

3] Based on Mode of Polymerisation

Polymerization is the process by which [monomer molecules](#) are reacted together in a chemical reaction to form a polymer chain (or three-dimensional networks). Based on the [type of polymerization](#), polymers can be classified as:

i) Addition polymers:

These type of polymers are formed by the repeated addition of monomer molecules. The polymer is formed by polymerization of monomers with double or triple bonds (unsaturated compounds). Note, in this process, there is no elimination of small molecules like water or alcohol etc (no by-product of the process). Addition polymers always have their empirical formulas same as their monomers. Example: ethene $n(\text{CH}_2=\text{CH}_2)$ to polyethene - $(\text{CH}_2-\text{CH}_2)_n$.

ii) Condensation polymers:

These polymers are formed by the combination of monomers, with the elimination of small molecules like water, alcohol etc. The monomers in these types of condensation reactions are bi-functional or tri-functional in nature. A common example is the polymerization of Hexamethylenediamine and adipic acid. to give Nylon – 66, where molecules of [water](#) are eliminated in the process.

4] Classification Based on Molecular Forces

Intramolecular forces are the *forces* that hold atoms together within a *molecule*. In Polymers, strong covalent bonds join atoms to each other in individual polymer molecules. [Intermolecular forces](#) (between the molecules) attract polymer molecules towards each other.

Note that the properties exhibited by solid materials like polymers depend largely on the strength of the forces between these molecules. Using this, Polymers can be classified into 4 types:

i) Elastomers:

Elastomers are rubber-like solid polymers, that are elastic in nature. When we say elastic, we basically mean that the polymer can be easily stretched by applying a little force.

The most common example of this can be seen in rubber bands(or hair bands). Applying a little stress elongates the band. The polymer chains are held by the weakest intermolecular forces, hence allowing the polymer to be stretched. But as you notice removing that stress also results in the rubber band taking up its original form. This happens as we introduce crosslinks between the polymer chains which help it in retracting to its original position, and taking its original form. Our car tyres are made of Vulcanized rubber. This is when we introduce sulphur to cross bond the polymer chains.

ii) Thermoplastics:

Thermoplastic polymers are long-chain polymers in which inter-molecules forces (Van der Waal's forces) hold the polymer chains together. These polymers when heated are softened (thick fluid like) and hardened when they are allowed to cool down, forming a hard mass. They do not contain any cross bond and can easily be shaped by heating and using moulds. A common example is Polystyrene or PVC (which is used in making pipes).

iii) Thermosetting:

Thermosetting plastics are polymers which are semi-fluid in nature with low molecular masses. When heated, they start cross-linking between polymer chains, hence becoming hard and infusible. They form a three-dimensional structure on the application of heat. This reaction is irreversible in nature. The most common example of a thermosetting polymer is that of Bakelite, which is used in making electrical insulation.

iv) Fibres:

In the classification of polymers, these are a class of polymers which are a thread like in nature, and can easily be woven. They have strong inter-molecules forces between the chains giving them less elasticity and high tensile strength. The intermolecular forces may be hydrogen bonds or dipole-dipole interaction. Fibres have sharp and high melting points. A common example is that of Nylon-66, which is used in carpets and apparels.

The above was the general ways to classify polymers. Another category of polymers is that of Biopolymers. Biopolymers are polymers which are obtained from living organisms. They are biodegradable and have a very well defined structure. Various [biomolecules](#) like carbohydrates and proteins are a part of the category.