

# Structure and property relationship in polymers

Polymer structure can affect the chemical, mechanical, electrical, and optical properties.

# Effect of Structure on properties of

## polymers

Effect on  
chemical  
properties



1. Effect on solubility
2. Chemical reactivity
3. Ageing and weathering



1. Polarity
2. Molecular weight
3. Degree of crosslinking

Effect on  
mechanical  
properties



4. Diffusion
1. Toughness
2. Strength
3. Elasticity

Effect on  
electrical  
properties



1. Electrical conductivity

Effect on optical  
properties



1. Amorphous and crystalline

# Effect on chemical properties

1) Effect on solubility or swelling behaviour:

**A . Polarity:** Polymers having polar groups (OH-, COOH- etc.) will dissolve easily in polar solvents like water, alcohol, aldehydes and ketones etc.

Polymers having non polar groups (alkyl, aryl, etc.) will be more soluble in non polar solvents like benzene, toluene etc.

**B . Molecular weight:** Solubility of a polymer in a particular solvent decreases with increase in molecular weight of polymer.

**C . Degree of cross linking:** More the degree of cross linking in the polymer, lesser will be the solubility.

2) Chemical reactivity of a polymer changes by changing the nature of functional group in the polymers.

Example-Nylon and polyester can undergo hydrolysis because they have amide and esteric linkage.

- Teflon is chemically inert because it has only C-C and C-F bonds.
- Rubber have C=C, which can easily be attacked by oxygen and ozone.

3) Ageing and weathering. (light and heat)-Different polymers shows different resistance power against weathering.

Example-Teflon has more resistance power towards heat than PVC.

-Teflon and cellulose degraded under high energy radiations.

4) Diffusion: Amorphous polymers are non uniform in arrangement of monomers, while crystalline polymers have regular arrangement. So amorphous polymers have more free space ,hence more diffusion is possible in Amorphous polymers.

# Effect on mechanical properties

- 1) **Effect on strength and toughness:** Strength of polymer depend upon magnitude of intermolecular force of attraction between monomers.
  - More the magnitude of intermolecular force of attraction more will be the strength of the polymer.
  - intermolecular force of attraction is of the order of
  - Cross linked  $\geq$  Branched  $\geq$  linear
  - Order of strength is also same.

Reason-The movement of molecules over each other decreasing due to increase in the no of bulky groups (side groups),so the strength of polymer also increases.

- intermolecular force are more in polymers having polar groups than in polymers with non polar groups.
- -Crystalline polymers have high strength than amorphous.



2)Effect on stress(load bearing capacity)-The extent of stress is determined by stress/strain ratio.Where stress=Applied force  
strain =Extent of stretch

3)Effect on elasticity:Amorphous polymers are more elastic than crystalline.

# Effect on electrical properties

Plastic substances act as electrical insulators

- Insulation property of polar polymers destroy in humidity because water has high dielectric constant, which raise the over all dielectric constant of polymer-water mixture. So resistivity decreases and electrical conductivity increases.
- In case of nonpolar polymer vice-a- versa is true.

# Effect on optical properties

- Amorphous polymers are generally transparent because they have nonuniform arrangement of monomers.
- Crystalline polymers may or may not be transparent because they have uniform arrangement of monomers.