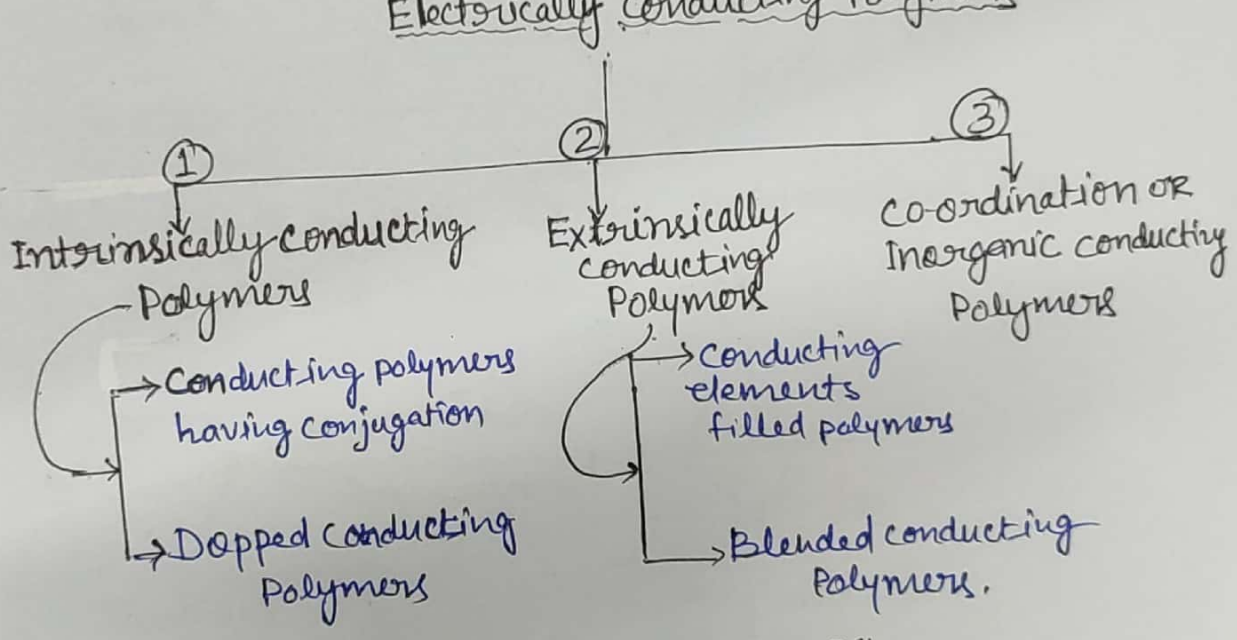
Conducting Polymers

Polymers which can conduct electricity are called electrically conducting polymers.

Ordinary polymers obtained by usual methods are electrical insulators. However, some specific polymers may act as conductors.

Such polymers are useful because of their ease of fabrication, flexibility or strength, lightness of weight and chemical inertness.

Electrically conducting polymers can be classified into the following groups:



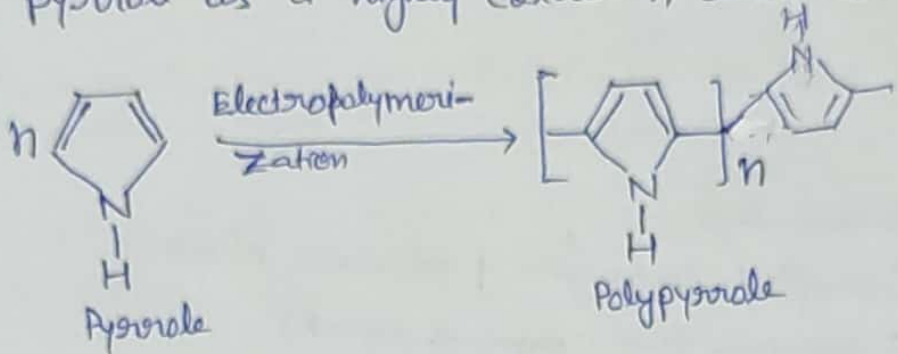
(1) INTRINSICALLY CONDUTING POLYMERS:

(i) Conjugated Polymers having conjugated π-electrons:

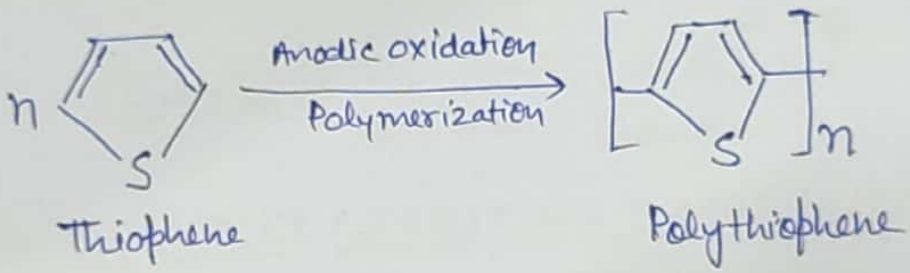
Such type of polymers essentially contain conjugated π-electrons backbone. These π-electrons are loosely held electrons and are responsible of electrical charge. Under the influence of electric field conjugated π-electrons of polymer get excited.

Then, they can be transported through the solid polymeric material. overlapping of orbitals over the entire back-bone results in the formation of valence bands as well as conduction bands, which extend over the complete polymer molecule. Thus presence of conjugated π-electrons in a polymer increases its conductivity to a large extent.

Example: Polypyrrole is obtained by electropolymerization of pyrrole as a highly coloured, dense-conducting film.



Example: Polythiophene can be polymerized by oxidation of thiophene.



(ii) Dopped Conducting Polymers:

Such kind of conducting polymers obtained by exposing the polymer to a charge transfer agent in either gas phase or in solution are called doped conducting polymers.

Dopping is the process by which conductivity of the polymers may be increased by creating negative or positive charge on the polymer—

---backbone by oxidation or reduction.

Dopping is of two types —

(a) <u>P-dopping</u>: It is a technique in which an ICP (intrinsically conducting polymer) is oxidised with Lewis acid (electron acceptor) creating the positive charge on the backbone of the polymer. Some of the common P-dopant are —

I_2, Br_2, FeX_3, PF_5, AsF_5 etc.

$$(C_2H_2)_n + 2FeCl_3 \longrightarrow (C_2H_2)_n^{\oplus}\ FeCl_4^{\ominus} + FeCl_2$$

Polyacetylene — Lewis acid — (Oxidation)

$$2(C_2H_2)_n + 3I_2 \longrightarrow 2[(C_2H_2)_n^{\oplus}\ I_3^{\ominus}]$$

Polyacetylene — Lewis acid — oxidation.

(b) <u>N-Dopping</u>: This is a technique in which an ICP is reduced with Lewis bases creating the negative charge on the backbone of the polymer. Some of the common N-dopant used are Li, Na, K, Ca etc.

$$(C_2H_2)_n + Na \longrightarrow (C_2H_2)^{\ominus}\ Na^{\oplus}$$

Lewis base — Reduction

(2) <u>EXTRINSICALLY CONDUTING POLMERS (ECP)</u>:

This type of polymers own their conductivity due to the presence of externally added ingrediants in them. It is of two types:

(a) <u>Conductive element filled Polymers</u>:

These polymers act as the binder to hold the conducting material (i.e. carbon black, metallic fibres, metallic oxides etc.) together in the solid entity. These are usually low cost, light weight, mechanically sound and easily processable.

(b) Blended conducting Polymers: It is obtained by blending a conventional polymer with a conducting polymer. Such polymers possess better physical, chemical, electrical and mechanical properties and they can be easily processed.

(3) Co-ordination or Inorganic polymers:

These polymers contain charge transfer complexes and are obtained by combining metal with polydentate ligands. Such polymers have very low degree of polymerisation (≤ 18).

Application: (i) In rechargeable light weight batteries.

(ii) Used in making button type batteries.

(iii) Used as conductive paints.

(iv) Used as electro-chemical accumulators

(v) Used as biosensors and chemical sensors. Used for making sensors for pH, O_2, NOx, SO_2, NH_3 and glucose as analytical sensors.

(vi) Used in solar cells.

(vii) Used in telecommunication systems.

(viii) Used in smart windows.