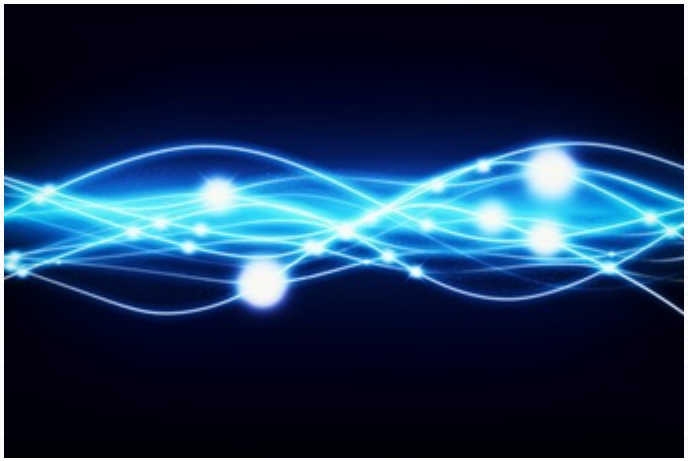
ELECTRONICALLY CONDUCTING POLYMERS



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Conducting polymers are macromolecules which in the solid state provide a pathways for electronic conduction.

They provide a pathways for electrons to migrate along a polymer chain and jump from chain to chain .

In polymers , the process generally depends on the presence of array conjugated, delocalized double bonds.

- **Many system of this type,**

poly(sulphur nitride)

poly acetylene

poly phenylene

poly pyrrol

poly thiophene

POLYACETYLENE

- Polyacetylene has received more attention than any other electronically conducting polymer.

TWO FORMS OF POLYACETYLENE

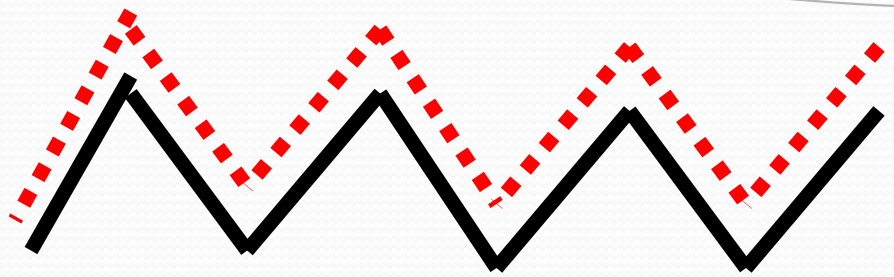
- Polyacetylene exists in cis-trans planar form and trans-trans form.

Cis-trans form

trans-trans form

STRUCTURES OF POLYACETYLENE

- The classical structure of polyacetylene is the one in which ∏-electron delocalization.
- This would correspond roughly to the structure of a metal and would yield a half-filled valence
- thermal or photolytic activation of electrons to give them sufficient energy to jump the gap into the lower levels of the conduction band..



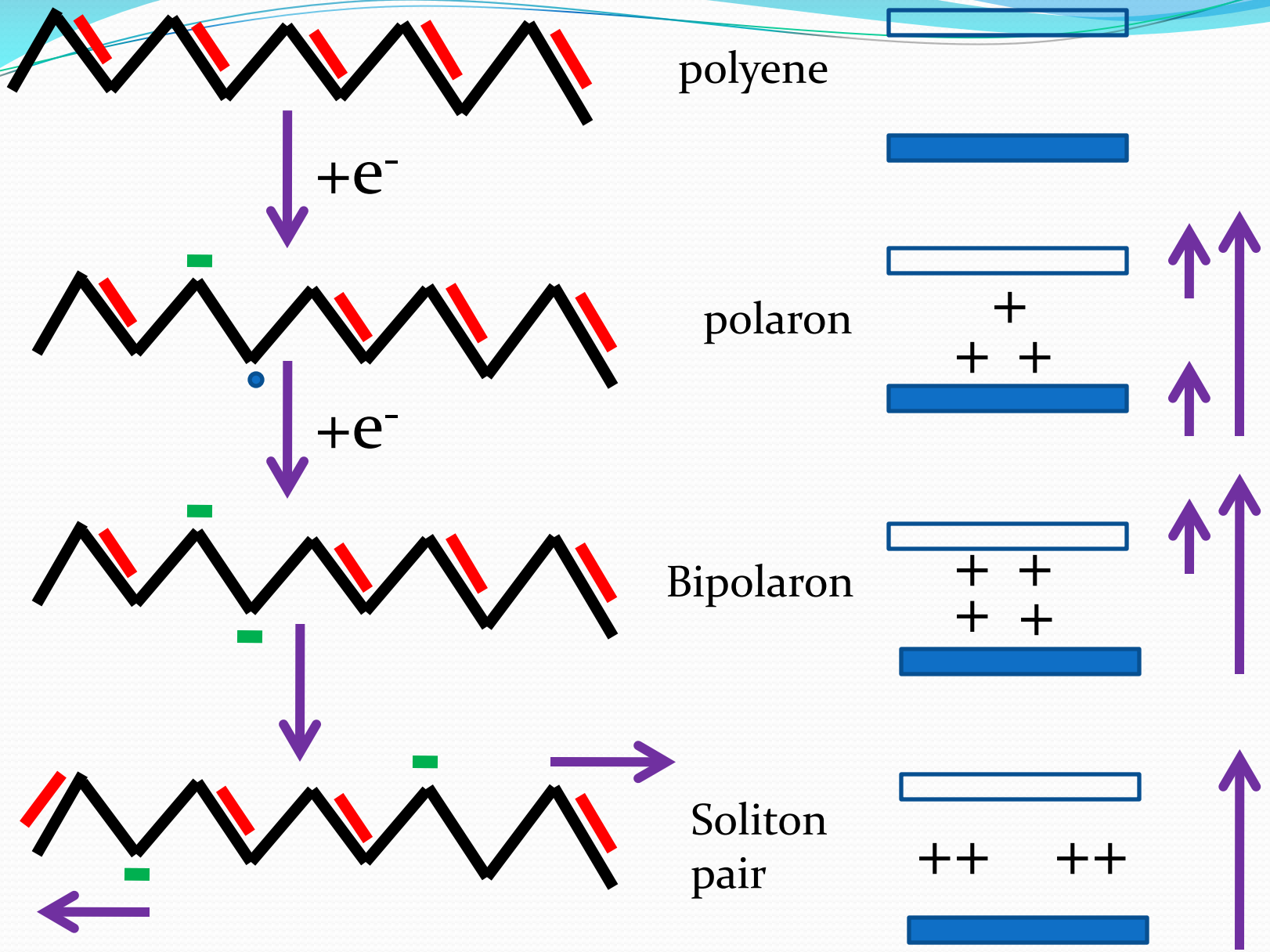
delocalized structure

Resonance structures

THE EFFECT OF THE DOPANTS ON POLYACETYLENE

- It is postulated that an electron added to polyacetylene by doping goes not into the conduction band but into an intermediate electronic state within the band gap.

- The effect of dopants on polyacetylene is illustrated in the following figures.


polyene
+e-
polaron
+e-
Bipolaron
Soliton
pair

POLY(SULPHUR NITRIDE)

$(SN)_x$

This polymer has remarkable properties , including its metallic (gold) appearance and its metal level electrical conductivity. .

The conductivity lower than that of mercury or Bismuth. ($1x10^4$ $ohm^{-1}cm^{-1}$) .

When cooled at 0.3 k the material undergoes a change to a superconductor at which there is no resistance to electrical flow.

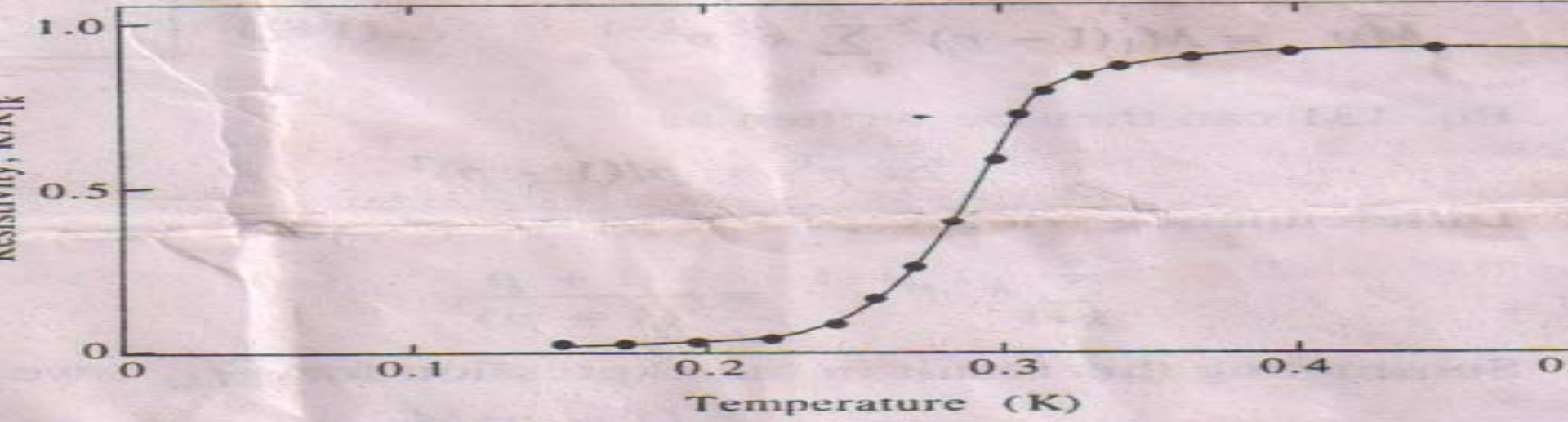


Fig. 6. $(SN)_x$ undergoes a change from a metallic conductor to a superconductor as it is cooled below 0·3 K.

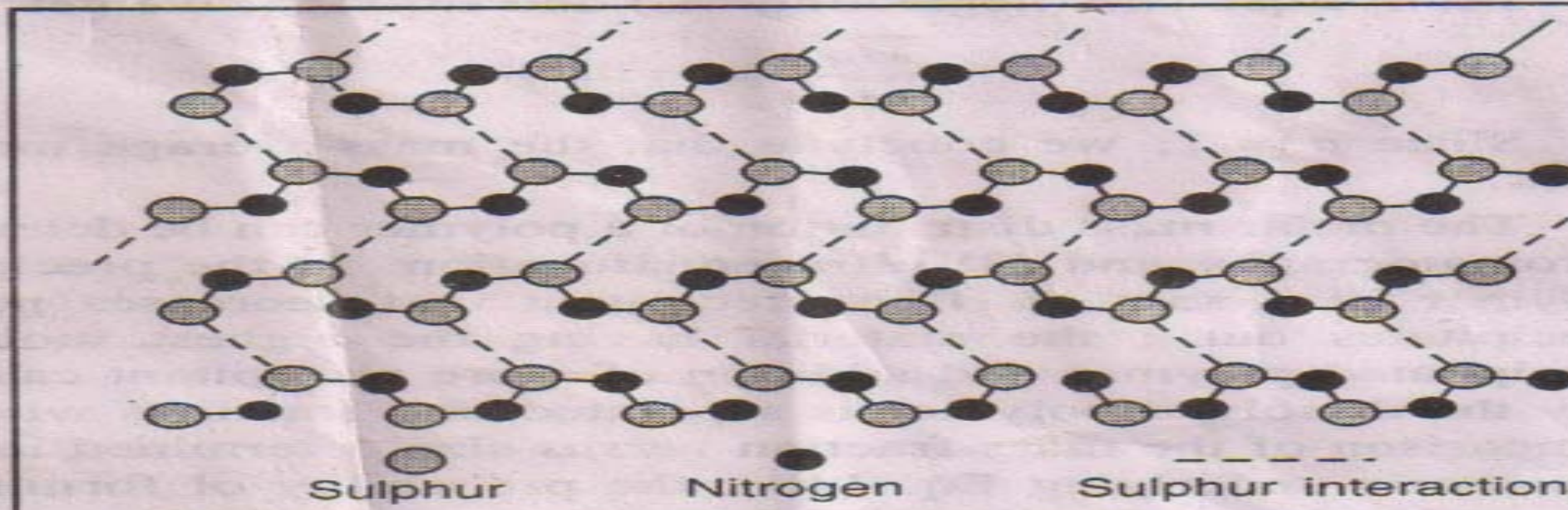


Fig. 2. Packing of the $(SN)_x$ chains in a crystalline matrix.

The superconductivity is anisotropic.

The electrical properties can be explained in terms of polymer structure.

Individual chains occupy cis-trans planar conformation with S-N bond lengths. Via delocalized half filled pi orbitals.

Electronic transmission could occur via orbital overlaps between S-S , N-N, or S-N pairs on adjacent chains.

These explanations neglect a complication delocalized skeletal system so called 'Peierls distortion'.

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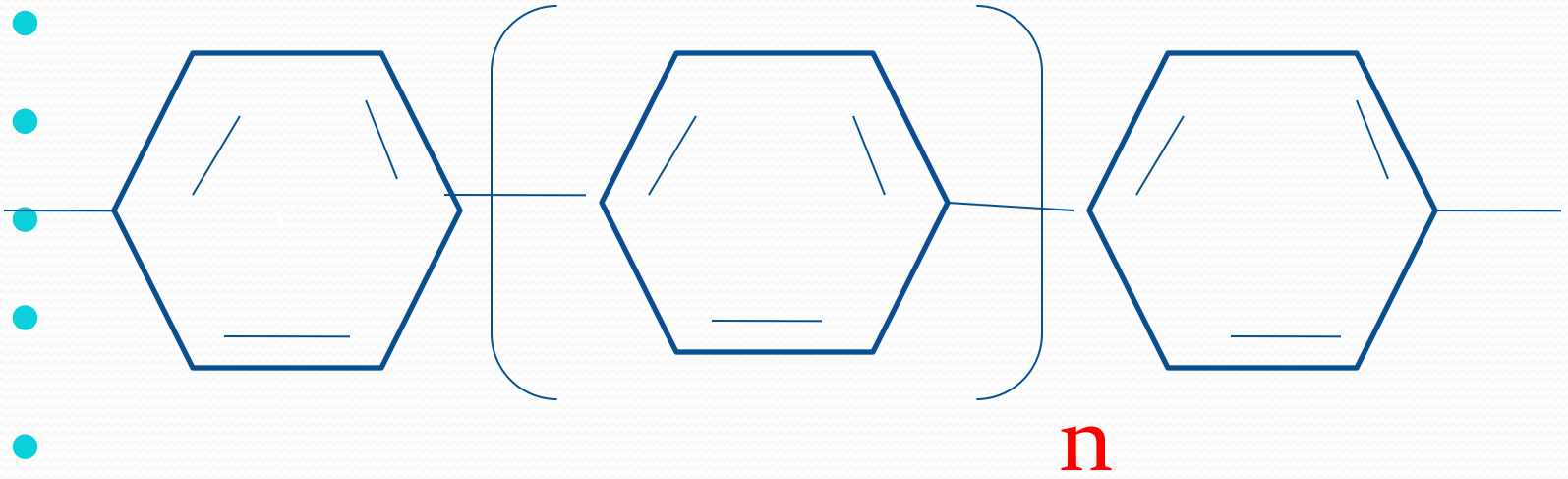
- **Poly (paraphenylenes)**

- Poly (para phenylenes) whose structure is shown belows.



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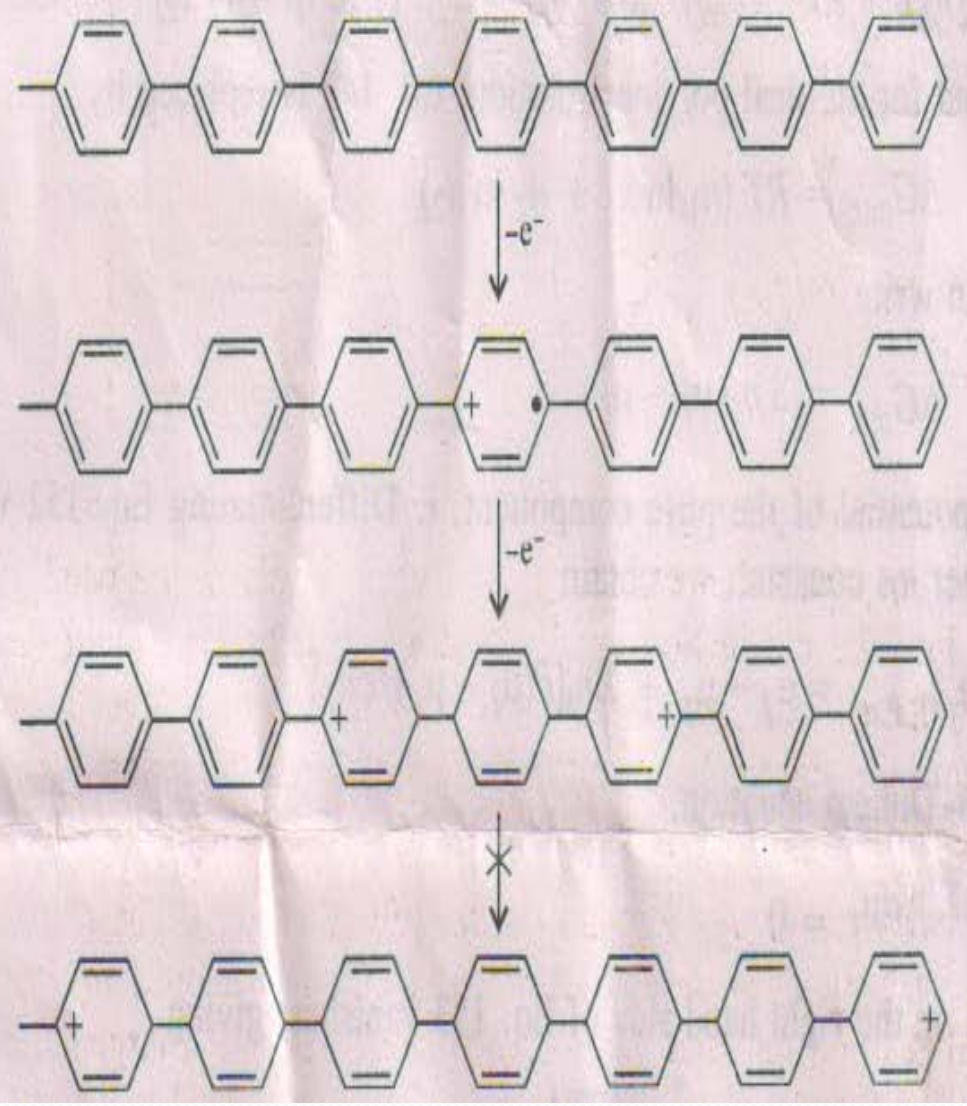
- Short chain polyphenylenes are insoluble in most solvents and have very high melting points.
- Thus during a synthesis process , use oligomers (low molar mass polymers).
- It has been considered a good candidate for electrical conductivity delocalized pi electron structure .

The conductivity of undoped oligophenylenes is low (10 ohm $^{-1}$ cm$^{-1)}$ doping with AsF5 = (5x 10^2 ohm $^{-1}$ cm^{-1})

It has been proposed that reduction or oxidation generates a radical anion or radical cation (polaron)

And the further reduction or oxidation gives a bipolaron .

band.



THANK YOU