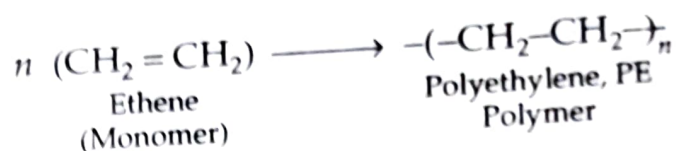


A **Polymer** is a long molecule formed by the joining together of thousands of small molecular units by chemical bonds. Due to their large size they are sometimes called as *macromolecules*.

The chemical process leading to the formation of polymer is known as **Polymerisation** and the number of monomeric units contained in the polymer is known as **Degree of Polymerization**. Small molecules which combine with each other to form polymer molecules are known as **Monomers**.

For example :

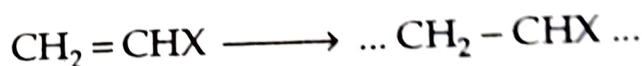


where n is degree of polymerization, it can be 10^4 or more.

2.1 Functionality

Functionality means the number of bonding sites in a monomer. The double bond in vinyl monomers ($\text{CH}_2 = \text{CHX}$) can be considered as a site for two free valencies. When the double bond is broken, two single bonds become available for combination.

For example,



Thus, vinyl monomers can be considered as **bifunctional** because they have two reactive (or bonding) sites. For a substance to act as a monomer, it must have at least two reactive (or bonding) sites.

Functionality and structures of polymers :

(i) When the functionality of monomer is two, linear or straight-chain polymer molecule is formed.

Examples of Bifunctional monomers. All vinyl monomers, Hexamethylene diamine, Adipic acid, Terephthalic acid, Ethylene glycol, Amino-acid, etc.

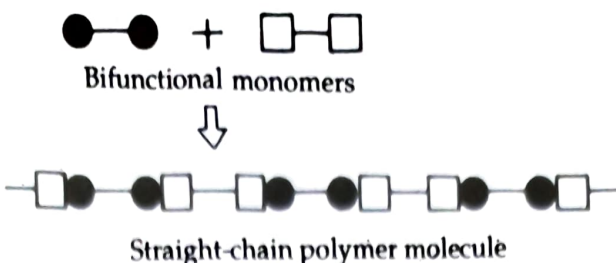
(ii) When the functionality of monomer is three, three-dimensional network polymer is formed.

Examples of Trifunctional monomers. Phenol, Melamine, etc.

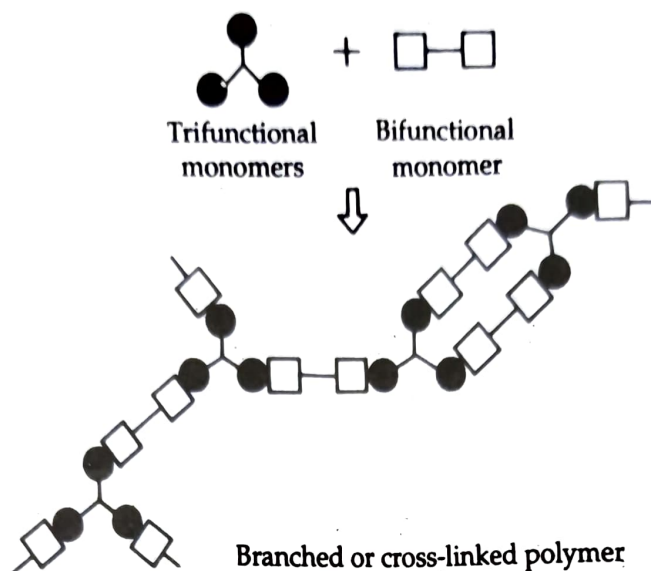
(iii) When a trifunctional monomer is mixed in small amounts with a bifunctional monomer, a branched chain polymer is formed.

(iv) When a bifunctional monomer is mixed in small amounts with a trifunctional monomer, a three-dimensional network polymer is formed.

I. Linear chain formation :



II. Branched chain (network polymer) formation :



Formation of linear and branched chains on the basis of functionality

2.2 Polymer classification

Polymeric materials can be classified into several ways as described below :

1. *Based on Structure/shape.* A polymer molecule may be Linear, Branched or cross-linked. Their structures & illustrative examples are given below :

Polymer	Structure	Examples
Linear		HDPE (High density polythene)
Branched		LDPE (Low density polythene)
Cross-linked		XLPE (Cross-linked polythene), Rubbers, Thermosets

2. *Based on Physical State.* A polymeric material can be Amorphous (e.g., LDPE, Rubbers etc.) or Semi-Crystalline (e.g., HDPE, Nylon, Polyesters).