

SYNTHESIS AND ELECTRONIC TRANSPORT THROUGH POLYARAMID

M.H. CHOHAN*
FARHANA SHAH**
Z. AHMED***

Traditionally organic substances, including organic polymers are insulators. They may be polar or non-polar, but they do not have any free electrons which could act as carriers for the electronic current. Carriers may be produced in insulators by injection at electrodes over a potential barrier, or current may be carried by ion migration within the material. The conductivity of intrinsically insulating polymers can be enhanced by the addition -doping- of electron donors or acceptors. These complexes are of great interest as they offer the promise to combine semiconducting characteristics with the plastic and elastic properties of organic polymers which could lead to some realistic attainment of the intriguing prospects.

Current-voltage characteristics of insulating films have become an important tool for the investigation of electron transport mechanism in such films. Many workers (1-5) have studied the conduction mechanism through insulating films and found that currents flow depend upon the thickness, interface barrier heights, temperature and the nature of contact of the insulator with electrode metals.

We have recently made a study of the possible electron transport through polyaramid. This Polymer has been synthesized by reacting phenylene diamines with terephthaloyl chloride at -30°C in dimethyl acetamide. The temperature of the reaction mixture was slowly raised to room temperature and kept for 24 hours with constant stirring so as to have polymerization reaction completed.

Viscosity of the polymer was then measured by dissolving 0.500 g of the polymer in 100 ml of dimethyl acetamide at 30°C and it was found to be 2.4. This reac-

tion mixture was used to prepare ceramers. A known amount of tetramethoxy silane in dimethyl acetamide was added to the polymer solution. The mixture was stirred for 8 hours. A stoichiometric amount of water containing 0.5% HCl was added as catalyst. The resulting homogeneous mixture was stirred for 8 hours at 45°C . This solution was then cast in petri dishes. The films obtained were further dried under vacuum for 24 hours at 50°C and kept in desiccator until characterized.

Films of 0.052 cm thick and 1 cm in diameter were used for the experimental study. Aluminum electrodes of circular shape having a diameter of 0.548 cm were deposited in the centre of the two sides of the films, in vacuum. Arrangement for the measurements of currents at various voltages and temperatures is described elsewhere (6).

The I-V characteristics shown in Figure 1 indicate almost an ohmic relationship between voltage and current. However as the temperature decreases, the increase in current with voltage slows down. At room temperature, the material acts like an insulator. Figure 2 shows the curves of $\ln I$ vs. $V^{1/2}$ which are plotted from the same data as used in Figure 1. An exponential increase in current giving negative slopes suggests either Schottky or Poole Frankel type conduction mechanism to be operative.

Figure 3 shows an average plot of $\ln I_0$ vs (KT^{-1}) for determining the activation energy, using a well known Arrhenius equation.

The slopes of the graph indicate three regions with activation energy values ranging from 0.15 eV to 0.19 eV. Small values of activation energy confirm the electronic conduction rather than ionic conduction and that different values of activation energy suggest the existence of the trapping levels. Dominance of Poole Frankel conduction mechanism is concluded.

Polyaramid's electrical conductivity can be increased by using some catalyst and keeping it in an atmosphere of polypyrrole vapors. Such work is under progress.

*From Department of Electronics, Quaid-i-Azam University, Islamabad-Pakistan.

**From Department of Computer Science, Quaid-i-Azam University, Islamabad-Pakistan.

***From Department of Chemistry, Quaid-i-Azam University, Islamabad-Pakistan.

Figure 1: Current vs. voltage at different temperatures.

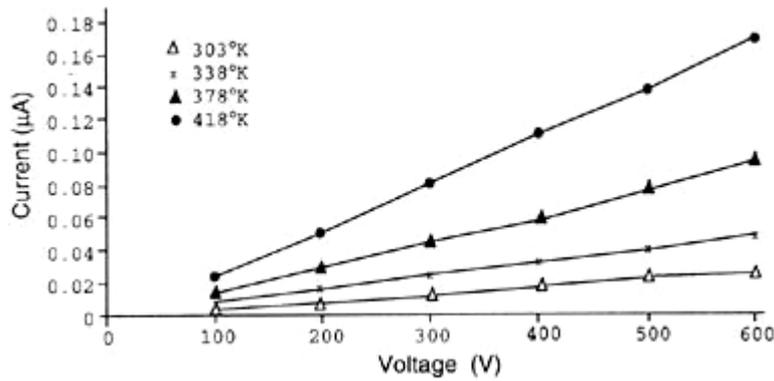


Figure 2: LnI vs V^{1/2} different temperatures.

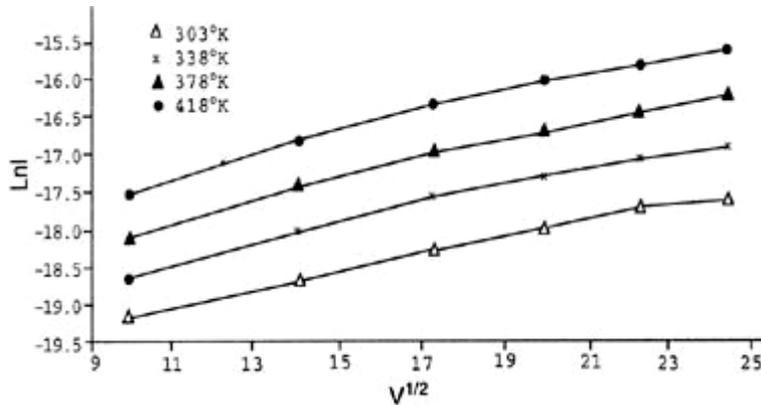
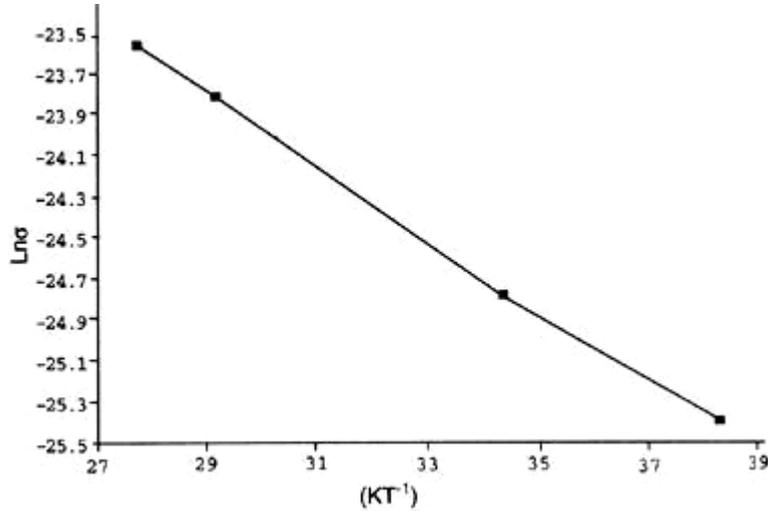


Figure 3: Lnσ vs KT⁻¹.



REFERENCES

1. Hartman TE : *J Appl Phys* 35, 3283, 1964.
2. Hartman TE and Chivian JS : *Phys Rev*, 134; A1094, 1964.
3. Pollack SR and Morris CE : *J Appl Phys*, 35;1503, 1964.
4. Simmons JG : *J Appl Phys*, 34;793, 1963.
5. Meyerhoffer D and Ochs SA : *J Appl Phys* 34;2535, 1963.

6. Chohan MH et. al. : *Mod Phys Lett*, B5;29, 1991.

Correspondence:
 M. H. Chohan
 Department of Electronics,
 Quaid-i-Azam University,
 Islamabad, PAKISTAN.