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:

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

(b) Chain Propagating Step:

$$C_6H_5-CH_2-CH_2 + CH_2=CH_2 \rightarrow C_6H_5-CH_2-CH_2-CH_2-CH_2 \rightarrow C_6H_5-(CH_2-CH_2)_N-CH_2-CH_2$$

(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:

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

Terylene or Dacran

Polyamudes

Nylon-6,6: Copolymer of Adipic Acid and Hexamethylene Diammine.

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

Nylon-6,6

Thermosetting Resin

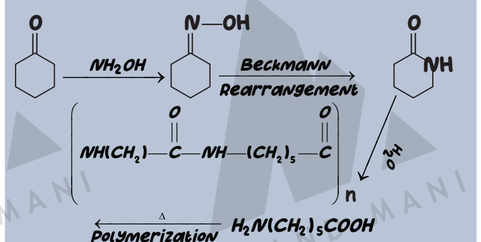
Bakelite: Phenol Formaldehyde resin.

$$n\,C_6H_4(OH) + n\,HCHO \xrightarrow{OH^-} \text{Bakelite}$$

Phenal

Preparation

Nylon-6: Homopolymer of Caprolactan



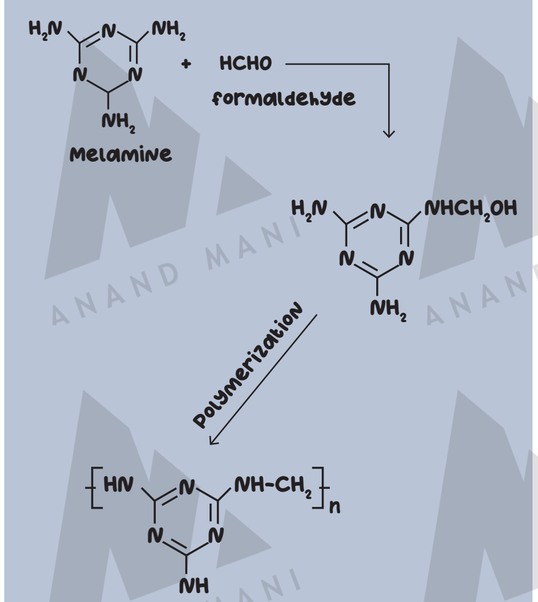
Polyesters

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

Melamine - Formaldehyde Polymer:



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 polymerization.

Example:

$$n-CH_2=CH-CH=CH_2 + CH=CH_2 \rightarrow (CH_2-CH=CH-CH_2-CH(C_6H_5)-CH_2)_n$$

Buna-S or SBR :

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

Buna-N:

$$nCH_2=CH-CH=CH_2 + nCH_2=CH(CN) \rightarrow (CH_2-CH=CH-CH_2-CH_2-CH(CN))_n$$

Neoprene:

$$nCH_2=CH-C(Cl)=CH_2 \xrightarrow{K_2S_2O_8} (CH_2-CH=C(Cl)-CH_2)_n$$

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:

$$nCF_2=CF_2 \xrightarrow[\text{High pressure}]{\text{Catalyst}} \left(-CF_2-CF_2-\right)_n$$

Tetrafluoromethane

ANAND MANI