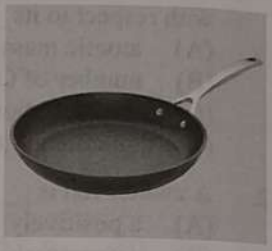
Textbook Chapter No.

15 Introduction to Polymer Chemistry

Subtopics

Oops..... I found it!



In 1938, Roy Plunkett was trying to make a new type of non-toxic, non-flammable coolant for use in refrigerators. He was using perfluoroethylene which was stored in iron cylinders. Once when checking an empty cylinder, he found that the weight was more than the usual empty ones. He cut the cylinder and found a slippery powder which is now called as Teflon. Actually, the gas in the cylinder changed to PTFE all by itself under pressure. He also discovered that the powder was capable of withstanding temperature as cold as –400 °F and as warm as 500 °F. So, it became an important coating for satellite components to electric wires. Wife of a French engineer who applied teflon on fishing wires to slip and untangle it, made him to coat her frying pan with teflon so that she could make omelets without them sticking to the pan.

Quick Review

➢ **Classification of polymers:**

Based on source or origin

Natural polymers
Obtained from nature, i.e., plants as well as animal sources.
e.g. Cotton, Linen, Silk, etc.

Synthetic polymers
Artificially prepared by polymerization of one monomer or copolymerisation of two or more monomers.
e.g. Nylon, Teflon, etc.

Semi-synthetic polymers or regenerated fibres
Derived from naturally occurring polymers by chemical modifications.
e.g. Acetate rayon, viscose rayon, cellulose nitrate, etc.

Fibres
e.g. Nylon

Synthetic rubbers
e.g. Buna-S

Plastics
e.g. Bakelite

Based on the structure

Linear or straight chain polymers
- Monomer molecules are joined together in linear arrangement.
- Obtained from bifunctional monomers or alkenes

e.g. PVC, HDPE, etc.

Branched chain polymers
- Have long chains with the side chains or branches of different lengths.
- Obtained from monomers with side chains or 3 functional groups .

e.g. LDPE, Polypropylene, etc.

Network or cross-linked polymers
- Have linear chain polymers which are cross-linked by covalent bonds leading to 3D network like structure.
- Obtained from polyfunctional monomers.

e.g. Melamine, Bakelite, etc.

Based on the polymerization process

Addition or chain growth polymers
Formed by direct addition of repeated monomers without the elimination of small molecules.
e.g. PAN, Teflon, etc.

Condensation or step growth polymers
Formed by the condensation of two or more than two bifunctional monomers (or polyfunctional monomers) with the elimination of small molecules like H_2O, CH_3OH, HCl, NH_3.
e.g. Terylene, Nylon 6, etc.

Ring opening polymers
Formed by addition of monomers (cyclic compounds) to growing chain molecules without elimination of small molecules like H_2O, CH_3OH, etc.
e.g. ε-caprolactum.

Based on the intermolecular forces

Elastomers
Elastic in character like rubber due to van der Waals forces and few crosslinks.
e.g. Vulcanized rubber, buna-S, neoprene, etc.

Thermoplastic polymers
Softened easily on repeated heating and hardened when cooled with little change in their properties.
e.g. Polystyrene, PVC, etc.

Fibres
Have strong intermolecular forces (hydrogen bonds or dipole-dipole interactions) between the chains resulting in high tensile strength.
e.g. terylene, nylon 6,6, etc.

Thermosetting polymers
Infusible solids with highly cross-linked or heavily branched structure due to strong covalent bonds and undergo permanent change on heating. **e.g.** melamine, bakelite, etc.

Based on type of different monomers

Homopolymers
Polymers containing only one type of repeating unit.
e.g. Nylon 6, PAN, etc.

Copolymers
Polymers containing two or more types of repeating unit.
e.g. Buna-S, Buna-N, etc.

Based on biodegradability

Biodegradable polymers
Polymers affected by microbes.
e.g. PHBV, Nylon 2-nylon 6, etc.

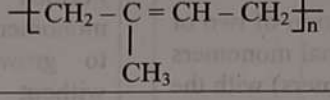
Non-biodegradable polymers
Polymers not affected by microbes.
e.g. Nylon 6,6, Terylene, etc.

➢ Some important polymers:

- **Rubbers:**

Natural rubber

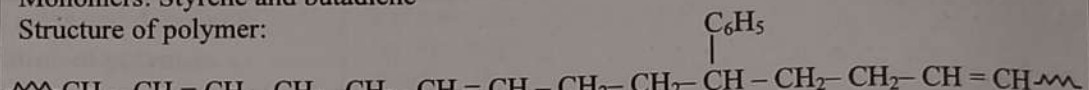
Monomer: Isoprene
Polymer: Polyisoprene
Structure of polymer:



Synthetic rubbers

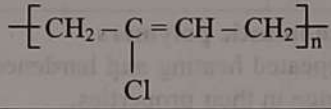
Buna-S

Monomers: Styrene and butadiene
Structure of polymer:



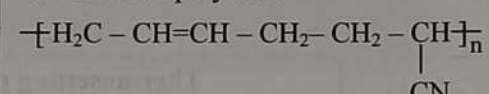
Neoprene

Monomer: Chloroprene
Structure of polymer:



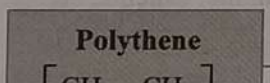
Buna-N

Monomer: Acrylonitrile and butadiene
Structure of polymer:



- **Polythene:**

Polythene



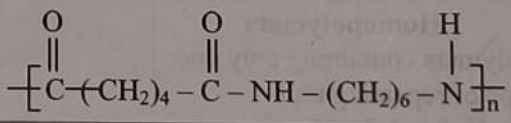
- LDP — Branched polymer
- HDP — Linear polymer

- **Polyamides:**

Polyamides (Nylon)

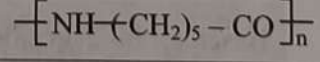
Nylon 6,6

Monomers: Adipic acid and hemamethylenediamine
Structure of polymer:



Nylon 6

Monomer: ∈-Caprolactum
Structure of polymer:

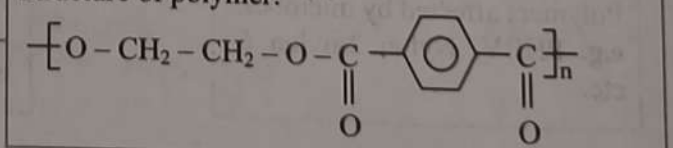


- **Polyesters:**

Polyesters

Terylene (Dacron)

Monomers: Ethylene glycol and terephthalic acid
Structure of polymer:

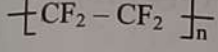


Other common polymers:

Teflon

Monomer:
Tetrafluoroethylene

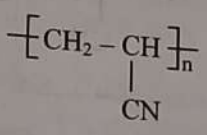
Structure of polymer:



Polyacrylonitrile

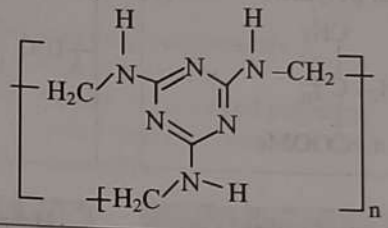
Monomer:
Acrylonitrile

Structure of polymer:



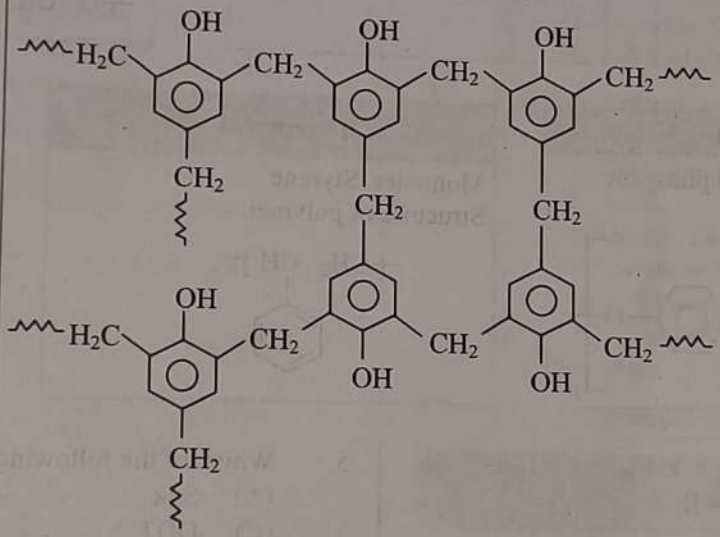
Melamine-formaldehyde polymer (Melamine)

Monomers: Melamine and formaldehyde
Structure of polymer:

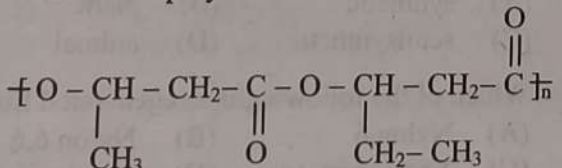
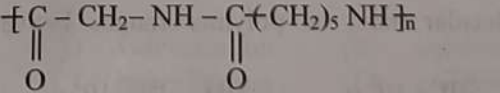


Phenol-formaldehyde polymer (Bakelite)

Monomers: Phenol and formaldehyde
Structure of polymer:



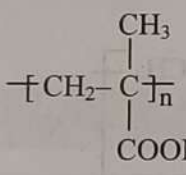
Biodegradable polymers:

Biodegradable polymers	
PHBV	**Nylon 2-nylon 6**
Monomers: β-Hydroxybutyric acid (3-hydroxybutanoic acid) and β-hydroxyvaleric acid (3-hydroxypentanoic acid). Structure of polymer: 	Monomers: Glycine and ε-amino caproic acid Structure of polymer: 

- Some commercially important polymers:

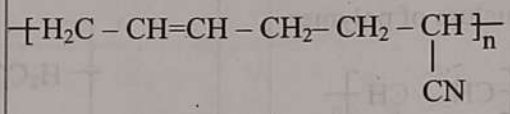
Perplex or acrylic glass

Monomer: Methylmethacrylate
Structure of polymer:



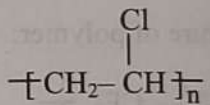
Buna-N or nitrile rubber

Monomers: Butadiene and acrylonitrile
Structure of polymer:



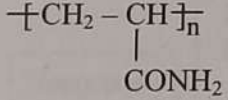
PVC (polyvinylchloride)

Monomer: Vinyl chloride
Structure of polymer:



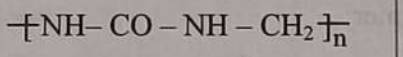
Polyacrylamide

Monomer: Acrylamide
Structure of polymer:



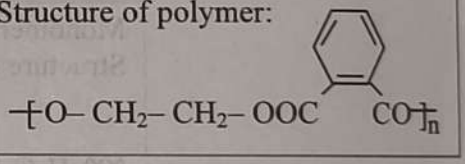
Urea-formaldehyde resin

Monomers: Urea and formaldehyde
Structure of polymer:



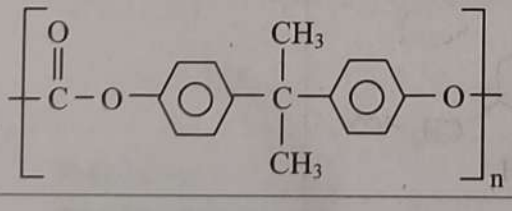
Glyptal

Monomers: Ethylene glycol and phthalic acid
Structure of polymer:



Polycarbonate

Monomers: Bisphenol and phosgene
Structure of polymer:



Thermocol

Monomer: Styrene
Structure of polymer: