POLYMERS

Very large molecules having high molecular mass.

Classification

Based on Source

Natural Polymers: Found in plants and animals.
Examples: Protein, Cellulose.

Semi-Synthetic Polymers: Cellulose Derivative.
Examples: Cellulose Nitrate.

Synthetic Polymer: Man-made polymer.
Examples: Plythene, Buna-S, Nylon-6,6.

Based on Structure

Linear: Long and Straight chains
Examples: Fibres and Plastics.

Branched: Linear chains with branches.
Examples: Amylopectin, glycogen.

Cross linked or Network Polymer: Strong covalent bonds between various linear polymer chains.
Examples: Bakellite, Malemine.

Based on Polymerization

Addition Polymer: Repeated Addition of Monomers containing Double or Triple bond.

- **Homopolyner:** Single monomeric species (Polythene).
- **Copolymer:** Two Different Monomers.

Condensation Polymer: Repeated Condensation between two differnt bi-functional or Tri-fumetional polymer.
Examples: Terylene, Nylon 6

Based on Molecular Masses

Elastomer:
Rubber like solids with elastic properties.
Examples: Buna-S, Buna-N

Fibers:
Thread forming solids.
Examples: Nylone 6.6, Terylene.

Thermoplastic Polymer:
Linear or slightly branched chain capable of repeated softening on heating.
Examples: Polythiene, Polystyrene.

Thermosetting Polymer:
Cross linked or Heavily branched molecules on heating excessive cross linking in mould and become infusible.
Examples: Bakelite

Types of Polymerization Reaction

Addition/Chain Growth: Governed by free Radical Mechanism:
Steps Involved:
(a) Chain Initiation:

$$C_6H_5—\underset{\underset{O}{\|}}{C}—COOH + NH_2N—(CH_2)—NH_2 \downarrow$$
$$2C_6H_5—\underset{\underset{O}{\|}}{C}—O \rightarrow 2C_6H_5 + CO_2$$

(b) Chain Propagating Step:

$$C_6H_5—CH_2—CH_2 + CH_2 = CH_2 \downarrow$$
$$C_6H_5—CH_2—CH_2—CH_2—CH_2 \downarrow$$
$$C_6H_5—(CH_2—CH_2)_n—CH_2—CH_2$$

(c) Chain Termination Step:

$$2[C_6H_5—(CH_2—CH_2)_n—CH_2—CH_2] \rightarrow$$
$$C_6H_5—(CH_2CH_2)_n—CH_2CH_2—CH_2—(CH_2—CH_2)_n—C_6H_5$$

Condensation Step Growth: Involves Stepwise Intermolecular Condensation:

$$N—HOCH_2—CH_2OH +$$
$$NHOOC—C_6H_4—COOH \downarrow$$
$$\left[—O—CH_2—CH_2—O—\underset{\underset{O}{\|}}{C}—C_6H_4—\underset{\underset{O}{\|}}{C}—\right]_N$$

Terylene or Dacran

Biodegradable Polymers

Non-resistent to environmental degradation -have functional group similar to functional group of Biopolymers.

Examples: Poly-B-hydroxy butyrate-co-β-hydroxy valerate (PHBv).
Nylon-2-nylon-6.

Types of Rubber

(i) Natural Rubber: Linear polymer of Isoprene (2-mettiyl-1, 3-butadiene)

Vulcanisoltion of rubber:
Raw RUBBER + SULPHUR
$\xrightarrow[373-415\ k]{\Delta}$
Stiffened rubber

Synthetic Rubber:
Homopolymer of 1, 3-butadiene Derivative.
Example: Buna-S, Buna-N

Neoprene

Copolymerization: A mixture of more than one polymeric species undergoes polyymerization.

Example:

$$n—CH_2 = CH - CH = CH_2$$
$$(CH_2—CH = CH—CH_2—\underset{\underset{C_6H_5}{|}}{CH}—CH_2)_n$$

Buna-S or SBR :

$$nCH = CH_2 + nCH_2 = CH - CH = CH_2$$
$$\xrightarrow{Na.\ \Delta}$$
$$(CH(C_6H_5)—CH_2—CH_2—CH = CH—CH_2)_n$$

Buna-N:

$$nCH_2 = CH—CH = CH_2 + nCH_2 = \underset{\underset{CN}{|}}{CH}$$
$$(CH_2—CH = CH—CH_2—CH_2—\underset{\underset{CN}{|}}{CH})_n$$

Neoprene:

$$nCH_2 = CH—\underset{\underset{Cl}{|}}{C} = CH_2 \xrightarrow{K_2S_2O_8}$$
$$(CH_2—CH = \underset{\underset{Cl}{|}}{C}—CH_2)_n$$

Molecular mass of polymers

- Expressed as an average
- Determined By physical and chemical method.

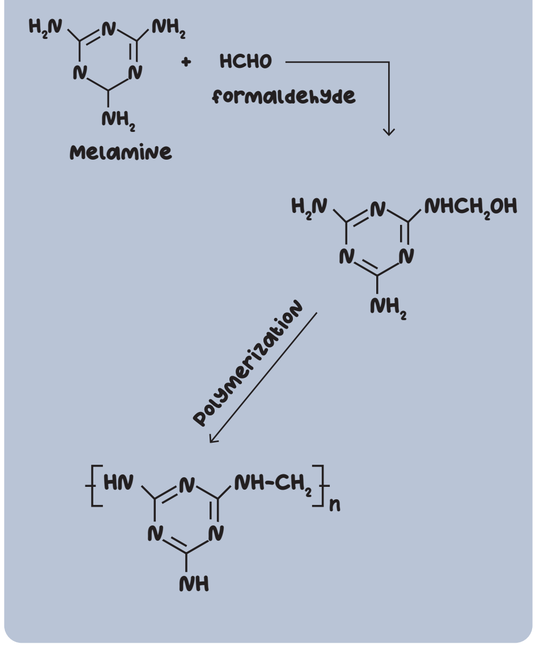
Polymers of Commercial Importance

(1) Polypropene used for Manufacturing of Ropes, Toys.
(2) Baklite use for Making Electrical Switchies.

Tetlon:

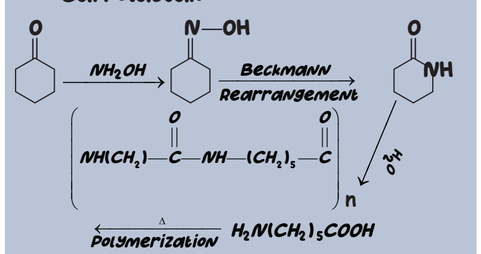
$$nCF_2 = CF_2 \xrightarrow[\text{High pressure}]{\text{Catalyst}}$$
Tetrafluoromethane
$$\left(\begin{array}{cc} F & F \\ | & | \\ —C— & —C— \\ | & | \\ F & F \end{array}\right)_n$$

Melamine - Formaldehyde Polymer:



Preparation

Nylon-6: Homopolymer of Caprolactan



Polyamudes

Nylon-6.6: Copolymer of Adipic Acid and Hexamethylene Diammine.

$$HOOC-(CH_2)_4-COOH + nH_2N-(CH_2)_6-NH_2 \downarrow$$
$$—\underset{\underset{O}{\|}}{C}—(CH_2)_4—\underset{\underset{O}{\|}}{C}—NH—(CH_2)_6—NH_2$$

Nylon-6.6

Polyesters

Terylene: (dacron)

$$nHOCH_2CH_2OH + nHOOC—C_6H_4—COOH \xrightarrow{\Delta}$$
$$\left(—OCH_2—CH_2—O—\underset{\underset{O}{\|}}{C}—C_6H_4—\underset{\underset{O}{\|}}{C}—\right)_n$$

Polyethyline terephthalate

Thermosetting Resin

Bakelite: Phenol formaldehyde resin.

$$n\ C_6H_5OH + n\ HCHO \xrightarrow{OH^-} \text{Bakelite}$$

Phenal