

Polymers



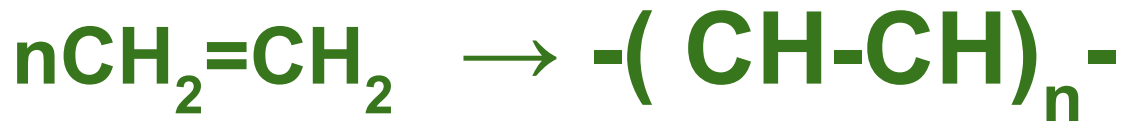
Poly - many

Mer-- units

Polymers- many units

Polymers formed by joining of repeating structural units using covalent bond on large scale.

The process of formation of polymers from monomers is calls polymerisation.



Ethene

polythene

Classification of polymers

1. Based on the monomeric units

I. Homopolymers

Polymers whose repeating structural units are only one type of monomers.

Eg-polythene- monomer is ethene

PVC(vinyl chloride)

Natural rubber(isoprene)

li.copolymers

Whose repeating units are different monomers

Eg- nylon -6,6 (hexamethylenediamine and adipic acid.

Buna-S (butadiene and styrene)

Classification based on sources of availability

1. Natural polymers

Polymers are found in nature i.e. in plants and animals,

Eg- protein, starch, cellulose

2. Semi-synthetic polymers

Polymers which are obtained from nature but modified by some chemical treatment.

Eg- rayon (cellulose acetate)

Gun cotton (cellulose trinitrate)

3.synthetic polymers

Which are man made .

Eg-fibers(nylon-66)

plastic(polyethene, polypropene)

Synthetic rubber(Buna-s)

Classification based on structure

1.linear polymers

Consist of long and straight chains of polymer molecules.

Because of the close packing these polymers have High density , high M.P, and high tensile strength eg-High density polyethylene(HDPE),nylon-66

2.branched chain polymers

These polymers contains linear chains having some branches.

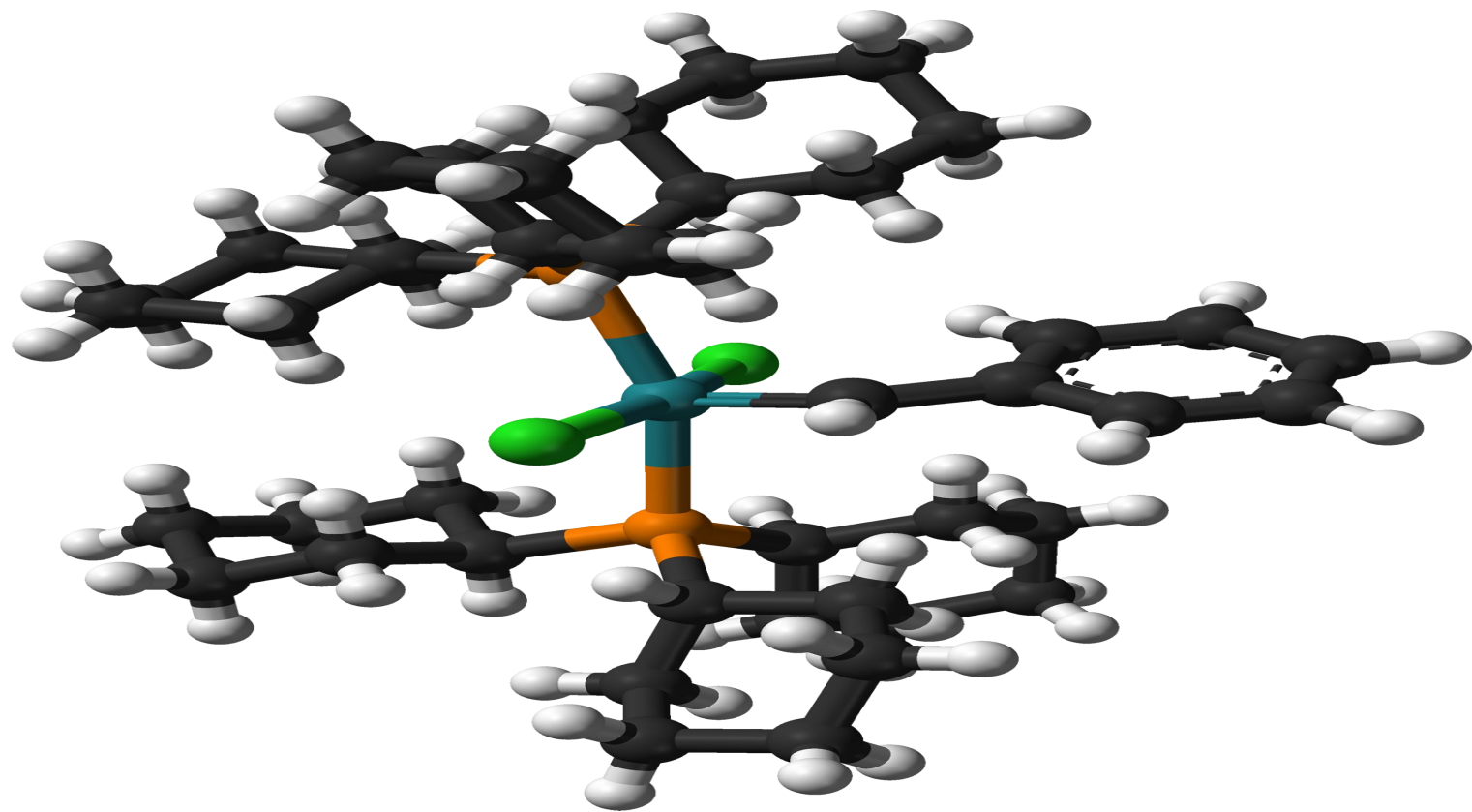
They do not pack well , so they have low M.P, low density, and low tensile strength.

eg-Low density polyethylene(LDPE)
glycogen

3.Three -dimensional network polymers or crosslinked polymers

These polymers contain strong covalent bond between various linear polymers.They have cross linking between the polymeric chain.

- **They are hard,rigid and brittle**
Eg-bakelite, urea formaldehyde polymers.



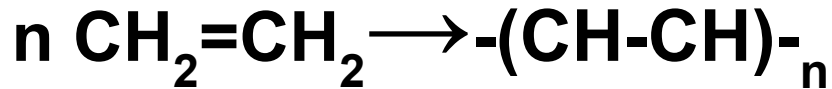
Classification based on the mode of polymerisation

1. Addition polymers

Formed by the repeated addition of monomers .

They are also called chain growth polymers.

Eg-formation of polyethene from ethene



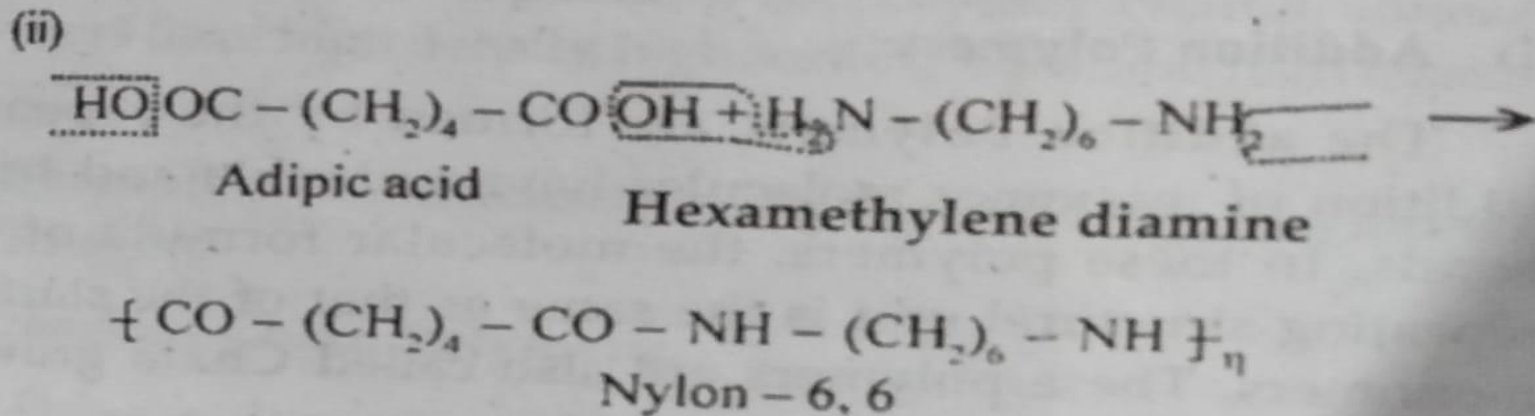
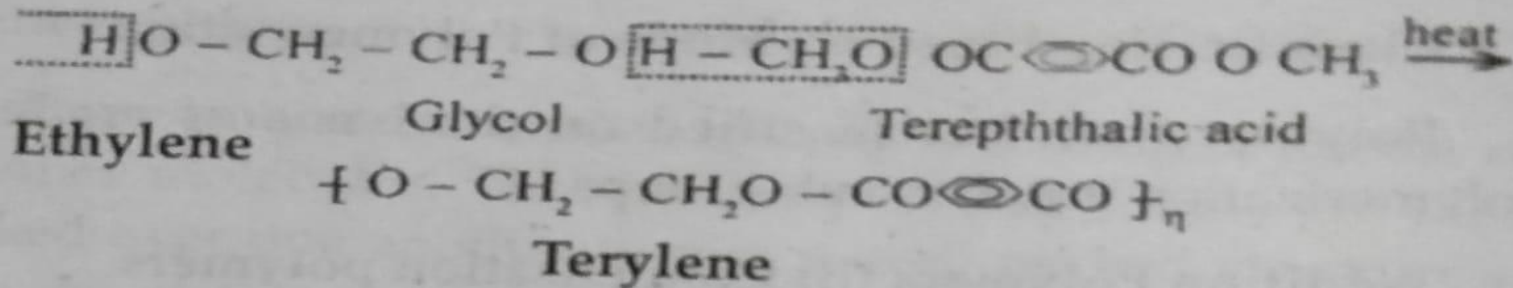
Buna-S, Teflon, Rubber, PVC etc



2. Condensation polymers

- These polymers are formed by repeated reaction between the two different bi-functional or Tri- functional monomeric unit.
- In these polymeric reaction elimination of small molecule like water, alcohol, hydrogen chloride etc take place.
- These polymers are also called as step growth polymers.

Eg- nylon-6,6,terylene etc



Classification based on molecular forces

Depending upon the magnitude of intermolecular forces, polymers are classified in to-

1.Elastomers

- In which the intermolecular force of attraction between the polymer chains are weakest.
- They have elastic properties.
- These weak bond permit the polymers to be stretched, and retain its original form.
- Eg- rubber, Buna-S, Buna-N

2.fibers

- Polymers in which the intermolecular force of attraction are strongest .
- These forces are either hydrogen bonding or dipole-dipole interaction.
- Fibers have high tensile strength.
- Long , thin and treadlike which lead to close packing , which impact crystalline nature with high M.P
- Eg-nylon-66,polyester'..

3. Thermoplastic polymers

- Polymers in which intermolecular forces of attraction are between elastomers and fibers.
- They are softening on heating and hardening on cooling.
- These polymers can be moulded into any shapes.
- eg-polyethene, polypropene, P.V.C., teflon.

4. Thermosetting plastics

- Plastic which can be moulded only once and cannot be remoulded by the application of heat and pressure.
- When heated it becomes hard and further heating result chemical decomposition.
- Non recyclable
- Cross linked polymers
- Eg-bakelite, melemine polymers.

Thermoplastics

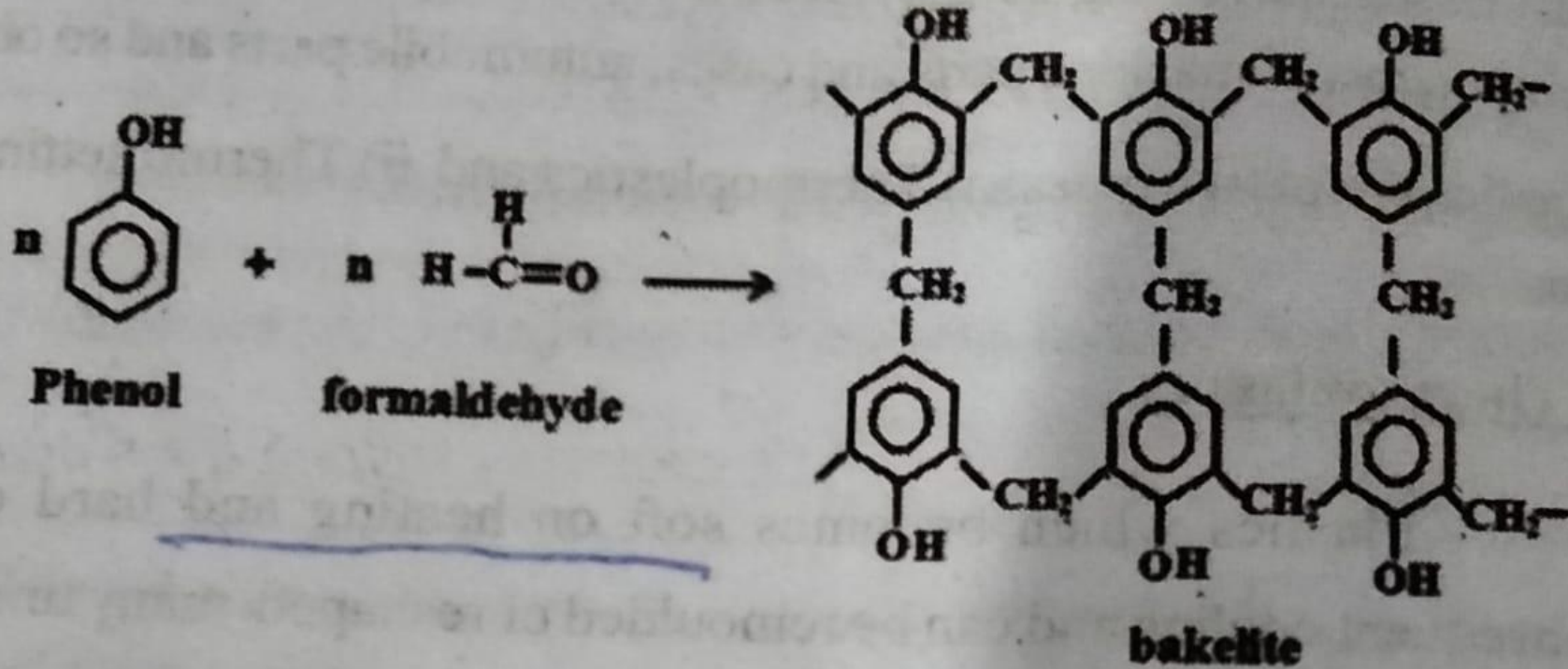
1. It is recyclable plastic.
2. It can be remoulded and reshaped many times by applying heat and pressure
3. It becomes soft on heating and hard on subsequent cooling.
4. These are linear polymers
5. Formed by addition polymerization.:
Eg. Polyvinyl chloride,
polyethelene, poly styrene.

Thermosetting plastics

1. It is non recyclable plastic.
2. It cannot be remoulded and reshaped by applying heat and pressure.
3. It becomes hard and decomposed on heating.
4. These are cross linked polymers
5. Formed by condensation polymerization.
Example: Bakelite,
melamine polymers.

Bakelite

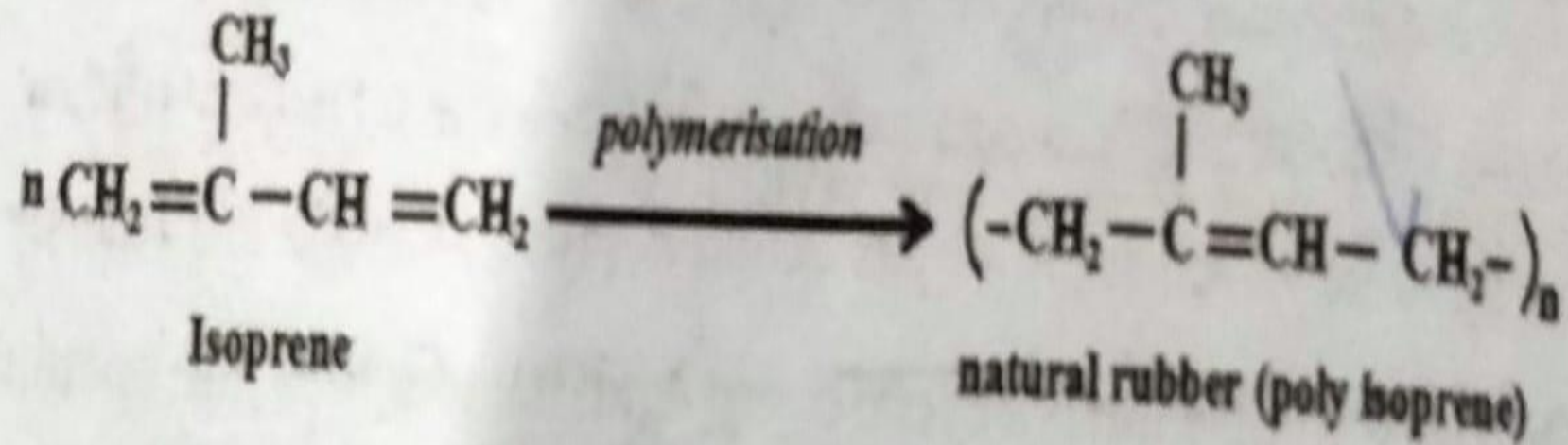
- ★ **Cross-linked thermosetting plastic.**
- ★ **Formed by the condensation reaction of phenol and formaldehyde.**
- ★ **Does not conduct electricity, resistant to heat, non inflammable.**
- ★ **Resistant to chemicals.**



Rubber

1. Nature rubber;-

- **Linear polymer of isoprene(2-methyl-1,3 buta diene)**
- **It have weak van der waals force and has coiled structure.**
- **Stretched like a spring and exhibits elastic properties.**
- **Used for making tyres, rubberbands, gloves etc**



Limitation of natural rubber

- *Low strength and elasticity.*
- *Quality is very poor.*
- *Damaged by atmospheric oxidation.*
- *Absorb water and swell.*
- *Used only at 10-50°C*
- *In hot weather it become soft and sticky.*
- *In cold weather it become hard and brittle .*



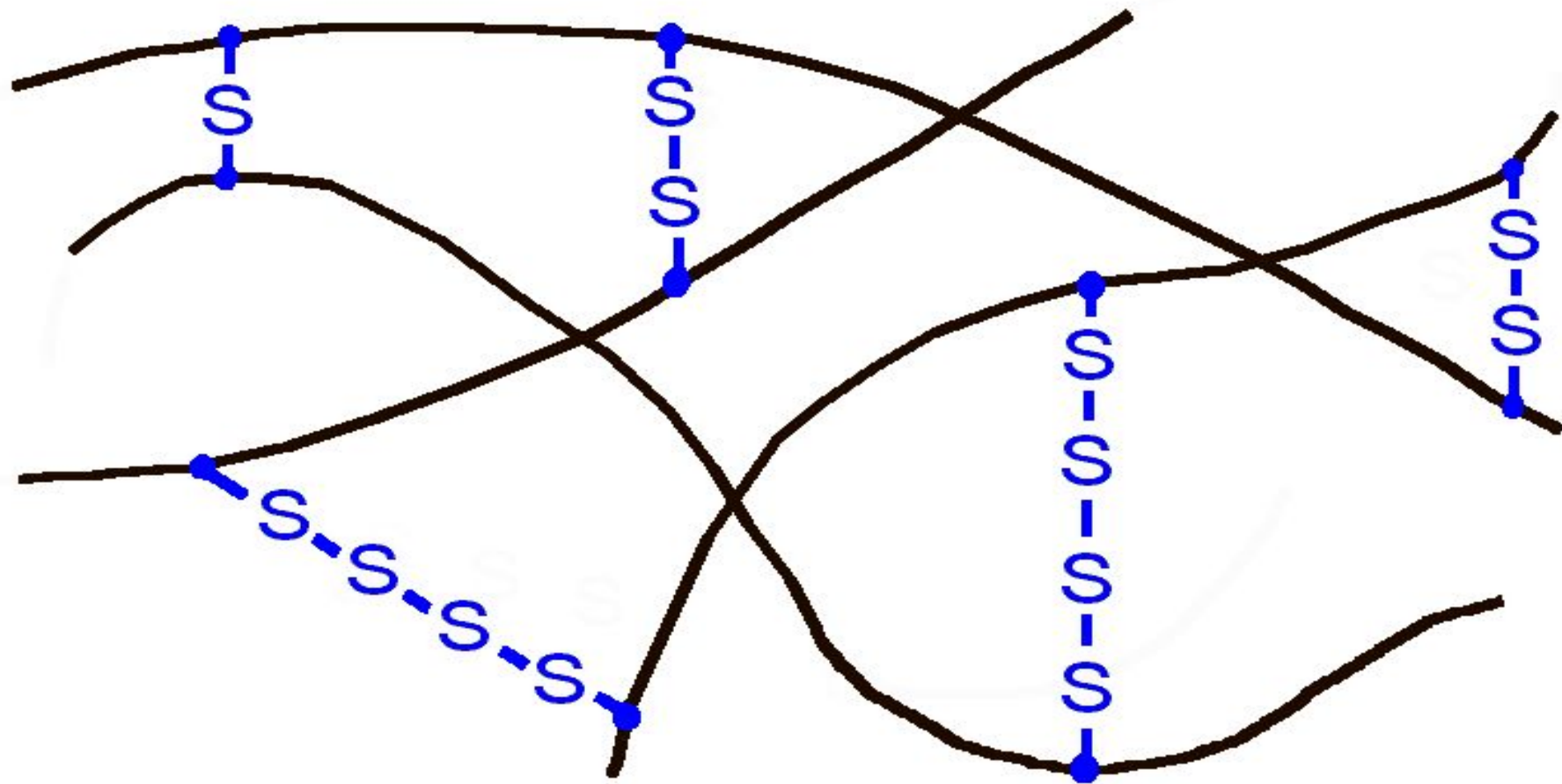
So it cannot be used in tyre production.

Vulcanization

- It is the process of heating natural rubber with sulphur (3-5%) and zinc oxide at temperature range of 110-140°C.
- It form sulphur cross linking between the rubber chain.

Merits of vulcanization

- ❖ It improve the elasticity , tensile strength , abrasion resistance and rigidity.
- ❖ Make rubber less sensitive to temperature changes
- ❖ Resistance the rubber from oxidation and swelling.
- ❖ Vulcanization make the rubber suitable for tyre making.



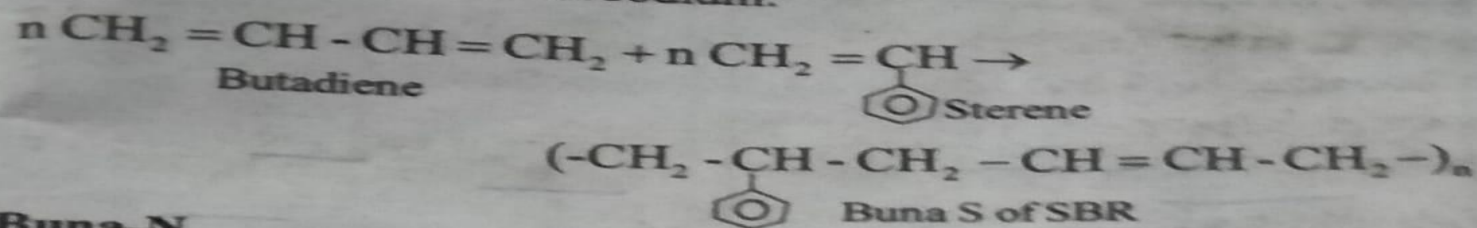
Synthetic rubber

Artificially produced elastomers are called synthetic rubber.

Eg- Buna -S, Buna-N, Neoprene.

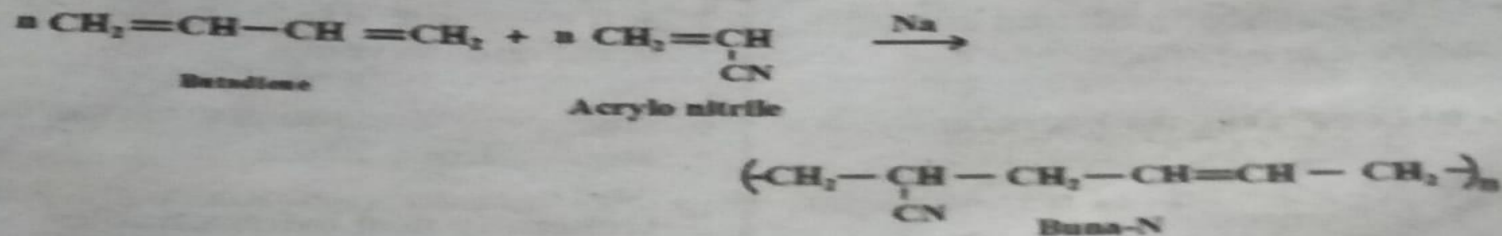
Buna-S or SBR

Buna-S is produced by the copolymerization of butadiene and styrene in presence of sodium.



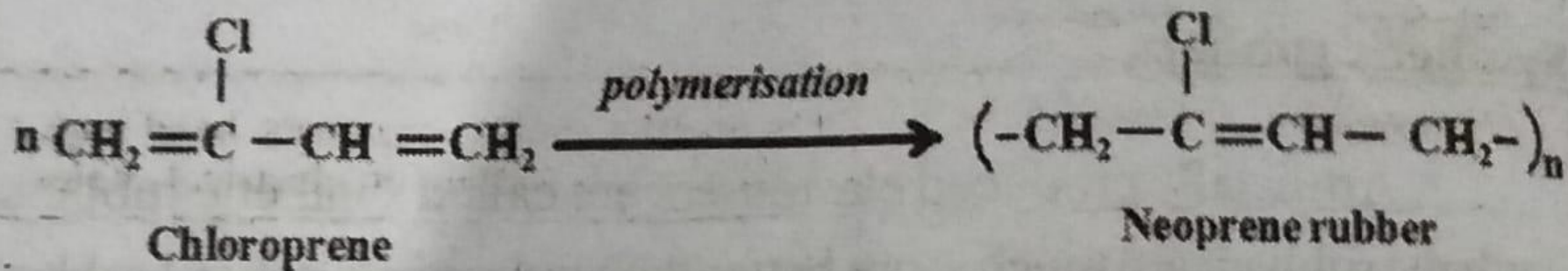
Buna-N

Buna-N is produced by the copolymerization of butadiene and acrylo nitrile in presence of sodium



Neoprene

Neoprene rubber is produced by the polymerization of chloroprene.



Natural rubber	Synthetic rubber
<ol style="list-style-type: none"> 1. Obtained from natural source (from rubber tree) 2. Quality is very poor. Requires <u>vulcanization</u>. Useful only within a <u>narrow</u> temperature range. 3. Low rigidity, tensile strength. 4. Low abrasion and chemical resistance. 5. Absorb water and swell. Less resistance to oil and solvents. 6. Low resistance to atmospheric attack. Very short life. 7. Inflammable. 	<ol style="list-style-type: none"> 1. Produced artificially. Raw materials are mainly petrochemicals. 2. Quality is very good. <u>vulcanization</u> may be done. Useful within a <u>wide</u> range of temperature. 3. High rigidity, tensile strength. 4. High abrasion and chemical resistance. 5. Very low absorption of water and swelling. High resistance to oil and solvents. 6. High resistance to atmospheric attack. Long life. 7. Generally non inflammable.

Polymer	Monomer	Uses
1. Polythene	Ethene	For making sheets, rain coats, hand bags, table clothes, coating on electrical cables
2. Poly propene	Propene	Fibres for carpets, clothing, car bumper dash boards, transparent bottles etc
3. PVC	Vinyl Chloride	For making housewares such as buckets, chair, tables, doors, containers, bottles, pipes, toys. Window frames, cable and wire insulation, footwear, credit cards
4. Neoprene	Chloroprene	Oil seals, gaskets, hoses, belts etc
5. Polystyrene	Styrene	For making toys, thermocol, cases of television and refrigerators etc.
6. Bakelite	Phenol and formaldehyde	For making handles for kitchen wares, electric switches, plug tops, telephone instruments etc.
7. Teflon	Tetrafluoroethylene	For making non-stick cookwares, industrial gaskets, leak proof sealing for pipe fittings etc.
8. Nylon - 6 or Perlon L	Caprolactam	For making carpets, fabrics, ropes, tyre cords, fisherman net etc
9. Nylon-6,6	Hexamethylene diamine and adipic acid	For making carpets, fabrics, ropes, tyre cords, fisherman net etc
10. Buna N	Butadiene & acrylonitrile	For making conveyor belts, fuel tanks, hoses, printing rollers.
11. Buna-S	Butadiene and Styrene	For making tyres, hoses, shoe soles.