Published on: 1st May 2011

ELECTRICAL CONDUCTIVITY OF POLY AZOPHENYLENES

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ABSTRACT:

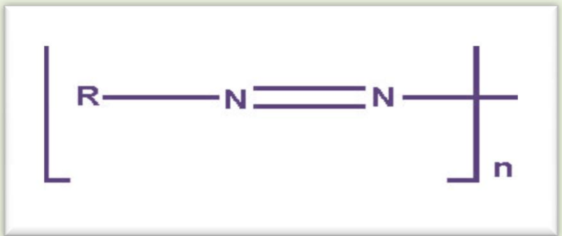
The Polyazophenylenes (PAP 1-6) were prepared by reported method. The PAP samples were purified and ground for the measurement of electrical conductivity. The electrical conductivity of PAP was measure in temperature range of 380°K to 523°K. All the PAP was found as semiconductors. The result of electrical conductivity of PAP reveals that the electrical conductivity PAP samples depend on the nature of the polymer structure.

KEY WORDS: Polyazophenylenes, Electrical conductivity

INTRODUCTION:

In recent years the study of the electrical properties of organic polymers has made much progress. Several polymers modified by doping or by metal atoms, are classified as organic semiconductors (Berlin *et al.*,1960). Well known polymers are Polyacettylene, Poly-p-phenylene, Polypyrrole, Polyaniline etc.(Aldissi,1999;Bredas *et a.l*,1990; Chandrasekhar,1999; Goodings,1977; Kaynak,1998 and Nalwa,1997). Most of conducting polymers are of conjugated chain systems. Some dopents enhanced the conductivity of polymers(Angelo *et al.*,1967; Bailey *et al.*,1971; Horowitz *et al.*,1964 and Snow,1982). One such area in which the polymer say, Polyazophrnylenes having conjugated system are reported (Majmudar *et al.*,1991) but their conducting properties has not been studied. Hence the present paper describes the study of electrical conductivity Polyazophenylenes having general structure.

Where R = ary1 ring



Polyazophenylenes(PAP)

MATERIALS & METHODS:

EXPERIMENTAL

All polyazophenylenes shown in Table 2 were prepared according to method reported (Majmudar *et al.*,1991) . All other chemicals used were of laboratory grade.

ELECTRICAL CONDUCTIVITY MEASUREMENT

For the electrical conductivity measurements, a pallet of the polymer under study was prepared by pressing a finely powdered and dried sample under hydrostatic pressure at 20,000 psi for 2 minutes. A uniform thin layer of silver paste was applied on both the sides of the pallet, providing electrical contacts. Average diameter and thickness of each pallet were measured. The pallet was firmly pressed between two circular metal disks functioning as electrodes. The other ends of electrodes were passed through the pallet holder for connections. The entire assembly was placed in a furnace. It was heated at a $1^{o}C$ / min. The resistance of pallet was measured by Hewleth Packrd resistometer. The specific conductivity (σ) of the sample in the pallet was estimated by the usual relation from the knowledge of the resistance of the pallet and its dimensions. The electrical conductivity (σ) of the polymer sample was measured at temperatures between $308^{o}K$ and $523^{o}K$. The plots of the log σ versus 1/T were made to examine weather variation of the σ with temperature follows the experimental relation.

$$\sigma = \sigma_o e^{-E/RT}$$

RESULT AND DISCUSSION:

Through the analytical parameter of PAP are reported (Majmudar *et al.*,1991). But for the sake of convenience all the PAP were characterized. The analytical data (C-H-N, IR-spectra studies, TGA etc.) not shown here are almost agreed with the data reported (Majmudar *et al.*,1991). Examination of result presented in table 2 reveals that the electrical conductivity of all PAP from 10^{-11} to 10^{-8} Ω^{-1} cm^{-1} at $25^{o}C$. Thus the conductivity of all PAP increases with increases with temperature, slowly initially and very rapidly after some point between $400^{o}K$ to $500^{o}K$ depending upon the nature of polymer. The plots of log σ versus 1/T for all the samples are found to be linear in the higher temperature range, the temperature at which this occure designated as the break temperature shown in figure 1. The change in the value of σ beyond this break temperature and in the high temerature range is compratively faster. Below the break temperature the change in the value of log σ versus 1/T is slow and regular. In all case value of σ increses and then decreses and further increses with increses in temperature. Usualy the break point is associated with thermal degradation of the sample. But the earkier investigation of thermal stability of the present polymers (Majmudar *et al.*,1991) showed no softening or melting properties at this temperature or indeed over the entire temperature range in which the present study was carried out. It has been established from the conductivity measurment on a new sample are not reproducible. The first measurments give conductivity curves which lies concicderably below and are steeper than the stabilized curve. This indicates that an orientation effect occurs when an external field is applied and that the curves below the break temperature perhaps are determined by parameters of secondary interest, such as grain size of the sample pallet are related to the fact that the sample was polycrystalline. Therefore it may be difficult to draw conclusions concerning the properties of the polymers from these initial parts of the curves. However the conductivity curves at temperature above the break temperature are reproducible for initial measurment on a new sample and can therefore be held to be significant for the material. Hence the linear portion of the plot of log σ versus 1/T in the higher temperature range – beyond the break temperature is used for estimation of E and σ_o. The estimated value of E is found to be between 0.90 eV and 1.5 eV depending upon the nature of the polymer. Examination of the results also reveals that over a certain range of temperature and electrical conductivity of PAP is found quit apperntly good due to incorporation of conjugated systems in the structure (Inouse *et al.*,1962). This may be also due to the ioniztion tendency of the salt (Inouse *et al.*,1962) or ions. It is worth nothing that the electrical conductivity of PAP is highly dependent on the nature of polymer structure, the nature of monomer and the size and shape of the macromolecules. In the present cases there would be linear structure of the PAP because the polymer formed through the bifunctional monomers. Here the structure of the diamines are give the information about the electrical properties of each PAP will not permit further conclusion to be drawn. However the results of our electrical conductivity measurments of all of the PAP reveal that they can be ranked as semiconducting materials with high resistance. It was also observed that PAP are found to be batter conductors and this may be due to the existance of higher conjugation in polymer structure. Further work in connection of this work like metal complexes of PAP with doping system under progress.

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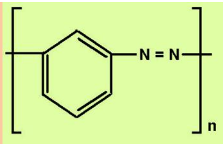
Table 1: Showing Polyazophenylenes

Sr. No.	Polyazophenylenes
1	
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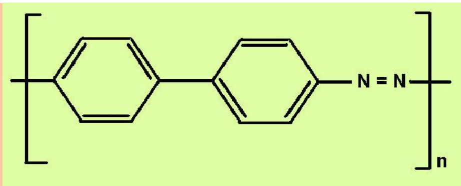
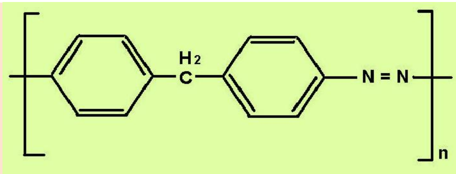
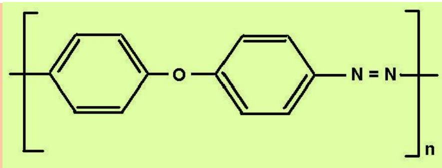
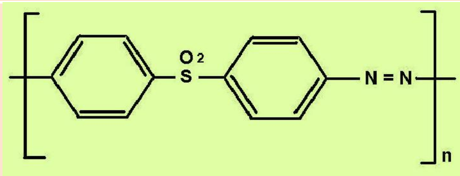
3	
4	
5	
6	

Table 2: Application of log σ = log σ_0 + (-E/2.303 KT) relation to Electrical Conductivity of Polyazophenylenes

PAP Sample	Electrical Conductivity(σ) At 308°K Ω^{-1} cm^{-1}	The break Range(°K)	Intransic Electrical Conductivity (σ) Ω^{-1} cm^{-1}	Activation Energy (E) for Electrical conductivity (eV)
PAP – 1	1.1×10^{-11}	460 – 500	1.9×10^{-4}	1.20
PAP – 2	1.4×10^{-10}	400 – 440	7.1×10^{-8}	1.40
PAP – 3	1.5×10^{-9}	450 – 490	0.6×10^{-1}	0.90
PAP – 4	7.1×10^{-10}	460 – 500	6.2×10^{-1}	1.33
PAP – 5	6.3×10^{-10}	455 – 500	9.8×10^{-1}	0.89
PAP – 6	3.5×10^{-8}	460 – 500	2.1×10^{-2}	1.20

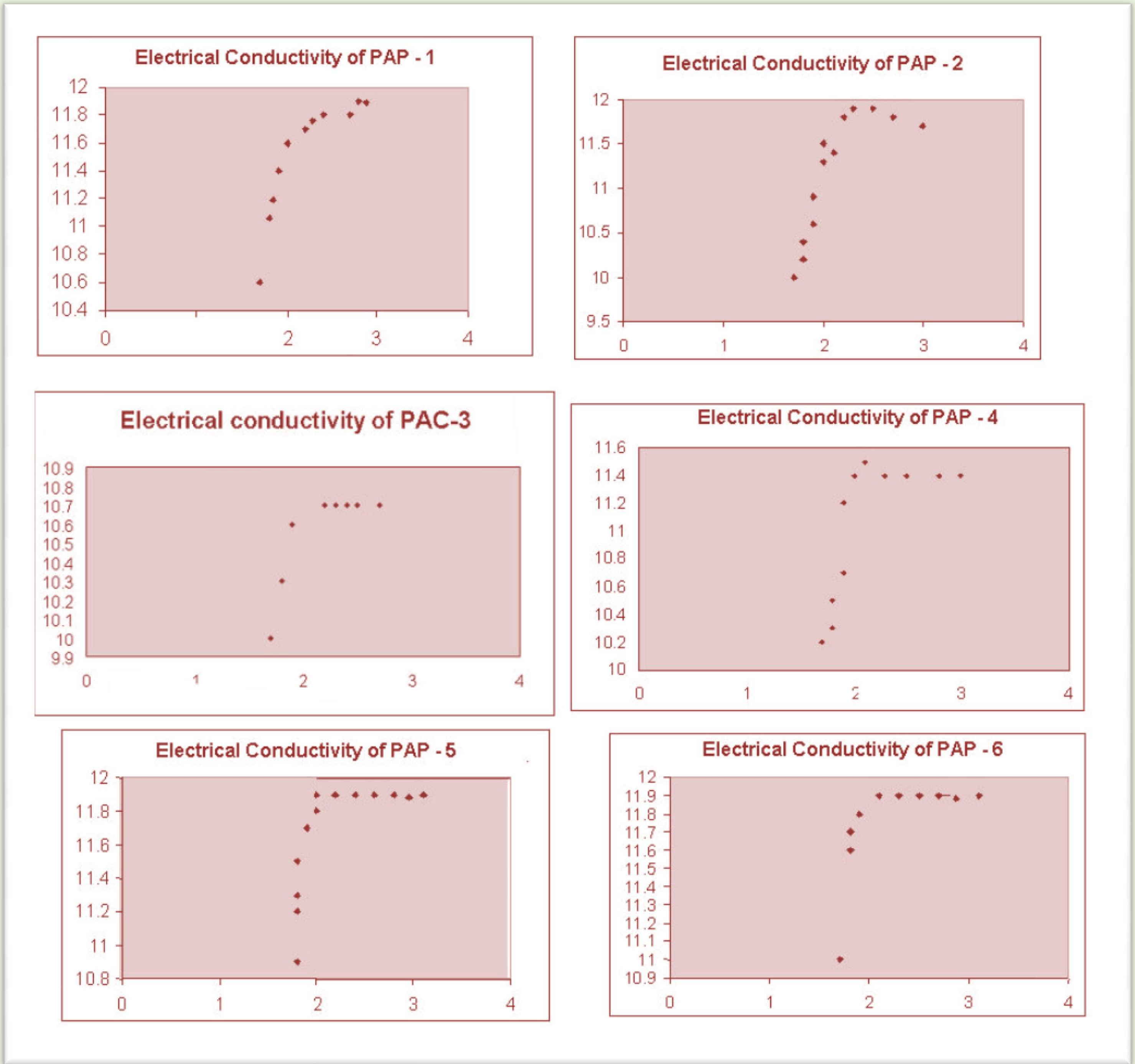


Figure 1: Electrical conductivity of all samples

Where, X-Axis = $1/T \times 10^3\ (^0K)^{-1}$ and Y-Axis = $-\log \sigma$