Impact of Ytterbium Ion on Substantial Effects of Biodegradable Equal Mixture of Polymer Blend of PVA and PVP

Md. Mohsin Uddin Azad[1] and Md. Islamul Haque[2]

[1] Northern University Bangladesh

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Abstract

A biodegradable solid polymer blend films of PVA (50)/ PVP (50) filled with Yb(NO3)2 were prepared by solution casting technique. The degree of amorphosity of the polymer blend composites was increased by the incorporation of filler into the polymer blend matrix. The decrease in the optical energy gap values was observed with the addition of filler which is illustrated by UV-Vis studies, indicating the interaction of filler with polymer blend matrix. With the temperature increase, the value of dielectric constant was found to increase depicting the more polar nature of polymer matrix. The tangent loss spectra of the samples showed a broad peak which confirms the presence of relaxing dipoles in the polymer composites.

Index terms— polymer blend, XRD, UV-vis absorption spectroscopy, nano-indentation.

1 Introduction

he polymer blending technology turned out to be a brilliant means for modifying a polymer compound for specific uses/multifunctional device applications, often at much lower fabrication costs than the currently available material. Very often precise properties are achieved by blending crystalline and amorphous polymers. Crystalline polymers have outstanding chemical resistance, better mechanical properties, low viscosity whereas amorphous polymers provide good dimensional stability. [1] Solution blending is one of the simple blending techniques which have control over the physical properties of the miscibility compositional regime.

Poly (vinyl acetate) (PVA) is a semi-crystalline, water soluble, nontoxic synthetic polymer which has the highest application in polymer industry. PVA exhibits interesting physical properties due to the presence of OH groups which are responsible for hydrogen bond formation with other polymers. [2] Poly (vinyl pipyridine) (PVP) is a low toxic amorphous vinyl polymer having outstanding physiological compatibility. PVP is soluble in water and most organic solvents. [3] The two polymers have polar side groups; PVA contains a hydroxyl proton and PVP containing pipyridine ring, which has a proton -Author ?: Senior Lecturer in Chemistry, Northern University Bangladesh. (NUB). e-mail: sacrotica@gmail.com Author ?: Lecturer in Chemistry, Northern University Bangladesh. (NUB). e-mail: islamulhaqueiuacct@gmail.com accepting carbonyl group. [4] It is therefore expected that a hydrogen bonding interaction occurs between PVA and PVP. [5] The superiority of polymeric materials is due to the aspects of their tremendous versatility and the amazing degree of tailoring to bring them closer to the novel applications. Polymers in combination with transition metal/ rare earth metal salts give complexes which find applications in high energy electrochemical devices. Dielectric properties of polymers play a dynamic role in device applications such as high performance capacitors, electrical cable insulation, electronic packaging to medical equipment, etc. [6] Rare earth ions filled polymer blend composites are extensively investigated because of their useful applications. The intention of this work is to explain the possibilities of fabrication of new polymer composites containing rare earth ions to make them useful in technological applications. Rare earth metal ion Yb 2 + has shown a significant effect on the crystallinity of the host matrix. Also, Optical, Mechanical and the Dielectric properties of pristine PVA (50)/ PVP (50) polymer blend films are improved with the addition of Yb 2 +metal ions.

2 II.

3 Experimental Work

Poly vinyl acetate (PVA) and (PVP) Poly vinyl pipyridine (PVP) were purchased from Aldrich. Double distilled water was taken as a general solvent for both polymers and filler particles. Initially, PVA (50)/ PVP (50) stock solution was prepared according to the procedure explained by H. M. Ragab. [7] The uniform and homogeneous solution mixture of known quantities of Yb(NO3)2.6H2O (5, 15, and 25%) were added to the polymeric stock solution after ultrasonication at room temperature for 30 minutes. The mixture was stirred continuously for 6-8 hours and then kept for 24 hours to remove the bubbles. The mixture was then transferred into polypropylene plates and dried in the oven for four days at 50oC to make the sample completely free from solvent traces. Results And Discussions a) X-ray diffraction analysis Fig. **??** represents XRD scans on pristine PVA (50)/ PVP (50) blend and PVA (50)/ PVP (50) blend filled with various concentrations of Yb(NO3)2. In the XRD scan on pristine PVA (50)/ PVP (50) blend the main peak centered at about 2? = 19.430 reveals the semicrystalline nature of the blend which confirms with earlier reported data. This peak has been shifted slightly in PVA (50)/ PVP (50) matrix filled with 5% and 15% filler to 19.720 and 20.460 respectively. Also, the close observation of the scans suggests that there is a drop in peak intensity values in the case of 5% and 15% filler mixed blend composites. The absence of sharp peaks confirms the amorphous nature of the polymer blend composites. This may be due to the interaction between the blend and the filler which results in the decrease in intermolecular interaction between the polymers blend chains. [9] This amorphous nature is responsible for ion diffusion in the matrix which can be obtained in the polymers that have flexible backbone. [10] But in the case of 25% filler concentration, the peak reappears at 19.430 and the peak intensity again increases. This shows that lower filler concentration of rare earth metal ions is more effective as a filler in creating an environment which is favorable for ion diffusion in the present chosen blend matrix. This shows that there is a shift in the absorption wavelength compared to the pristine blend matrix. In the visible region, the samples were transparent. The absorption coefficient (?) is given by the relation, Where, hv-incident photon energy, B -constant. Exponent r is found out from the slope of the linear part of the plot (?h?) 1/r v/s h?.

Depending on the electronic transition that is taking place in the samples, r can take the value ½, 3/2, 2 and 3. From the optical absorption spectra recorded for the samples, best straight line fit is obtained for r = 2, which indicates that an indirect transition is allowed near the fundamental band edge [12, 13]. The values of the band gap energies are estimated from the extrapolation of the straight line part of the plot of (?h?)1/2 v/s h? to the energy axis as the shown in Figure 3. The estimated values of the Eg are given in Table **??**. It can be observed from the table that the Eg of the pristine PVA (50) /PVP (50) and Yb(NO3)2 filled PVA (50) /PVP (50) polymer blend decreases with the increase in the concentration of filler. Also, the values recorded in the table justify the change in the behavior of polymer complexes tending towards semiconducting nature. This decrease in the energy band gap may be explained, that during polymer mixing, defects formation may occur, such as voids, which give rise to desirable localized states in the band gap of a material. [11, 12] Table **??**: Band gap energy (Eg) for pristine PVA (50)/PVP (50) and filler incorporated PVA (50)/PVP (50) blend films IV.

4 Conclusions

Yb(NO 3) 2 incorporated PVA (50)/ PVP (50) polymer blend films have been prepared using solution casting technique. X-ray diffraction scans have shown an increase in the amorphosity of composites which is a favorable condition for ion diffusion. Optical studies have confirmed the decrease in Eg with the increase of Yb(NO 3) 2 making the material semiconducting in nature. All these significant results are obtained for 5% and 15% filler concentration whereas higher concentration 25% is losing its role as effective filler. From the above investigations of physical properties, the results confirm that 15% is the optimized filler concentration showing significant improvement in many areas. Hence based on these results it could be recommended that this Ytterbium filled PVA (50)/ PVP (50) polymer composite films are found to be potential novel multifunctional materials for various optoelectronic and electromechanical devices.

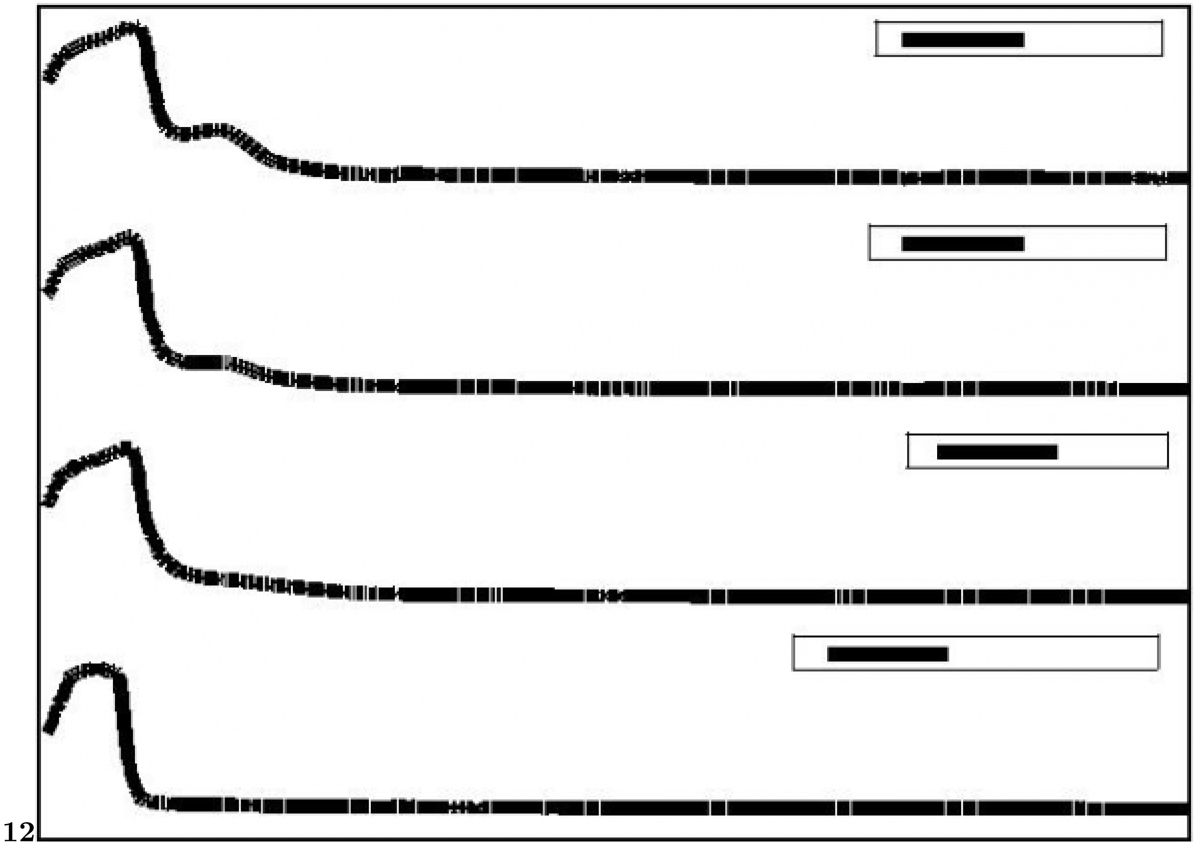
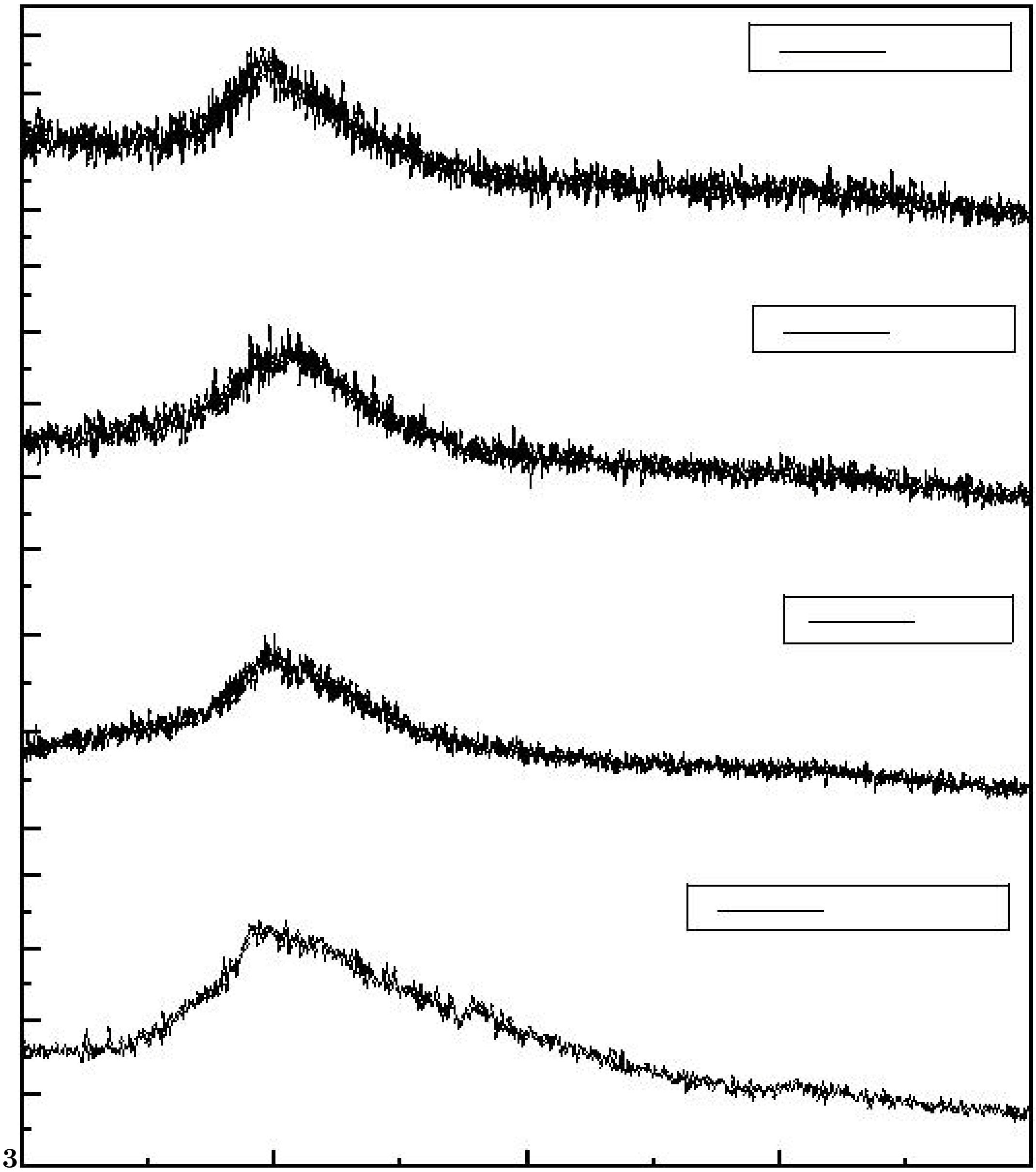


Figure 1: Figure 1 :Figure 2 :



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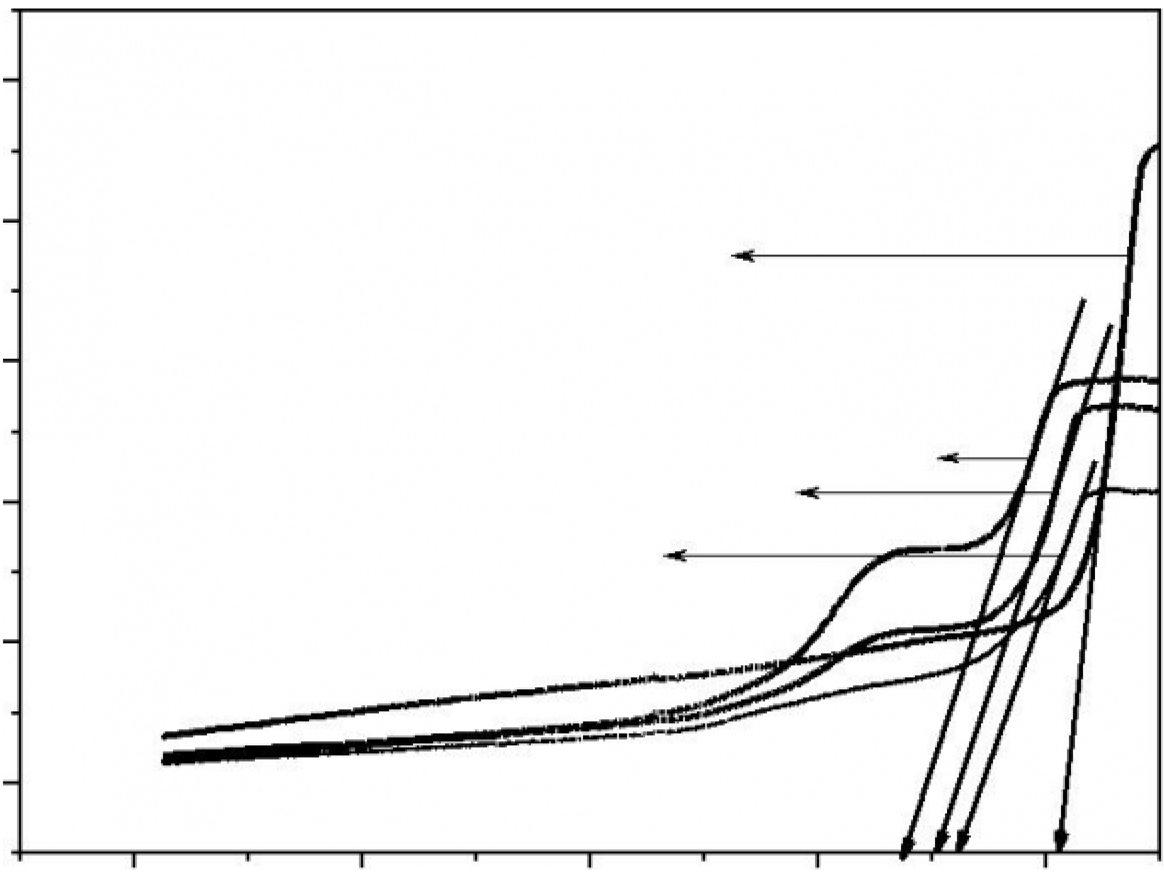

Figure 3:

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[Germany] , T A Instruments Germany .

[El-Shahawy ()] , M A El-Shahawy . *Polym.Int* 2003. 52 p. 1919.

[Hatta et al. ()] , F F Hatta , M Z A Yahya , Ali A M M Subban , R H Y Harun , M K , Mohamad A A . *Ionics* 2005. 11.

[Yuweijin et al. ()] , Xiaofeng Yuweijin , Ce Lu , Wang . *Journal of applied Polymer Science* 2006. 102 (6) p. .

[Reddych et al. ()] , Subba Reddych , Xia Ha , Quan-Yao Zhu , -Q Iang Li , Wen Mai , Chen . *Microelectronic Engineering* 2006. 83 p. .

[Abdelrazek et al. ()] , E M Abdelrazek , I S Elashmawi , S Labeeb . *Physica B* 2010. 405 p. .

[Ragab ()] , H Ragab . *Physica B* 2011. 406 p. 3759.

[Kumar et al. ()] , Harish Kumar , H G Mathad , R D Ganesh , S Sarma , K S S Haramghattic , R . *Brazilian Journal of Physics* 2011. (1) p. 41.

[Rajeswari et al. ()] , N Rajeswari , S Selvasekarapandian , C Karthikeya , Y Sanjeeviraja , J Iwai , Kawamura . *Ionics* 2013. 19 p. .

[Armand et al. (ed.) ()] *Fast ion transport in solids*, M B Armand , J M Chabangno , Duclot In , M Vashistha , P Murthy , JN . Shenoy GK (ed.) 1979. Amsterdam: North Holland.

[Franck] *Introduction to Polymer blends and Alloys*, A Franck .

[Kumar and Mathada ()] *Ratiation effects and defects in solids*, Harish Kumar , H G Mathada , R . 2011. 166 p. .

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