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Optical and Conductivity Studies of Polymer Blend Thin Films of PMMA and PEO

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***Abstract*—Poly (methyl methacrylate) (PMMA)/Poly ethylene oxide (PEO) blends of different concentrations were prepared via solution casting technique. The polymer thin films were characterized by Fourier Transform Infrared Spectroscopy (FTIR), Optical absorption, dc electrical conductivity techniques. FTIR studies of polymer thin films indicate complexation / interaction formation between two polymers. The conductivity of the polymer thin films is also found to increase with increase concentration of PEO to PMMA. A systematic decrease in the band gap was revealed from the shift in the absorption towards longer wavelength as studied using UV-visible spectrometer.**

***Keywords*— PMMA, PEO, FTIR, Conductivity, optical absorption, band gap**

I. Introduction

Several approaches have been explored in the past two decades to improve the overall performance of poly (ethylene oxide) (PEO) -based polymer electrolytes [1–4]. However, such highly conductive materials exhibit poor mechanical stability and may give rise to problems such as leakage and short circuits, which are commonly encountered in conventional liquid electrolyte systems [3]. The use of composite polymer electrolytes with inert inorganic or organic fillers could greatly improve the mechanical properties of the pristine PEO electrolyte and extend their thermal stability. Moreover, the reduction in crystallization of the PEO host could to some extent contribute to an increase in the ionic conductivity and even improve the interfacial stability with electrode materials [2].

Polymers have different physical, thermal, electrical and mechanical properties, which depends upon the nature of the polymer. To achieve the required valuable properties, blending is suitable technique, in which two/more polymers uniformly mixed with each other.

The blending process is very attractive because of its versatility, simplicity, inexpensiveness and producing new polymeric materials with modified properties (morphological, thermal, mechanical, electrical or degradation behaviour can be change by a favourable choice of the second component of the blend) without having to synthesize totally new materials. Blending technology has important and valuable applications in various fields of science and engineering [7]. The problem in choosing the polymer blends is the miscibility of the components. Combinations of proton donating and accepting polymers can form inter macromolecular complexes in aqueous or organic media. Poly methyl methacrylate (PMMA) and PEO form one such couple [5,6]. The miscibility behavior of PMMA/PEO blends has been studied on the using of different techniques such as FTIR, Optical absorption, dc electrical conductivity.

II. Experimental Description

A. Starting Materials

The blend solid polymer thin films have been prepared by the solution cast technique. In which main Polymer as Poly(methyl methacrylate)(PMMA) (M.W~15000) and Co Polymer as Poly(ethylene oxide) (PEO) (M.W.2×10^5) have been purchased from Sigma Aldrich. PMMA and PEO were weighed in to different weight percentages and dissolved in THF (Tetra hydro furan).

B. Sample Preparation

PMMA and PEO were mixed each other and dissolved in THF (Tetra hydro furan) and stirred for several hours using a magnetic stirrer at room temperature. Finally the solution was poured into a Teflon Petri dish and evaporated the solvent slowly at ambient temperature. The dried films were removed from the Petri-dish and then were stored in desiccator to prevent from moisture.

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C. Characterization

FTIR Spectroscopy measurements of pure PMMA and PMMA/ PEO blend films were recorded with the help of Spectrophotometer-Series II. Optical absorption data of pure PMMA and PMMA/ PEO blend films were recorded with the help of UV-VIS Spectrometer (LABINDIA UV-3000+ Model). Conductivity of polymer blend thin films have been measured with the help lab made conductivity setup.

III. Results And Discussion

A. FTIR Analysis

FTIR is a useful technique to characterize the organic, inorganic and composite materials [8]. Figure 1. shows room temperature FTIR spectra of pure PMMA, pure PEO and PMMA/PEO polymer blends. From Fig.1 it is observed that with addition of PEO to PMMA shows that the some of the bands found to be shifted and intensities of some of the bands are decreased and some are disappeared. It is clear that the characteristic bands of PMMA appeared at 2911 cm^{-1} (C-H stretching mode), 1333 cm^{-1} (CH_2 deformation), 1254 cm^{-1} (CH rocking), 959 cm^{-1} (trans-CH wagging mode), 833 cm^{-1} (C-Cl stretching mode) and 616 cm^{-1} (Cis –CH waging) are modified or shifted with the addition of PEO Polymer. The found changes in blend films of PMMA/ PEO compared to pure PMMA and PEO indicates the complexation/ miscibility between two polymers PMMA and PEO.

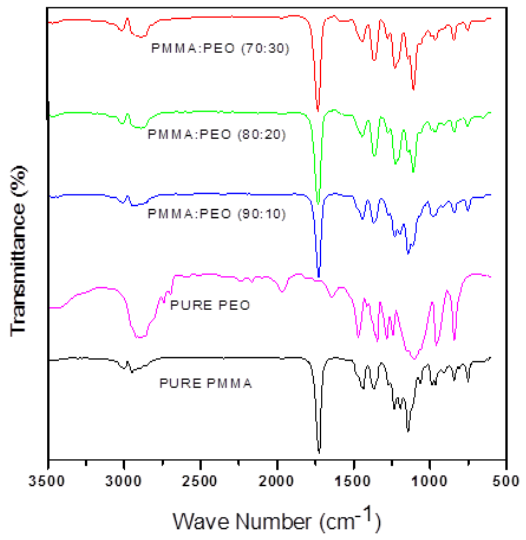

Figure 1. FTIR analysis of Pure PMMA, PEO and their ratios

B. UV Analysis

The optical absorption spectra of pure PMMA and blend films of PMMA and PEO are shown in figure 2. Indirect band gap values of pure PMMA and blend films of PMMA and PEO are listed in Table 1. From the table it is observed that there is a decrease in indirect band gap when concentration of PEO increases to PMMA. It may be due to the formation of complexation/ interaction between two polymers PMMA and PEO.

TABLE I
UV ANALYSIS OF PURE PMMA AND DIFFERENT CONCENTRATIONS OF PMMA AND PEO

Wt.Percentage(%)		Band gap(Eg) eV
PMMA	PEO	
100	0	4.13
90	10	2.79
80	20	2.23
70	30	2.01

C. DC conductivity

The variation of conductivity with temperature for pure PMMA blended with PEO are shown in figure 3. The DC conductivity of polymers depends on the mobility of charge carriers. The conductivity versus Temperature follows Arrhenius behaviour throughout. The conductivity increases with temperature in pure PMMA and in all blends of PMMA+PEO. According to Druger et.al [9,10] blend systems the change of conductivity with temperature is due to segmental motion which results in an increase in the free volume of the system. The increase in free volume facilitates the motion of charge carriers. From the plots it is clear that PMMA+PEO(70:30) has showed highest conductivity which may be due to the optimal composition of PEO with PMMA for high charge transfer.

IV. Conclusion

Synthesized polymer thin films are characterized with FTIR, UV spectrometer and DC conductivity. FTIR studies confirmed that the complex/ blend formation between PMMA and PEO polymer. UV analysis observed that indirect band gap (E_g) decreases when concentration of PEO increases to PMMA. The conductivity increases with temperature in pure PMMA and in all blends of PMMA+PEO.

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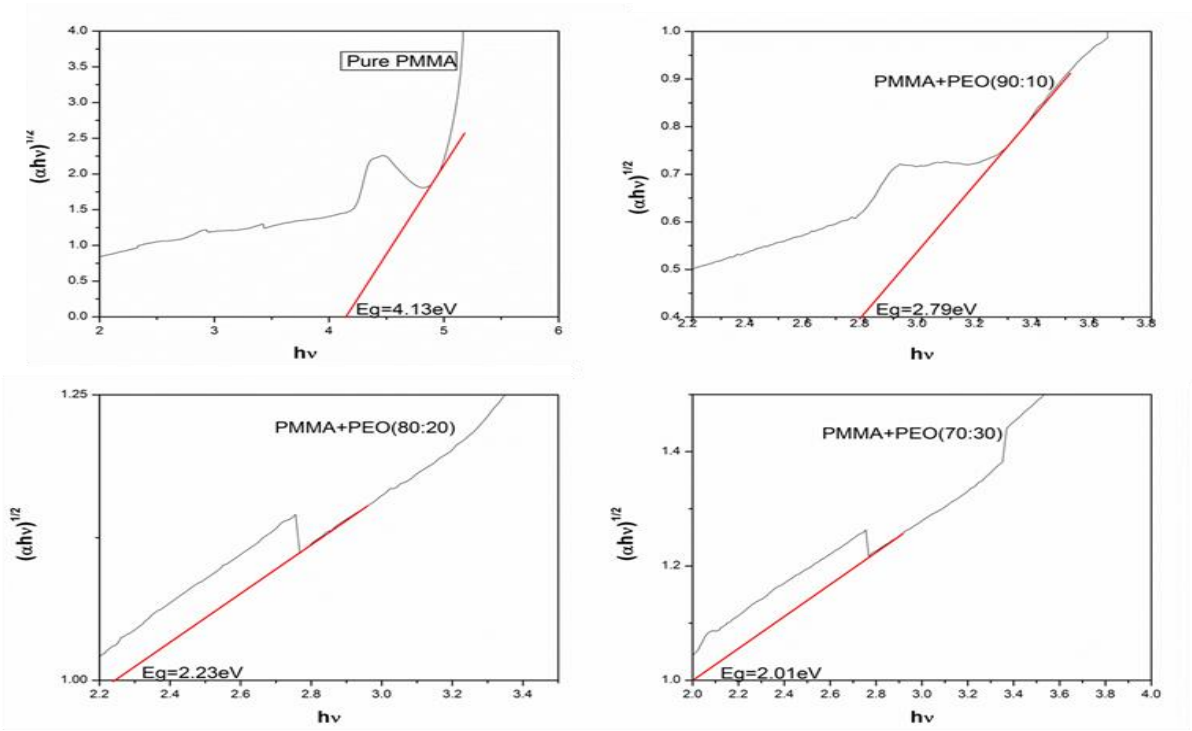

Figure 2. UV plots of Pure PMMA and different concentrations of PMMA and PEO

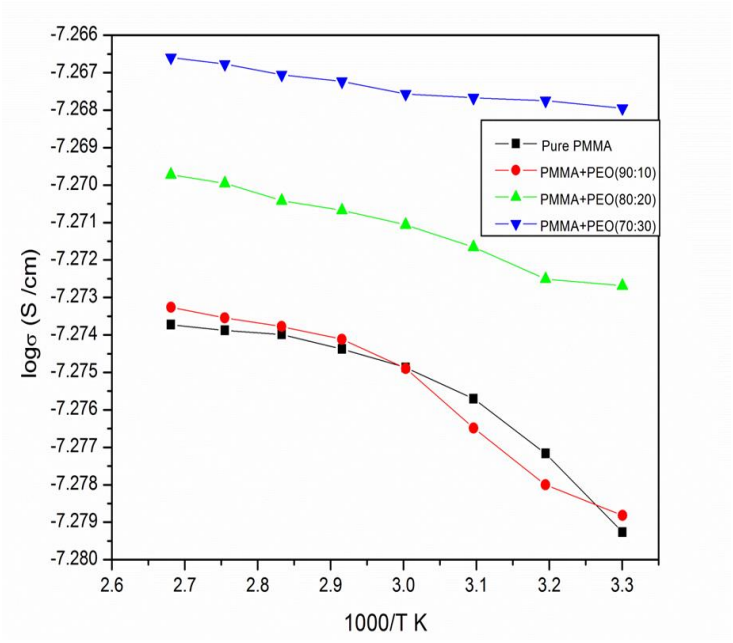

Figure 3. DC conductivity of Pure PMMA and different concentrations of PMMA and PEO

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