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Optical, Electrical and Structural Characterization of MNA Doped PS: PVS Polyblends Thin Film

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Abstract: *PS: PVC polyblend thin films doped with various concentration of Meta nitro aniline (MNA) (0.01 %, 0.05 %, 0.1 %, 0.5 %, 1 %, and 5 %) were synthesized by using the method of solution evaporation technique. The amorphous nature of doped thin film samples was confirmed by the X – Ray diffraction pattern which shows the decrease in intensity with the increase in the concentration of dopant. UV - vis spectra show increase in the absorption band with the increase percentage of dopant.The electrical conductivity study shows that the doping of MNA into the PS: PVC polymer blend thin film enhances its ionic conductivity with increase in temperature. This improved properties in the doped polyblend thin films are due to the increase in mobility of charge carriers.*

Keywords: PS, PVS, MNA Doped Polyblends, Optical Band Gap Energy, Electrical Conductivity

I. Introduction

The blending process in polymers has gained a lot of attention since it allows to prepare the new material of desired properties having specific applications [[1], [2], [3], [4], [5]]. Thus, blending is an effective process to prepare flexible polymeric compound with a high degree of miscibility. The Polystyrene (PS) is a transparent polymer widely used in the cell culture applications because of its non-toxicity and high transparency [6]. The poly vinyl chloride (PVC) is a thermoplastic polymer is chosen as a partner in the blending process which has valuable properties, wide applications like high chemical resistance, barrier properties etc[[7], [8], [9]].This thermoplastic-hydrophobic polymer is extensively used in various industrial applications because of its low cost, good flexibility, high electrical insulation, and excellent chemical/mechanical stability as a result of the dipole-dipole interaction between the Cl and H atoms [[8], [9], [10]]. But, due to few properties like heat-softening temperatures, low thermal stability in processing and poor toughness are the major obstacles for the PVC to increase its application. Furthermore, PVC is an appropriate nominee in biomedical applications such as surgical dressings, tubes oxygenators, and blood bags since the effect of ascertained stabilizing that exerted on the red cells of blood by this material [[7],[8],[11]]. Thus, this polymer is blended with some other polymers [[7], [12]]. Thus, PS and PVC is undoubtedly important for health care applications [[13],[14]]. The PVC and PS polymers are the most frequently used synthetic polymeric materials in engineering medical devices and food packaging [[12],[15]]. Thus, these polyblends exhibit a broad range of excellent properties for applications in business equipment and computers, the automotive industry, electronics, telecommunications, electrical insulation, and many other industries [16].

Polymer blend/ polyblend has induced a lot of interest in industrial applications because blending process allows one to establish tailored properties in materials that are superior compared to that of each individual component polymer [[17], [18]],

The presented work aims to shade further insight about the new characteristics and applications of the prepared polymer blend thin film sample from MNA doped PS: PVC polyblends.

II. Material and Methods

2.1 Materials and Sample Preparation

Polystyrene (PS) and Poly vinyl chloride (PVC) was supplied by Reliance Industries, Mumbai. Meta Nitro Aniline

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(MNA) was supplied by New Modern Chemical Corporation, Mumbai. The thin films of undoped (PS + PVC) (50% PS + 50% PVC) and MNA doped (PS + PVC) were prepared in the laboratory by weight percentage method using an electronic mono pan balance (Adiardutt - 180) having an accuracy of 0.0001 g. The percentage ratio of PS + PVC is 50: 50 and different weight percentage (0.01 %, 0.05 %, 0.1 %, 0.5 %, 1 %, 5 %) of MNA is dissolved in common solvent i.e., cyclohexanone (A R Grade).

All thin films were prepared by isothermal evaporation technique [19]. These films were subjected to 12 hrs. heat at constant temperature of 40 0 C and for another 12 hrs. at room temperature to remove traces of solvent. The resultant specimens were used for electrical studies. The thickness of polyblend samples were measured by micro meter screw guage with a least count of 0.001cm. But for greater accuracy a compound microscope in conjunction with an occulometer having least counts 15.38 µm at the magnification of 1:100 was used [20]. The thickness of all samples was kept constant and it is of the order of ~46.14 µm. For good ohmic contact, both sides of thin films were coated by quick drying conductive silver paint supplied by Eltecks Corporation, Bangalore.

Metal – polymer – Metal sandwich structure was made by placing the coated film in between circular brass electrode. The sample holder having Metal – Polymer – Metal sandwich structure was placed in a furnace and heated up to the poling temperature. The sample was allowed to remain at that temperature for about 30 min. then electric field of (6 KV/cm) strength was applied for 1 hr. at poling temperature. The sample was allowed to cool down at room temperature in the presence of electric field. Total time of polarization was adjusted to be 2 hrs. in each sample. At room temperature the sample was short circuited for 20 min. to remove stray charges. The electrets were prepared at 6KV/ cm D.C. polarizing field.

Experimental thin film samples of MNA doped PS: PVC polyblend were characterized by X-ray diffraction with Powder method by Philips PW 1710 from Sophisticated Analytical Instrumentation Facility (SAIF), Punjab University, Chandigarh and intensity vs. 2θ curves techniques is used to study the nature of the samples. In the present study optical characterization was done through thin films from Hitachi 330 UV-VIS Spectrophotometer, Dept. of Physics, Pune University, Pune to study the absorption band in the thin film samples. The D.C. electric conductivity was measured by determine the resistance of a sample with in a range of 303 0 K – 403 0 K at a rate of 2 0 /min. The measurement of voltage drops across high resistance was taken on digital multi - meter (Systronics, 435) having accuracy of ±1mV^2.

III. RESULT

3.1 X–Ray Diffraction

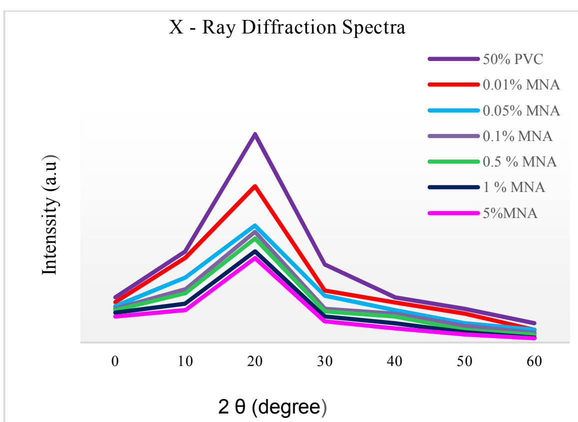

Figure 1: X – Ray diffraction spectra of PS: PVC and MNA doped PS: PVC polyblends

X – Ray diffraction spectra is used to analyse the crystalline nature of the polymeric sample. Figure 1 shows the XRD pattern of undoped and MNA doped thin films. From the diffraction spectra, a peak was observed at 20 degrees and this reflects the semi – crystalline nature of the sample [21].

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From the spectra, it is observed that intensity decreases as the percentage of dopant increases. This revels that the degree of crystalline nature decreases by increasing the percentage of dopant in the polyblend sample. Thus, polyblends samples are amorphous in nature. This attributes the strong interaction between dopant and PS: PVC polyblends, which implicit the increase in amorphous nature of the sample.

3.2 UV Spectra

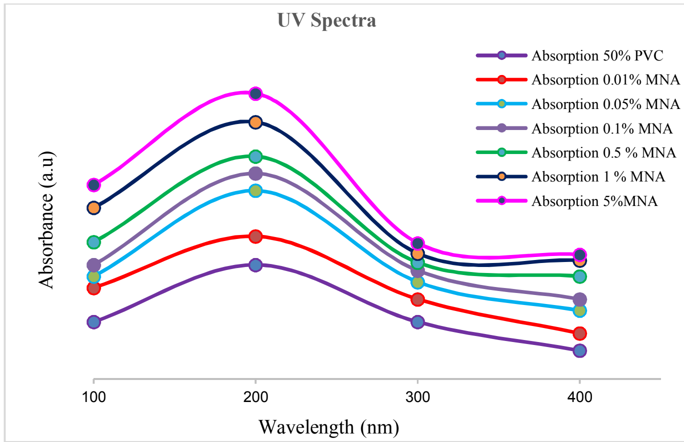

Figure 2: Ultra Violet absorption spectra of PS: PVC and MNA doped PS: PVC polyblends

UV absorption spectra of undoped and MNA doped thin films are shown in Fig 2. Spectra reflects that the absorption is due to the presence of excitation of electrons from the valence band to the conduction band. These excitation of electrons helps in determining the value of band gap energy of the sample. Thus, from UV spectra we review that as dopant increase the absorption of the polymer blend sample increases.

3.3 D. C Electrical Conductivity

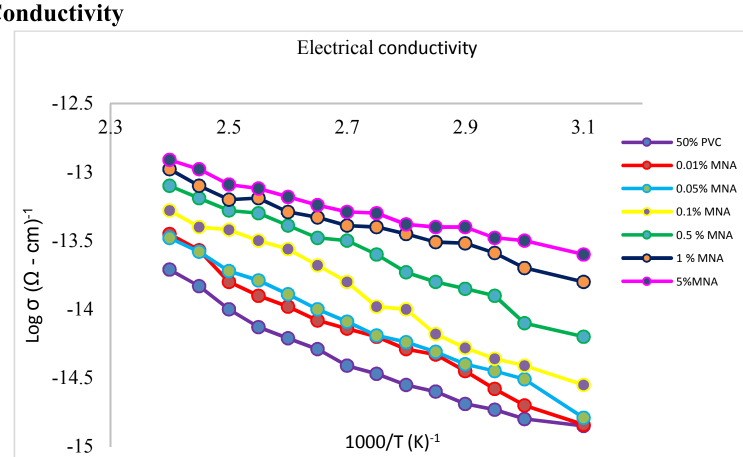

Figure 3: Variation of D.C. electrical conductivity (σ) of PS: PVC and MNA doped PS: PVC polyblends

The D.C electrical conductivity thermograms which are plotted between log of thermally stimulated discharge conductivity σ (ohm - cm)-1 and temperature (103/T) at constant polarizing fields (6KV/cm).

Fig 3. shows the conductivity graph between undoped and MNA doped polyblend thin films at 6KV/cm polarizing field remains in the insulating region. Thermogram shows slight decrease in conductivity at low temperature region and thencontinuousincreaseinconductivityisobservedupto4030K.Ourstudyrevealsthat d.c. electrical conductivity increases due to increase in temperature approximately follows the equation

$$\sigma = \sigma_0 \exp \frac{-E_0}{KT}$$

Where σ is conductivity, σ_0 the pre-exponential factor, E_0 activation energy of conduction and K is Boltzmann's constant.

The main constituents of the Polyblends are PS and PVC, which are amorphous in nature. This insulating polymer material requires extra thermal energy for excitation of charge carriers [[22], [23]]. The slight decrease in electrical conductivity at low temperature may be due to local motion of molecular groups present in the sample. At high temperature due to softening of the sample the injected charge carrier can move easily into the volume of the sample resulting increase in conductivity. Addition of dopant enhances the mobility of ions and polymeric bond rotation results the formation of hetrocharges and discharge by dipole disorientation is thermally activated and so it can be speeded up by increasing temperature. Thus, the existence of mobility of charge carriers in the sample, enhanced the electrical conductivity of polyblend samples by the addition of dopant.[24]

IV. Conclusion

Undoped and MNA doped PS: PVC polyblend thin films were prepared by using isothermal evaporation technique and characterized by different techniques. The structural characterization of thin film samples (undoped and MNA doped) were examined by X – Ray diffraction pattern. The spectra imply the amorphous nature of the sample enhances by the addition of dopant which reflects the decrease in the intensity and broadness of the spectra. UV – Vis spectra reveals that as dopant increase the absorption of the polymer blend sample increases due to which the optical band gap energy shifted to lower energy value. The increase in conductivity due to increasing percentage of dopant as well as increase in temperature explains the increase in amorphous nature of the sample. Thus from this study it reveals that due to addition of dopant the polyblend sample shows sensitivity towards optical and electrical characteristic. Thus, applicability of such material in optical, electrochemical devices is better.

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