	5700 °C	19.3
Nickel [Ni]	1453 °C	2730 °C	8.8

- ❖ Aluminum is used in power cables due to its lightWeight (sp. gravity 2.7) and good electrical conductance.
- ❖ Aluminium forms a thin protective film of Aluminium Oxide , thus is protected from corrosion .
- ❖ Copper is used for cable wire as it has high electrical conductivity.
- ❖ Tungsten is the most ductile metal.

## THERMOCOUPLE ALLOYS

Thermocouple	Type
Nickel-alloy thermocouple	T, J, M, K
Platinum -Rhodium alloy thermocouple (Pt/Rh)	B, R, S
Tungsten - Rhenium Alloy thermocouple (W/Re)	C , D, G
Chromel Gold -Iron Alloy Thermocouple	Chromel Alloys composition is Nickel (90 %) + Chromium (10%)

### Properties of Thermocouple

Thermocouple Alloy	Temperature Range	Sensitivity	Remark
Ni- Alloy	-200 °C to 350°C	40 to 50 $\mu\text{V}/^\circ\text{C}$	
Pt/Rh Alloy	Around 1600 °C	10 $\mu\text{V}/^\circ\text{C}$ <i>The lowest Sensitivity.</i>	This alloy is used in Oxidising or Inert Atmosphere
W/Re Alloy	0 °C to 2315°C <i>The temp can also be extended upto 2760°C</i>	--	This alloy is used in $\text{H}_2$ or Inert Atm. But Cannot be used in Oxidising or Inert Atmosphere
Chromel Gold -Iron	It is used for Cryogenic Uses below 0 °C	15 $\mu\text{V}/\text{K}$	

## Composition of Alloy

Nickel Alloy			
TYPE	COMPOSITION	POSITIVE WIRE	NEGATIVE WIRE
T	Copper Constantan	Copper -100%	Copper -55% +Nickel-45%
J	Iron Constantan	Iron - 100%	Copper -55% +Nickel-45%
M	Molybdenum Constantan	Ni -82% + Mo -18%	Ni - 99.2% + Cobalt - 0.8%
K	Chromel Alumel	Chromel -100%	Ni - 95% + Mn - 2% + Al -2%+Si - 1%

Platinum Rhodium Alloy		
TYPE	POSITIVE WIRE	NEGATIVE WIRE
B	Pt - 70% + Rh - 30 %	Pt - 94 % + Rh - 6 %
R	Pt - 87 % + Rh - 13 %	Pt - 100
S	Pt - 90% + Rh - 10 %	Pt -100%

Tungsten Rhenium Alloy		
TYPE	POSITIVE WIRE	NEGATIVE WIRE
C	W - 95% + Re - 5%	W - 74% + Re - 26%
D	W - 97% + Re - 3%	W - 75% + Re - 25%
G	W - 100	W - 74 % + Re - 26 %

Chromel Gold - Iron Alloy		
TYPE	POSITIVE WIRE	NEGATIVE WIRE
Chromel Gold - Iron	Chromel -100%	Gold-0.03-0.15 % in Iron

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## **ELECTRICAL INSULATORS**

**Insulators** are the substance which retards the flow of Heat [Thermal Insulators] or Electricity [Electrical Insulators].

When the main function of Insulating material is storage of charge, the material is called **Dielectric**.

### **Classification of Insulating materials**

1. Solid Insulating materials : Ex Polymers, Glass, Mica, Ceramics etc.
2. Liquid Insulating materials : Ex Mineral oil, Silicone fluid
3. Gaseous Insulating materials : Ex-Hydrogen, Carbon dioxide, Inert gases

**Inert gases** ( Gaseous Insulating materials) are also used as dielectrics due to its excellent dielectric properties.

### **Silicon fluid** (Liquid Insulating materials )

- ❖ Working temperature range is -90°C to 200°C
- ❖ It is used as mechanical fluid, coolant & lubricants.
- ❖ Due to high gloss & water repellent property
- ❖ It is used in automobile paint .
- ❖ Due to dielectric property it is used as coolant. in radio pulse and air-craft transformers

### **Solid Insulating materials**

#### **Ceramics**

- ❖ They are made of clay, sand and feldspar.
- ❖ Ceramics are used in chamber in high voltage Frequency applications.
- ❖ Ceramics are inert to chemicals
- ❖ Ceramics are processed and used at high temperatures.

#### **Mica**

- ❖ Mica is a mineral Silicate of potash and Alumina.
- ❖ Mica is directly used without any processing
- ❖ Mica is thermally stable, so is used in cloth Irons, heaters toasters etc .

#### **Asbestos**

- ❖ Asbestos is a mineral silicate with varying amounts of calcium and Iron.
- ❖ Asbestos has low thermal Conductivity, thus used in boilers.
- ❖ Asbestos sheets are light in weight, durable, fireproof , Weather proof, thus are used in roof-covering of houses

### Urea formaldehyde

- ❖ It is rigid and transparent.
- ❖ It is used in plastics and also used as Adhesives,
- ❖ It is used in bonding wooden surfaces.

### Glass

- ❖ Glass is a mixture of silicates or phosphates, Borates and other materials.
- ❖ Glass is amorphous, transparent, brittle, material.
- ❖ Glass is a super cooled liquid.
- ❖ Glass is used in fluorescent tubes, filament support, X-ray tube etc.

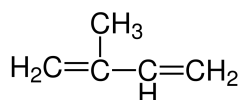
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## RUBBER

- ❖ Rubber Rubber is an elastomer obtained Naturally from Rubber trees and also prepared Synthetically.
- ❖ Rubber has the property of elasticity.

### Natural Rubber

- ❖ **Natural Rubber** has Isoprene unit arranged in a spiral structure thus, providing elasticity.



- ❖ Isoprene unit:
- ❖ Natural Rubber is obtained from Latex obtained from Rubber trees.
- ❖ Latex contains 30.50% of Rubber
- ❖ latex is coagulated by formic and or Acetic acid .
- ❖ Drawbacks of Natural rubber :Natural Rubber is weak, it absorbs water, it easily deforms and gets oxidised in air.

### Vulcanisation of Rubber.

- ❖ Natural Rubber / Crude rubber is vulcanised by heating it with sulphur at high temperature.
- ❖ Vulcanised rubber is also called "Ebonite Rubber “.
- ❖ Vulcanised rubber is mainly used for making tyres.

### Synthetic Rubber

Rubber	Name		Raw Material
Buna - N	GR -A	Nitrile Rubber	1,3Butadiene + Acrylonitrile
Thiokol	GR-P	Polysulphide Rubber	1,2 Dichloroethane + Sodium Polysulphide
Neoprene	GR-M	Polychloroprene	Polymerisation of Chloroprene

**Buna -N** is less resistant to heat, light, Oil , acids ,but resistant to alkalis due to its cyano group.  
**Thiokol** is resistant to organic solvents, ozone  
**Neoprene** properties are enhanced by ZnO or MgO and are used for making Gloves and coated fabrics.

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## UNIT OPERATION

Unit Operations are the process carried out at industrial level.

**Evaporation** - liquid changes into vapours. E.x.Drying of water, wet surface or wet cloths.

**Evaporation** is an operation carried in industry to concentrate weak (dilute) solutions by evaporating/ Vapourising the solvent.

**Condensation** - Vapours changes into liquid.Ex, dew drops on leaves in winter ,water droplets on the Outer wall of cold bottles etc.

**Condensation** occurs when the vapour is cooled to its saturation level.

**Distillation process** used to separate Constituents of a liquid mixture. Ex..Separating a mixture of water and alcohol.

**Fractional Distillation** is used to separate constituents of petroleum.

**Sublimation** - Solid changes directly into vapour

**Freezing** - liquid changes into solid

**Conservation of Mass & energy**

Mass & Energy of the universe remains constant.

**Types of Systems.**

1. Open systems - both mass & energy exchanges with the universe.
2. Closed systems - mass does not change but energy is exchanged with the universe.
3. Isolated systems - No change in mass or energy is exchanged with the universe.

**Systems** - The part under observation.

**Universe** - The part other than system

**Boundary** - The line that separates the system from the surrounding.

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## NANOMATERIALS

- 1 Nanometer =  $1 \times 10^{-9}$  meter
- Fullerene (C60) is an allotrope of carbon.
- Fullerene has Similar structure to graphite.
- C60 is also called bucky ball (football shape).
- Carbon nanotubes are material having high electrical Conductivity, strength and are

chemically inactive.

- Graphene is a crystalline , single layer , Hexagonal lattice of carbon atoms .
  - Graphene is strongest material (stronger than diamond)
  - Graphene is also a flexible, stable, good conductor.
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