Electrical Properties of Doped Polyblends

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Abstract

Thin films of Polystyrene / Poly vinyl chloride (PS/ PVC) doped with Meta Nitro Aniline (MNA) have been prepared by isothermal evaporation technique. In present paper we have discussed D.C. electrical conductivity of MNA doped PS/PVC thermo electret samples. The conductivity values are found to be dependent on dopant in polyblend samples and exhibits Arrhenius behavior in temperature range studied.

Key words: Polystyrene, Polyvinyl chloride, Meta Nitro Aniline, Conductivity, Poly blend.

Introduction

In this century, Polymers are promising materials because of their low cost, easy processability, low weight, easy fabrication in thick and thin film samples etc. One of the most valuable properties of polymer was capacity to inhibit electrical conduction as insulator but now in this new technical era, they have attracting considerable attention as conducting polymers. Due to their easy processability capacity, polymers have become the center of attraction. One can design the material of required properties by blending and reinforcing of polymers. Blending of two biodegrable polymers Poly vinyl alcohol and 2- hydroxyl ethyl cellulose has been studied[1]. Poly blends are mixing of two or more homopolymers and chances of charge trapping in them are much more than in individual homompolymer[2]. Addition of dopant in poly blends is one of the methods used to boost conductivity value. Conductivity of poly blends (PS/PMMA) increases with increasing percentage of iodine as a dopant[3]. In present communication, an attempt is made to study the conductivity of thin films of poly blend are based on addition of dopant Meta Nitro Aniline (MNA). The effect of MNA doped PS: PVC thin film has been analyzed at various temperatures and at different polarizing field.

Material and Methods

In the present study, insulating polymers PS, PVC and dopant MNA are supplied by Reliance group. The percentage ratio of PS + PVC is 50: 50 and 1percentage of MNA is

dissolved in common solvent i.e. cyclohexanone (AR grade). All the films were prepared by isothermal evaporation technique. Electrical conductivity of doped cinnamic acid in PS/ PMMA poly blend thin films which was prepared by using isothermal evaporation technique[4]. A similar procedure was adopted in the present case for preparation of MNA doped PS: PVC samples. For measuring thickness micrometer screw gauge with a L.C. of 0.001 cm (10μm) with an occulometer of L.C. 13μm and 3.3 μm at the magnification of 1:10 and 1: 100 respectively was used[3]. The films of measured thickness were coated by using quick drying and highly conducting silver paint supplied by Eltecks Corporation, Bangalore. These coated samples were sandwiched between two brass electrode of sample holder and form metal – insulator – metal (M – I – M) system which was placed in furnace[5]. The thermo electrets of samples were prepared by applying polarizing field (6, 12, 15, 18 and 24 KV/cm) through constant D.C. supply. The conductivity of samples was determined by calculating D.C. resistance in temperature range (30 – 130 ^{0}C).

Results and Discussion:

Fig 1 and Fig. 2 show the variation of D.C. electrical conductivity (σ) for undoped and MNA doped thin films at temperature range (30 – 130 ^{0}C) respectively. The curve shows that conductivity (σ) increases with increasing temperature.

For undoped sample of PS: PVC poly blend, the D.C. electrical conductivity value shows very small change with respect to temperature. But as the applied voltage increases conductivity increases slowly. In MNA doped thin films curve conductivity increases with respect to increase of temperature as well as applied electric effect. Our experimental study revealed that electrical conductivity increases with the increase in temperature approximately by the following equation

$$\sigma = \sigma_0 \exp(-E_0/KT),$$

where σ is conductivity, σ_0 is pre – exponential factor, E_0 is activation energy of conduction and K is Boltzmann's constant. The activation energy was calculated from the graph of log σ vs $10^3/T$ plot.

Addition of Meta Nitro Aniline increases the conductivity of polymer blend considerably (Fig. 2). Initially increase in conductivity at low temperature shows zig – zag path may be due to the injection of charge carrier directively from the electrodes. The filler is very sensitive to temperature. There are two phases i.e polymer phase and filler phase in poly blend sample. They formed hetrocharges and discharge by dipole disorientation is thermally activated and so can be speeded up by heating. The increase in conductivity at high temperature may be due to softening,

the injected charge carrier can move more easily into the volume of the poly blend sample resulting large current and increase in conductivity at higher temperature.

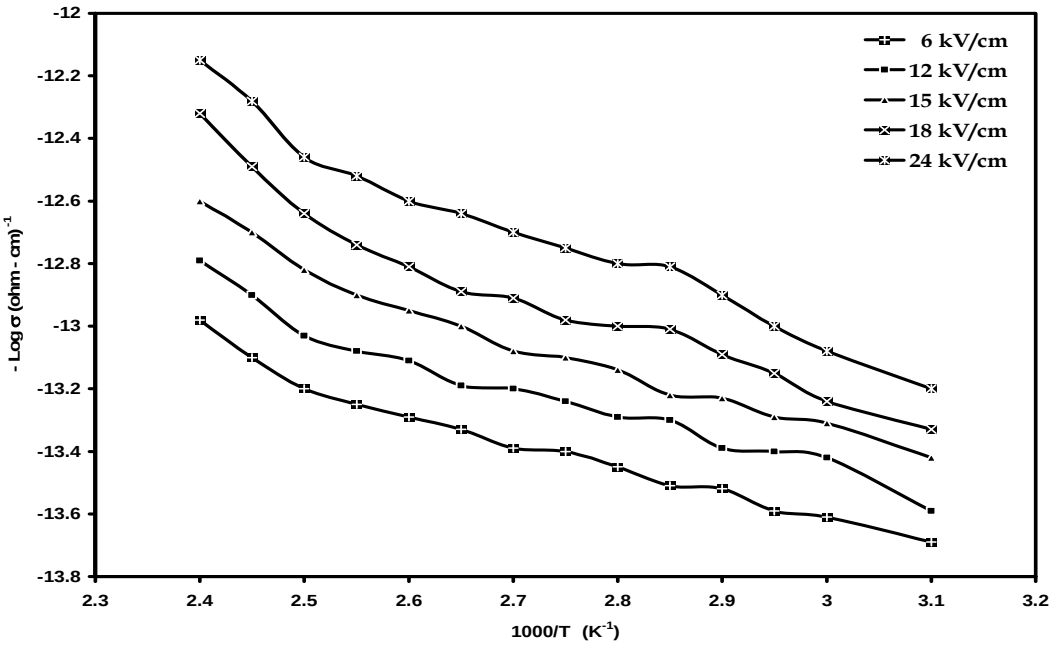

Figure 1

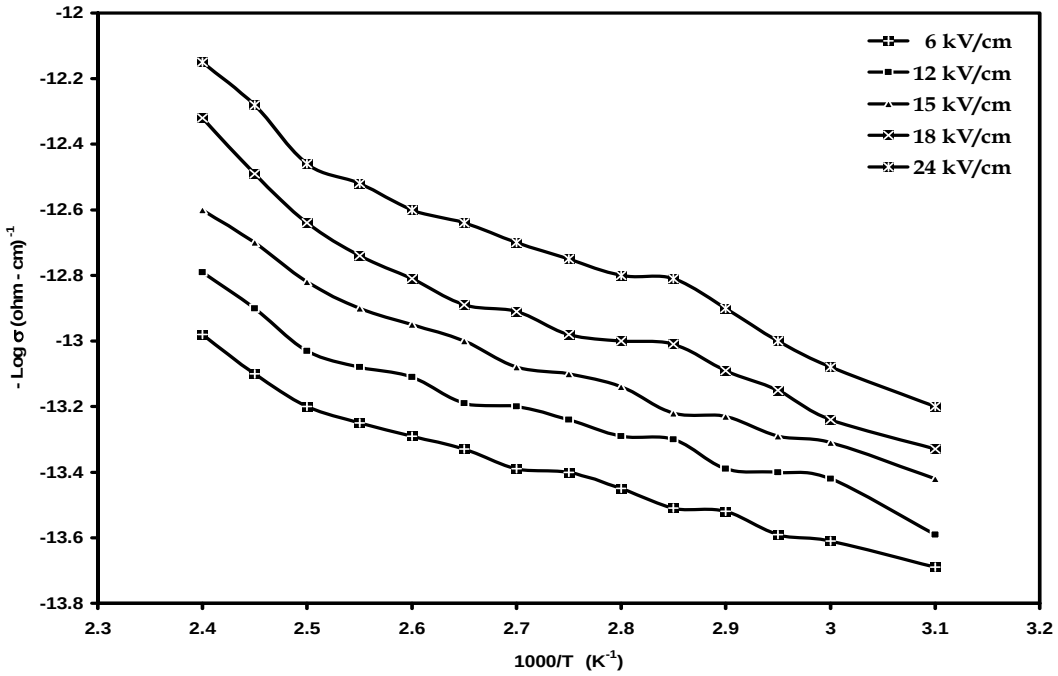

Figure 2

The main constituents of the poly blends are PS and PVC, which are amorphous in nature. These polymeric materials require excitation for transport of charge carriers[3]. In polymeric samples, various types of molecular relaxations are possible. The only motions possible at low temperature are local movement of molecular groups, e.g. rotation of side groups or internal motion within the side groups. Hence at low temperature there may be slight decrease and then increase in conductivity of thermo - electrets of PS: PVC poly blend.

The MNA dopant has electron attracting group which attracts electron from phenyl group of PS which is basically electron donor. This enhances the possibility of formation of charge transfer (CT) complex in PS: PVC poly blend. These dopant molecules starts bringing the gap separates between two localized states and lower the potential barrier enhances the transfer of charge between the two localized states.

Conductivity (σ) is also influenced by an injection of charge carriers from electrodes. These injected charge carriers with-in the material itself increases conductivity. The introduction of localized states due to doping facilitates the injection of charge carriers from the electrode as injection takes place via localized states.

Conclusion:

In PS: PVC poly blend conductivity increases with

i) Increase in temperature
ii) Increase in electric field and
iii) Addition of dopant.

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