Conduction mechanism of poly (P-Aminobenzaldehyde) terminated by phenylene diamine doped with $Na_2[Fe(CN)_5.NO].2H_2O$

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ISSN –1817 –2695

(Received 9/1/2007 , Accepted 30/4/2007)

Abstract

The electrical properties of poly (P-Aminobenzaldehyde) terminated by pheneylene diamine doped with $Na_2[Fe(CN)_5.NO].2H_2O$ films prepared by cast method have been investigated.

The (Current – Voltage) and (Conductivity – temperature) relationships are measured in the voltage and temperature ranges (5-120) V and (288 -348) K respectively.

The resistance of the doped films is found to have a negative thermal coefficient. The activation energy at temperature (288 -348)K about (0.175)eV is found from the ohmic region of the dark (current – voltage) characteristic. The conductivity at room temperature was equal to 2.5×10^{-14} ($S.cm^{-1}$).

The deviation from ohm's law has been analysed in term of the available conduction theories. Hopping conduction mechanism was concluded to be the most probable as interpreting the behavior of charge transport that supplied by injector electrodes.

Key words: Electrical properties, D.C. conductivity, Hopping conduction mechanism

Introduction

Polymeric materials are well known as insulating materials (as an inherent property) and are used widely for many industrial applications [(1)]. Even conductivity polymers in their intrinsic nature are insulators and can be transferred to conductors by suitable doping with strong acceptor or donor agents [(2)].

A great efforts are consumed to control the electrical conductive properties of polymers in an analogous manner to semiconductors taking into account the possibility of combining the desirable physical properties with electronic functions[(3)]. The mechanism of the electrical conduction in polymers is not fully understood and usually characterised as a complex process depending not only charge transfer in the bulk, but also across the polymer – metal interface at the electrode [(4)].

Ionic conduction mechanism was found in LPC series – $LiCF_3CO_3$ complex[(5)], Plasticized poly(methylmethacrylate)/poly(vinylidene fluoride) [PMMA/PVdF] blend polymer electrolytes[(6)], $LiCLO_4$/PEO/PCL Ternary Blends[(7)] and single crystals of $KTiOPO_4$[(8)].

Space charge limited current mechanism (SCLC) is observed in several organic polymers such as polyethylene[(9)] and poly alpha naphthyle acrylate (PNA) doped with Lithium chloride (LiCl)[(10)].

Tunneling conduction mechanism is the dominant one in the very thin films such that thickness ~ 35Å [(11)]. The conduction mechanism type Schottky is found in poly(pyromellitic-1,2 Naphthylene diimide) [PPND][(12)], Fe – doped $BaTiO_3$[(13)] and PPAB terminated by phenylene diamine[(14)]. The conduction mechanism type hopping was observed in (4-Bromo Isatin – $4B_1$) films[(15)], (PPAB – DDS) films[(4)], poly (phthalocyanine) (PC)[(16)], Benzidine terminated poly (P-Aminobenzaldoxime) thin films[(17)] and Amorphous Heavy – Hydrogenated silicon.[(18)]

In the present study the electrical properties of poly (P-Aminoben zaldehyde) terminated by phenylene diamine doped with $Na_2[Fe(CN)_5.NO].2H_2O$ have been investigated based on measuring (current – voltage) and (conductivity – temperature) characteristics. The conduction mechanism in the polymer film has been identified.