5.15 CONDUCTING POLYMERS

Generally polymers like plastics, elastomers are regarded as insulators because of the presence of strong C - C covalent bond. But, under certain circumstance, these can be made to behave like a metal (conductor).

Thus, ***those polymers, which conduct electricity are called conducting polymers***. The conduction in the polymers is mainly due to the following reasons.

Reason for the conduction in the polymer

1. Presence of unsaturated conjugated double bonds in the polymer.
2. Addition (or) removal of electrons (doping) into the polymer.

5.15.3 Conduction in trans-polyacetylene

Preparation

Polyacetylene is prepared by the addition polymerisation of acetylene. Acetylene gas is passed over the Ziegler - Natta catalyst to get polyacetylene.

$$\underset{\text{Acetylene}}{n CH \equiv CH} \xrightarrow[Al(C_2H_5)_3]{Ti(OBu)_4} \underset{\text{Polyacetylene}}{[CH_2 = CH_2]_n}$$

Polyacetylene is infusible, insoluble and becomes brittle on exposure to air.

Mechanism of conduction in trans-polyacetylene

The conductivity of cis-polyacetylene is less when compare to trans-polyethylene.

The conductivity of polyacetylene can be improved by either p-doping or n-doping.

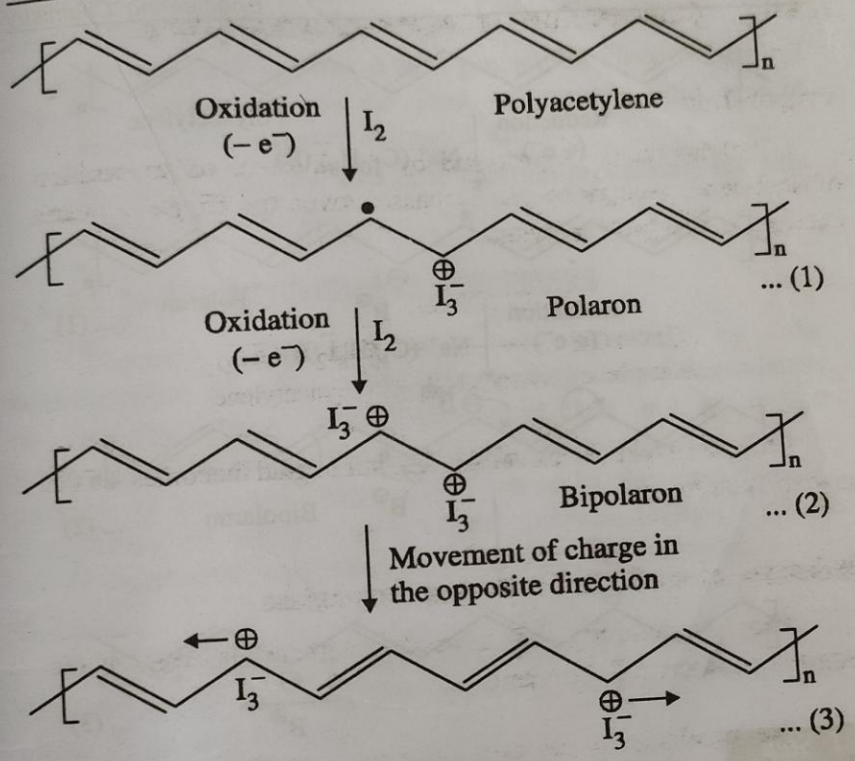
1. p-doping

It involves, the following two steps.

I Step

I step involves the oxidation of a polyacetylene with iodine vapour (Lewis acid).

During oxidation, (as shown in reaction 1) the iodine molecules remove an electron from polyacetylene chain and becomes I_3^-. Now the polyacetylene chain carrying the +ve charge called polaron.

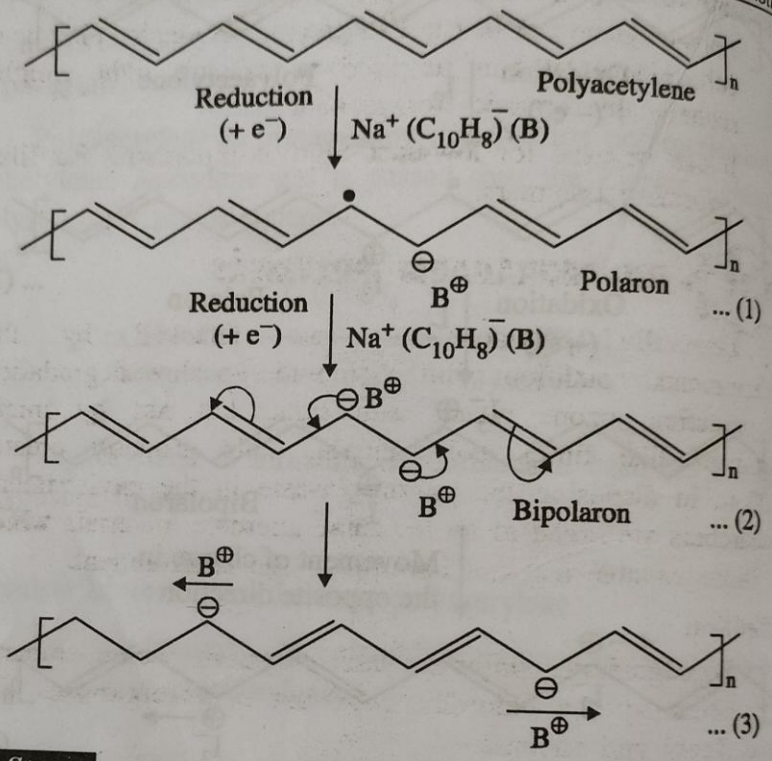


II Step

The second oxidation of polaron (as shown in reaction 2) produces two +ve charges on the chain called bipolaron. This +ve charges are mobile because of delocalisation and responsible for electrical conductance (as shown in reaction 3).

2. n - doping

n - doping also involves two steps



I Step

Step 1 involve reduction of polyacetylene with sodium naphthalide $Na^+ (C_{10}H_8)^-$. During the reduction (as shown in reaction 1) sodium naphthalide donates an electron to plyacetylene chain. Now the polyacetylene carrying the (–)ve charge. This is called polaron.

II Step

Step 2 involves second reduction of polaron (as shown in reaction 2) to produce two (–)ve changes on the chain called bipolaron. This (–)ve changes are mobile because of delocalisation and responsible for electrical conductance (as shown in reaction 3).

5.15.2 Applications of Conducting Polymers

1. Conducting polymers are used in solar cells.
2. It is used in telecommunication systems.
3. It is also used as a very good electrode material for rechargeable batteries.
4. Conducting polymers are used in antistatic coatings for clothing.
5. It is used as a membrane film for gas separations.
6. Conducting polymers are used as electrocatalytic materials in fuel cells.
7. It is used for making analytical sensors.
8. It is used for making ion exchangers.