Types of polymers

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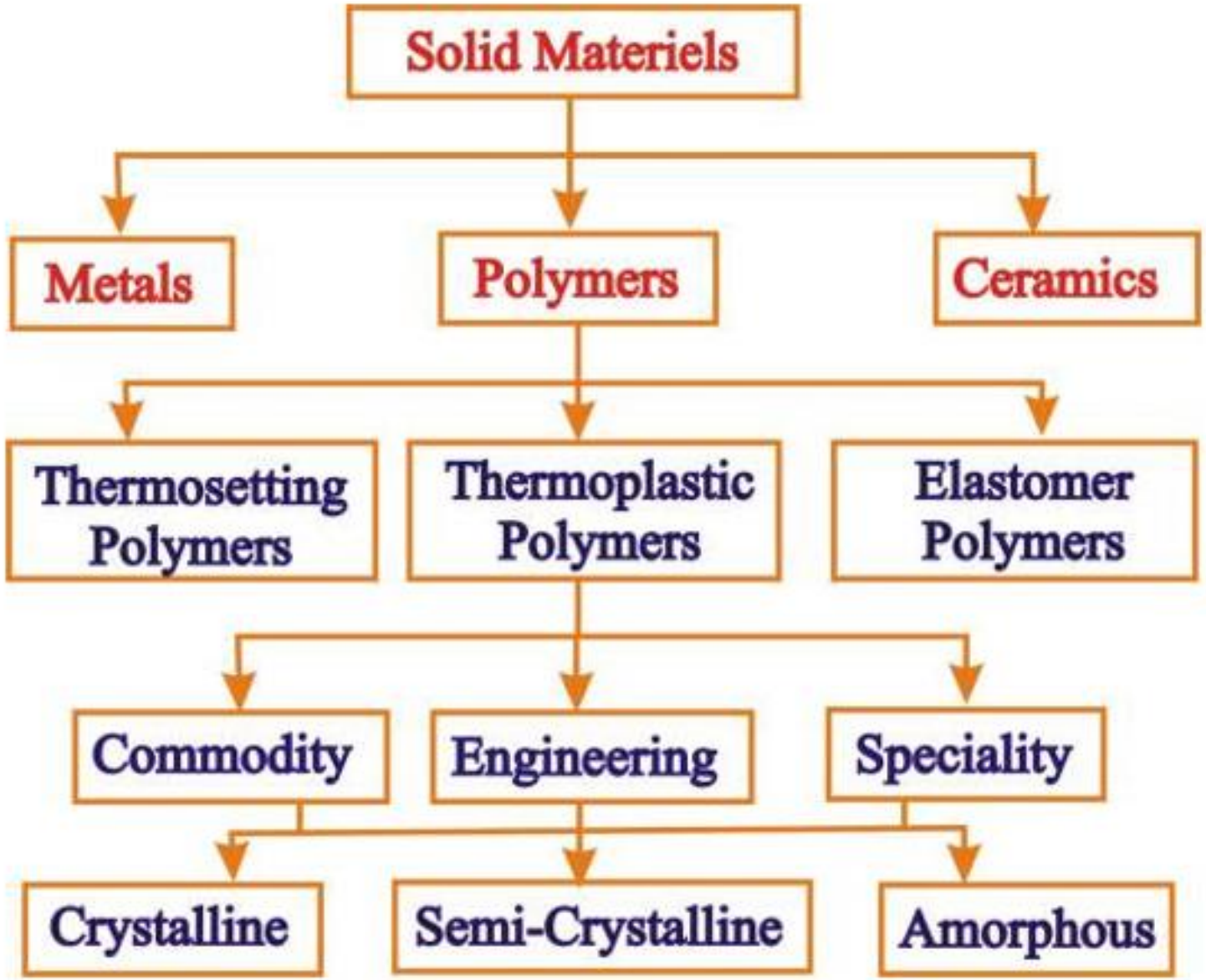
Classification of Polymers



•**Polymerization**: ***"The process by which, monomer combine to form polymers is known as polymerization".***

***Degree of Polymerization (DP)*: *"The numbers of repeating unit present in it call degree of polymerization (DP)"*.**

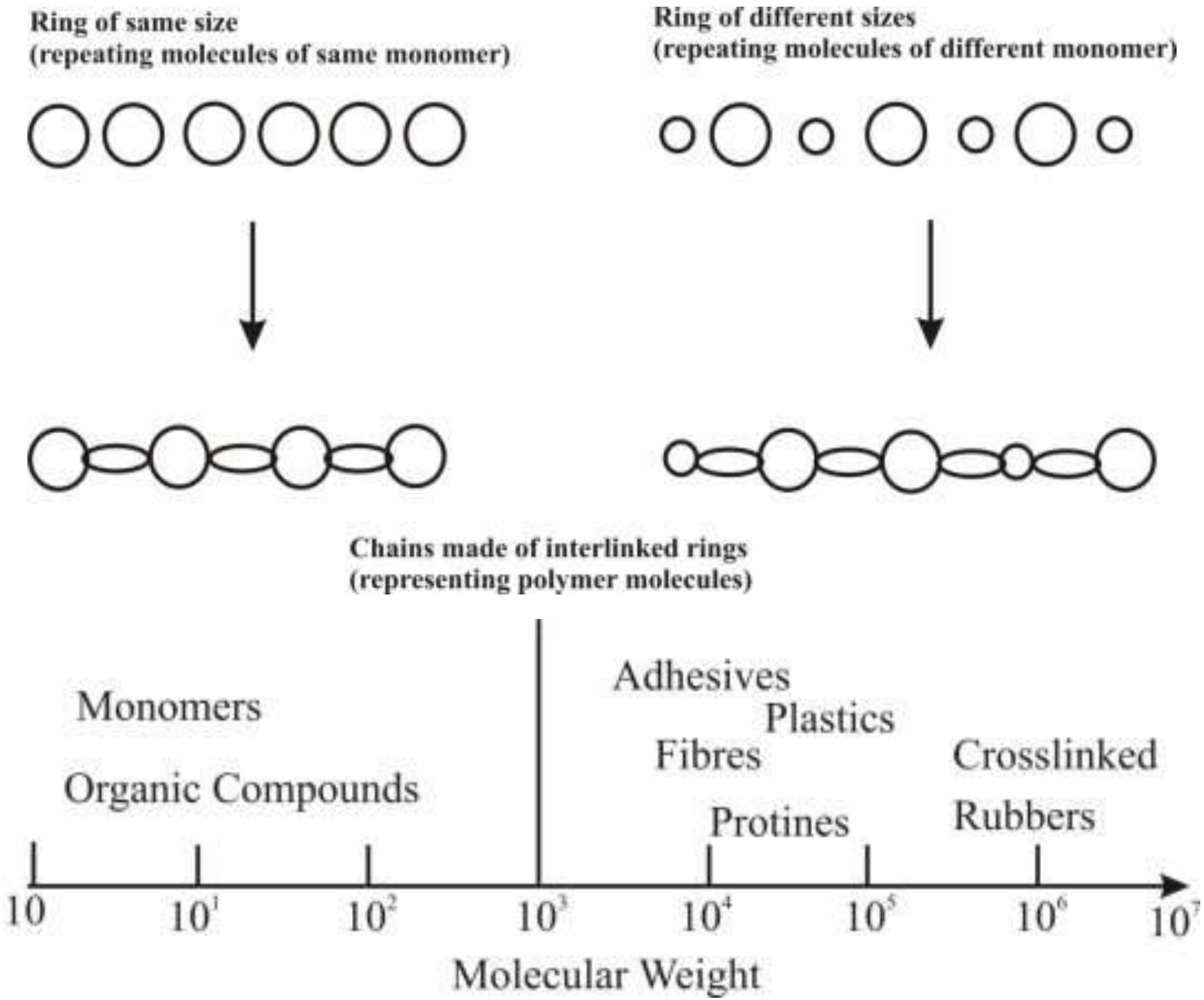
Addition Polymerization: *: 'When molecules just add on to form the polymer, the process is called 'addition polymerization'* In 'addition polymerisation' the molecular weight of the polymer is roughly equal, to that of all the molecules, which combine to form the polymer.

Ex; Polyethylene, polypropylene

Condensation Polymerization: When, however, molecules do not just add on but also undergo some reaction in forming the polymer, the process is called ‘condensation polymerisation’

- **The molecular weight of polymer is lesser by the weight of simple molecules eliminated during the condensation process**
- **The condensation takes place between the two reactive functional groups, like the carbonyl group (of an acid) and hydroxyl group (of an alcohol) to form polyesters.**

Ex. Nylon, PET

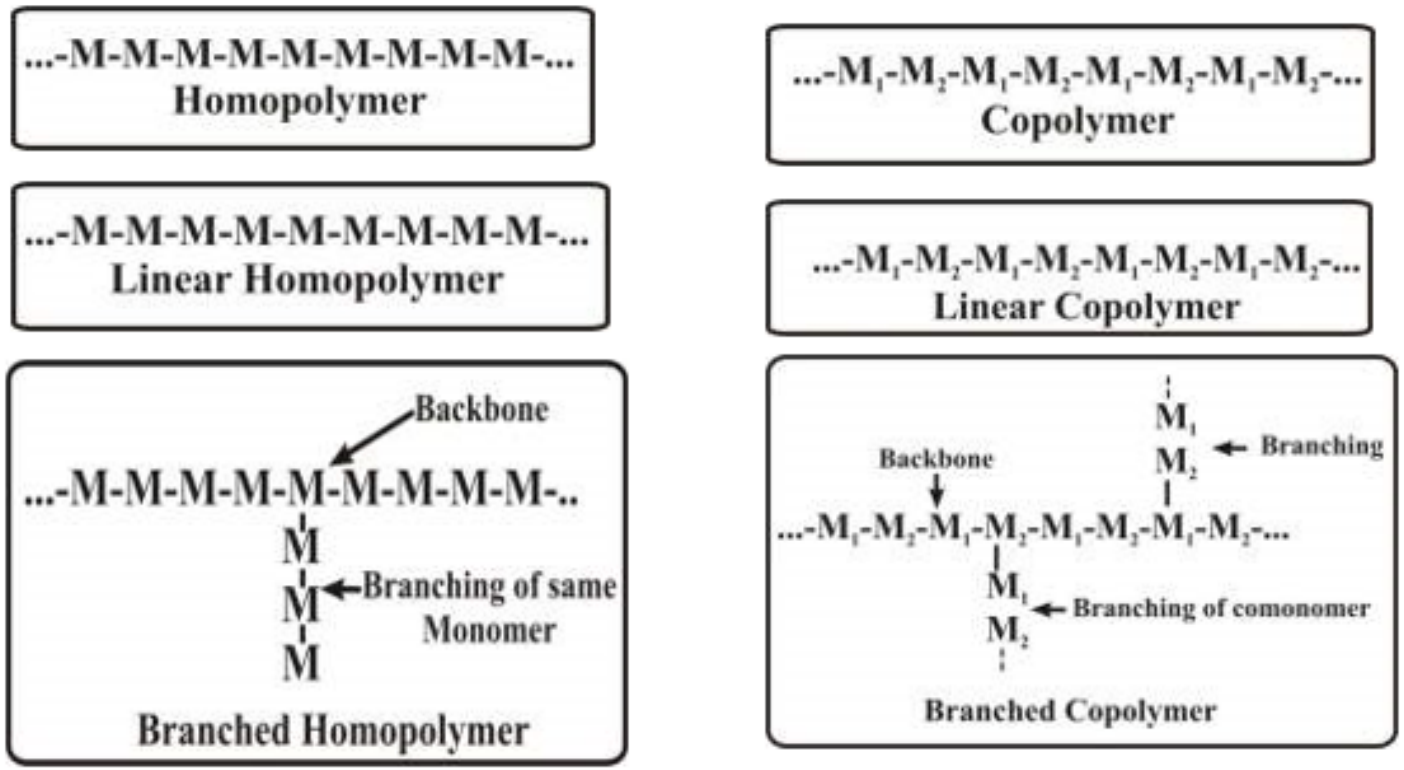

Ring of same size
(repeating molecules of same monomer)
Ring of different sizes
(repeating molecules of different monomer)
Chains made of interlinked rings
(representing polymer molecules)
Monomers
Organic Compounds
Adhesives
Plastics
Fibres
Protines
Crosslinked
Rubbers
10
10^1
10^2
10^3
10^4
10^5
10^6
10^7
Molecular Weight

Polymer Material Properties Depends on

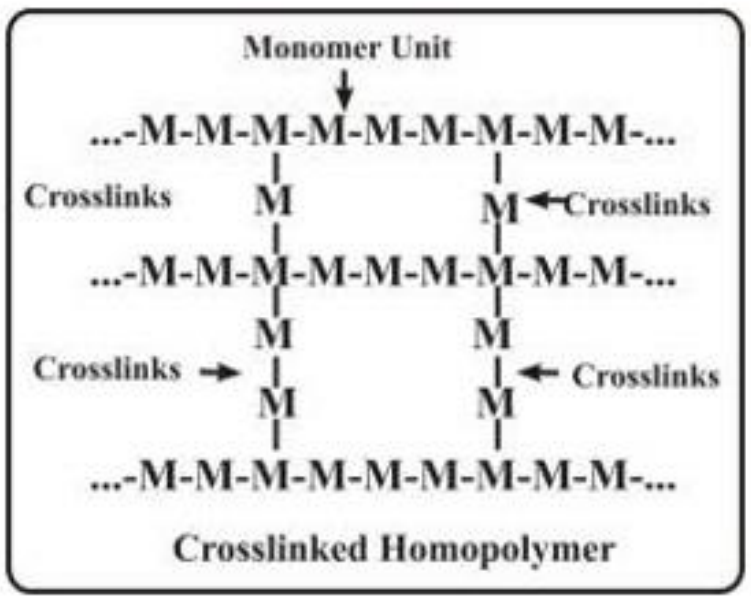
1. **Degree of Polymerization**
2. **Molecular Weight of the Polymer**
3. **Molecular Weight Distribution**
4. **Glass Transition Temperature**
5. **Percentage of Crystallinity**
6. **Structure and Distribution of Chain Branching**

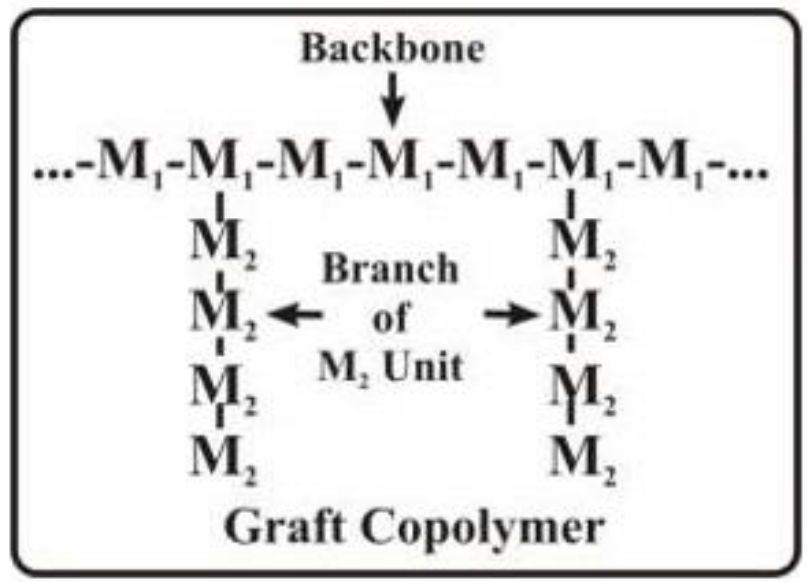
Types of Polymers

A polymer consist of identical monomers or monomers of different chemical structure and accordingly they are called homopolymer and copolymers respectively. If the main chain is made up of same species of atoms, the polymer is called 'homochain polymer' Graft copolymer are branched structures in which the monomer segments on the branches and backbone differ



The monomeric unit in a polymer may be present in a linear, branched or cross-linked (three dimensional) structure



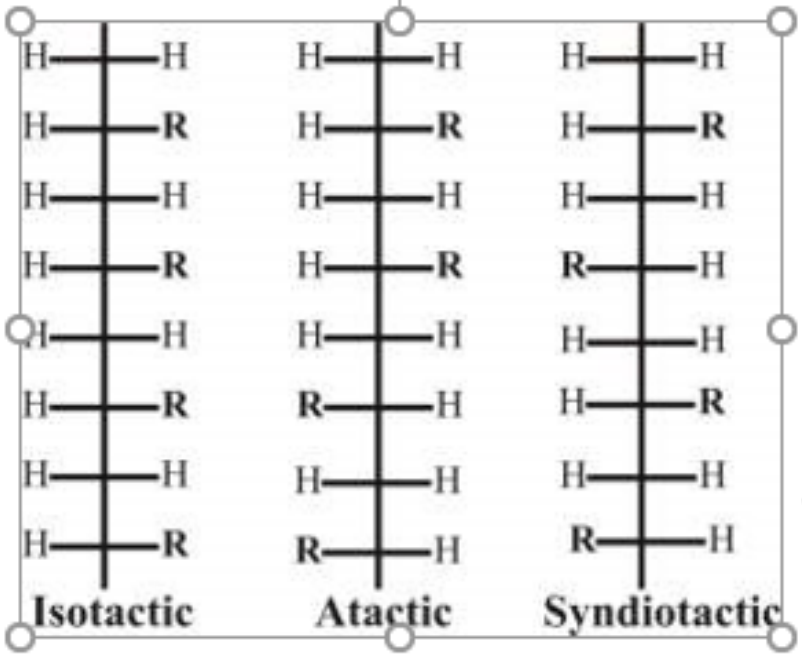


Tacticity

1. The head to tail configuration in which the functional groups are all on the same side of the chain, is called 'isotactic polymers'.

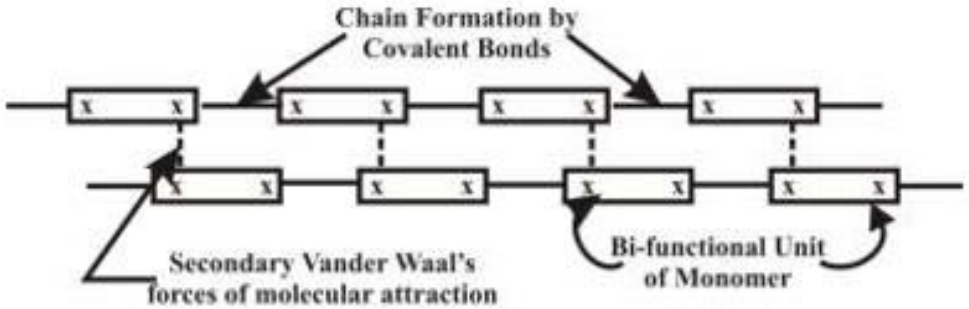
2. If the arrangements of functional groups are at random around the main, it is called 'atactic polymers' e.g. polypropylene.

3. If the arrangements of side groups is in alternating fashion, it is called 'synditactic polymers'

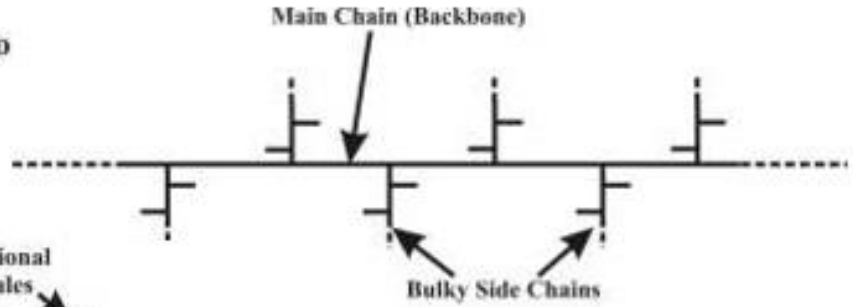


Where R = Alkyl Group

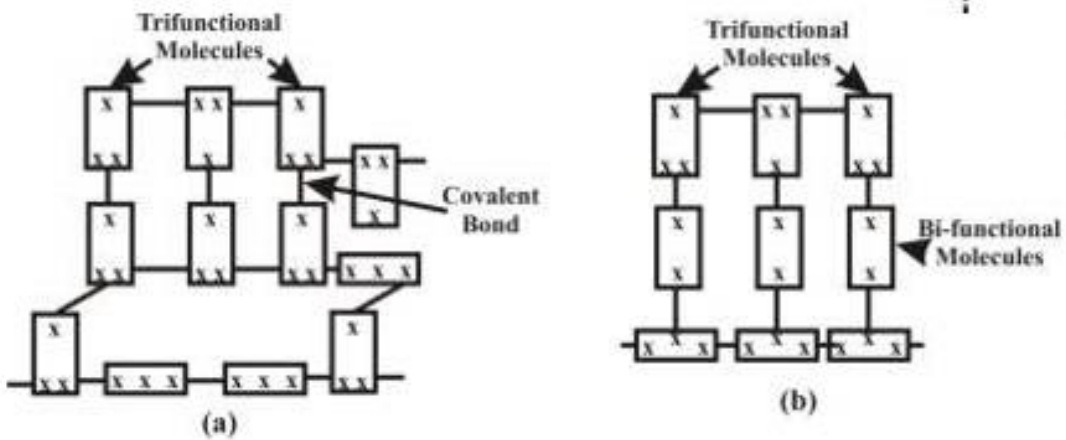
Functionality



Linear Chain polymer from a bi-functional mono



Branched Chain Polymer



Formation of three dimensional network polymer
(a) reaction of three functional molecules
(b) reaction between two and three functional molecules

Thermoplastics Polymers

Thermoplastics are resins that repeatedly soften when heated and harden when cooled

Thermosetting Polymers

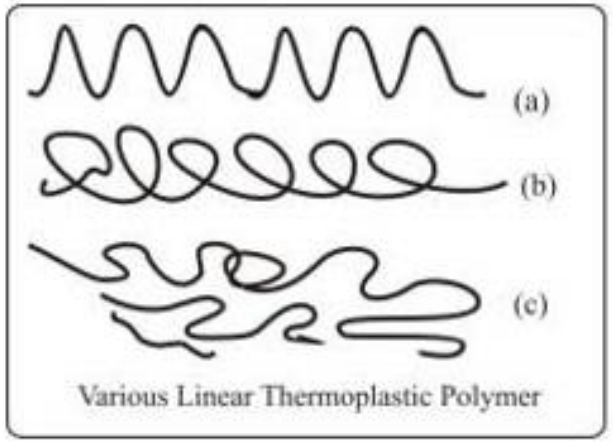
Thermosets are resins that undergo reaction during processing to become permanently insoluble and infusible due to they formed three-dimensional cross linked network structure when heat is applied.

Characteristics of thermosetting resins:

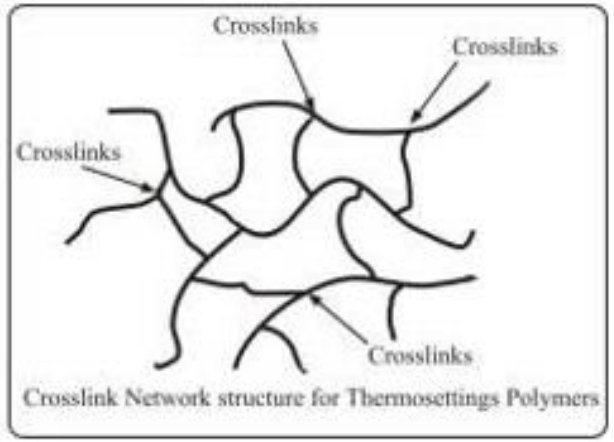
1. During the hardening the cross-links are formed between adjacent molecules, resulting in a complex, interconnected network that can be related to its viscosity and performance
2. These cross-links prevent slippage of individual chains, thus preventing plastic flow under addition of heat
3. If excessive heat is added after cross links, degradation rather than melting will occur.

Ex: Phenolic Resin, Epoxy Resin, Polyester resin

Thermoplastics and Thermosetting Polymers

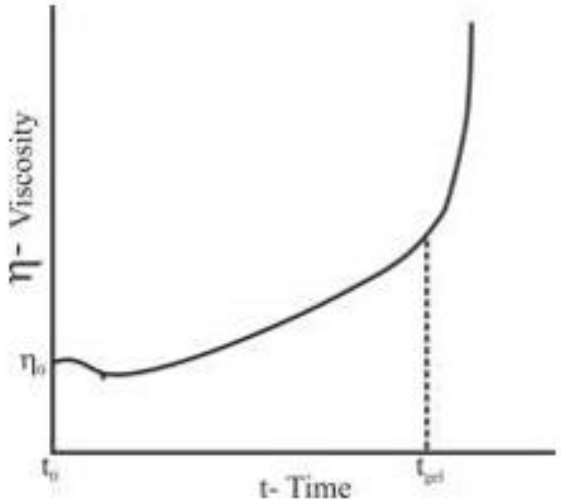


Various Linear Thermoplastic Polymer



Crosslink Network structure for Thermosettings Polymers

Structure of Thermoplastics and Thermosetting Polymers



Thermoplastics	Thermo-settings
1. They are usually formed by addition polymerization and condensation	1. They are usually formed by condensation polymerization
2. They consist of long chain linear polymers with negligible cross-links	2. They have three dimensional network structure
3. They soften on heating readily, because secondary forces between the individual chain can break easily by heat or pressure or both	3. They cross-link and bonds retain their strength on heating and hence they do not soften on heating.
4. By reheating to a suitable to a suitable temperature, they can be softening, reshaped and thus reused.	4. They retain their shape and structure, even on heating. Hence, they cannot be reshaped and reused.
5. They are, usually, soft, weak and less brittle.	5. They are, usually, hard, strong and more brittle.
6. These can be reclaimed from waste	6. They cannot be reclaimed from waste.
7. They are, usually, soluble in some organic solvents	7. Due to strong bonds and cross-links they are insoluble in almost all organic solvents.
8. Examples: Polyethylene, Polypropylene etc.	8. Phenolic Resin, Epoxy, Polyurethans, Polyesters etc.