D.C. Electrical Conductivity and Magnetic Susceptibility of Iodine Doped Polythiophene

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Abstract - Polythiophene was chemically synthesized, undoped using aqueous ammonia and then re-doped with iodine. FTIR spectra confirm iodine doping. The XRD analysis shows the structural modification due to doping. Electrical conductivity (σ) measurements of undoped and doped samples were carried out using two probe technique. Both samples shows semi conducting nature. After doping electrical conductivity increases by eight orders of magnitude at 318 K. Magnetic susceptibility (χ) measurements were carried out using Guoy's method, both samples show diamagnetic nature. The results of electrical conductivity and magnetic susceptibility measurements indicate that the predominant charge carriers, in the iodine doped polythiophene, are bipolarons.

Polythiophene is an important class of conjugated polymers, which finds applications in electronics and molecular electronics. Hence it needs to be studied from electrical conductivity point of view by doping with different dopants so that conductivity can be enhanced.

The polythiophene was chemically prepared from 2,5-dibromothiophene by debromination with magnesium, catalyzed by nickel chloride [1]. The synthesized polymer was undoped using aqueous ammonia and then re-doped with iodine by exposing undoped sample to iodine vapors. Characterization of both undoped and doped samples was carried out using FTIR and XRD technique. Analysis of FTIR spectra shows that iodine forms complex with polymer and gets doped. The XRD analysis has been used determine the structural modifications due to doping and to calculate crystallinity of the sample [2].

Electrical conductivity (σ) measurements were carried out using two probe technique at various temperatures (T) in the range from 306K to 373K. I-V characteristic shows ohmic behavior. The log σ versus 1/T graphs for both samples have been plotted (figure 1) and it is observed that both polythiophene samples have semi conducting nature. In the present work, it has been observed that after iodine doping, the electrical conductivity of polythiophene increases by eight order of magnitude at 318K, In order to decide about the nature of charge carriers' magnetic susceptibility(χ) measurements of both samples were carried out using Guoy's method at various temperatures in the range 300K to 500K. Susceptibility measurements revealed that undoped as well as doped sample is completely diamagnetic in nature (figure 2).
The results of electrical conductivity and magnetic susceptibility measurements indicate that the predominant charge carriers, in the iodine doped polythiophene, are bipolarons.

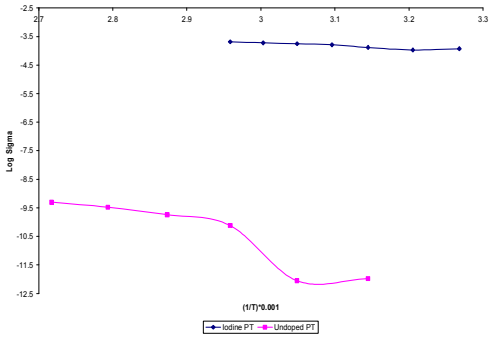

Figure 1: log σ Vs 1/T for undoped and iodine doped sample at 50 V/cm field

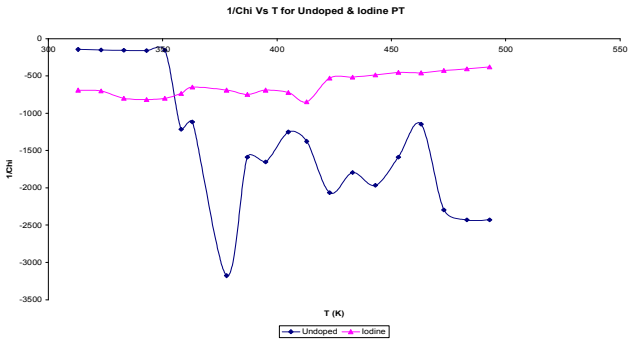

Figure 2: 1/χ Vs T for undoped and iodine doped sample at 100 Gauss

Reference:

1. T. Yamamoto, K. Sanechika, A. Yamamoto, J. Polym. Sci., Polym. Lett. Ed. 18, (1980) 9.
2. B.R. Manjunath, A. Venkataraman and Thomas Stephen, J. Appl., Polym. Sci., 17, (1973) 1091.