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Influence of Fe_2O_3 Dispersion on the Properties of $PVA_{(1-X)}POM_x$ Polymer Blends

P.R.Rajkumar[1], K.P.Subhash Chandran[2]

[1]Research and Development Center Bharathiar University Coimbatore, India
[2]Research and PG Department of Chemistry Sri Vyasa NSS College Vyasagiri P.O.Wadakkancherry

Abstract: *The present investigation was carried out forthe preparation and properties of Fe_2O_3 nanoparticle dispersed $PVA_{(1-x)}POM_x$ (x = 0.0,0.50,1.0) polymer blend films .X-ray diffraction measurement carried out on the six prepared films shows an increase in crystallinity with Fe_2O_3content. In order to understand the change in some physical properties of blend due to Fe_2O_3 dispersion, the prepared films were subjected to UV-Vis spectral measurement. Results obtained in the present study indicate an increase of optical extinction coefficient, UV absorption, absorption edge wavelength. Optical bandgap calculation lead to the application of prepared films in photonic devices.*

Keywords: *Polymer blendfilms, nano composites, nanoparticles, XRD*

1. INTRODUCTION

Polymer nanocomposites are materials in which nanoscopic inorganic particles, typically 1nm-100 nm in at least one dimension, are dispersed in an organic polymer matrix in order to dramatically improve the performance properties of the polymer. Polymer nanocomposites represent a new alternative to conventionallyfilled polymers. Because of their nanometer sizes, filler dispersion nanocomposites exhibit markedly improved properties when compared to the pure polymers or their traditional composites. Now aday's hybrid materials for various applications can be developed by incorporating transition metal oxides in organic polymer matrix. The doping of nanoscopic organic or inorganic materials into polymeric matrices represents a strategic route to improve the performance of material characteristics like structural, physical, chemical, optical, electrical, and mechanical properties.

2. MATERIALS AND METHODS

2.1. Synthesis of Fe_2O_3 Nanoparticles

All the chemicals and reagents used were of analytical grade.Ferric nitrate and glycine were purchased from local suppliers.Ferric nitrate and glycine were taken in equimolar ratio was dissolved in double distilled water under constant stirring.Then the solution was heated to its boiling point to complete the reaction.At the end of the reaction the reddish brown precipitate was obtained. The precipitate was collected and dispersed in ethanol and centrifuged to get fine nano particles of Fe_20_3.

2.2. Preparation of Pure and Nanoparticle Dispersed $PVA_{(1-X)}POMX$

Polyvinyl alcohol (PVA) and poly oxy methylene (POM) monomers were obtained from Sigma Aldrich and used without any purification. Dimethyl sulphoxide (DMSO) and double distilled water were used as solvent.For the casting of the$PVA_{0.5}POM_{0.5}$ blend film 10 wt % pure PVA and POM were dissolved in a DDW-DMSO mixture individually and stirred for one hour at 60 ^{0}C, and then two solutions were mixed.After subsequent stirring, homogeneous solution of these hydrogel was transferred into a petridish at room temperature to obtain smooth film under ambient conditions in fume hood over a week. Polymer film was then dried under vaccum to remove the residual solvent. A similar method was used to prepare pure PVA and POM films. As prepared 2.5 wt% nano particle was added under stirring before casting into films for the preparation of dispersed films.

3. RESULTS AND DISCUSSION

3.1. X-Ray Diffraction Measurement

X-ray diffraction (XRD) analysis has yielded a great amount of valuable information on the crystal structure,orientation,and size of ordered regions of materials.The XRD patterns obtained for as

prepared Fe_2O_3 nanoparticles was shown in figure 1-a .All the XRD peaks could be identified with α-Fe_2O_3 structure. The crystallite size was obtained using Scherrer formula with FWHM of (1 0 4) and (1 1 0) peaks. The average crystallite size comes out to be 17.4 nm. Comparison of XRD data with the standard JCPDS source for the α-Fe_2O_3 (JCPDS file No. 89-8104) reveals a fairly well rhombohedral structure. The typical X-ray diffraction patterns (XRD) of PVA and POM co-polymers, and their blend samples, at room temperature, in the scanning range $10^\circ \leq 2\theta \leq 80^\circ$ are shown in Figures.

The appearance of sharp reflections and diffuse scattering, observed from the XRD of pure PVA (Figure 1-b), is characteristic of crystalline and amorphous phases of conventional semi-crystalline polymers.It is also clear from, the XRD patterns of PVA/POM blend samples exhibited the characteristics of pure PVA but with less intensity for the crystalline peaks. Thus, one can say that the amorphous structure of POM is decreased upon mixing with PVA.Also Fe_2O_3 dispersion produces in crystalline peaks in all the three films, which conforms the presence of nanoparticles in PVA/ POM matrix. In addition, some crystalline peaks are no longer detectable (when compared with JCPDS of Fe_2O_3) since they are of vanishingly small intensity in the XRD pattern of co-polymers. This is attributed to weak reflections from the ordered structure. For the semi-crystalline amorphous blends, the noncrystallizing component could strongly modify the crystallization behaviour of crystallizing component. The phase morphology of these systems of blends is governed by the compatibility of the amorphous phase and nature of the crystalline phase.

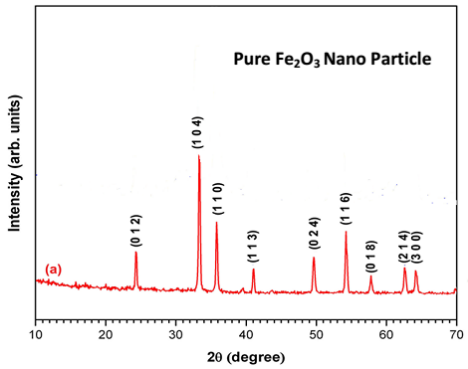

Fig1a

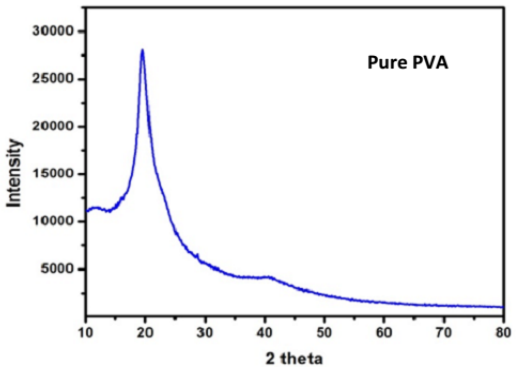

Fig1b

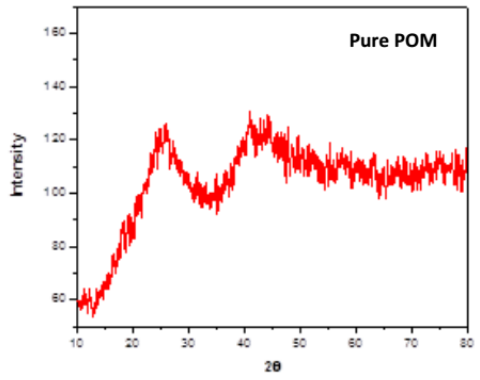

Fig1c

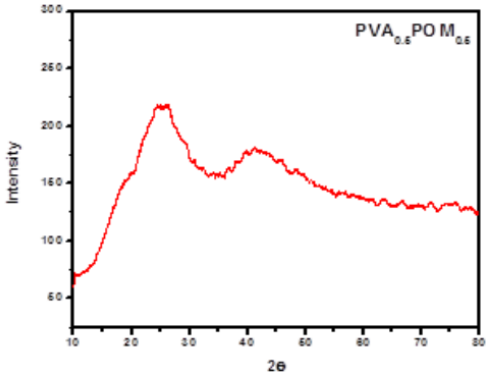

Fig1d

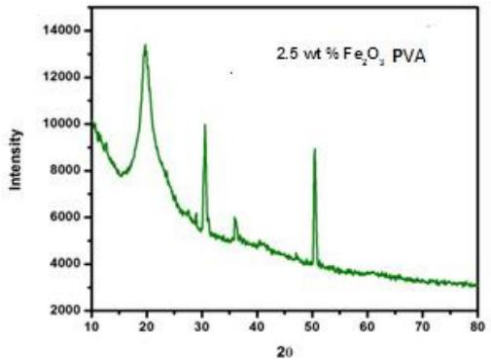

Fig1e

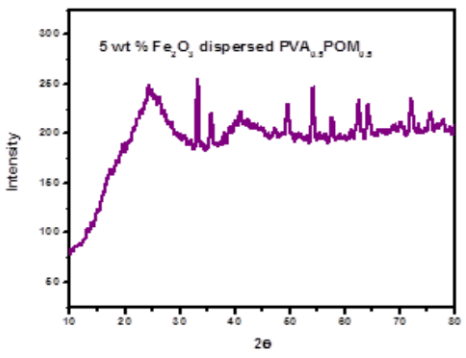

Fig1f

3.2. UV-Visible Spectroscopic Studies

From the UV-spectra it is clear that Fe_2O_3 addition produces a slight absorption in visible region. Also it produce a slight blueshift in the absorption edge of PVA(1-x) POMx films. Which in turn induces the band gap increment. Also In PVA0.5POM 0.5 blend film the transmittance in UV region get enhanced due to poor absorbance of UV light by POM molecules.Thus we can conclude that we may tune the optical bandgap by controlling the concentration of Fe_2O_3 and by varying different concentration of POM.

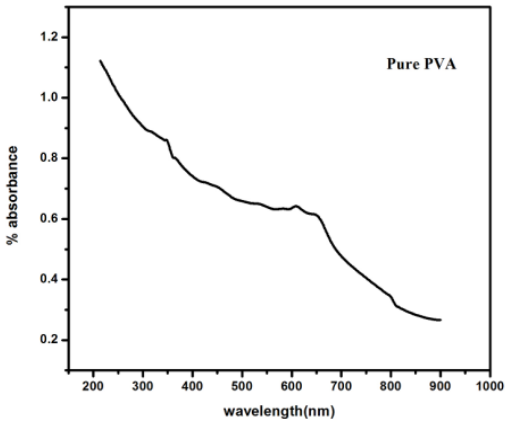

Fig2a

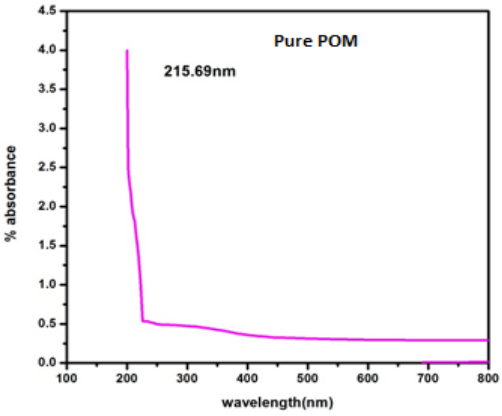

Fig2b

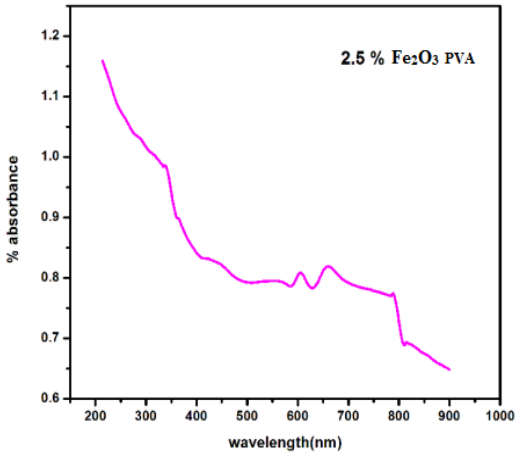

Fig2c

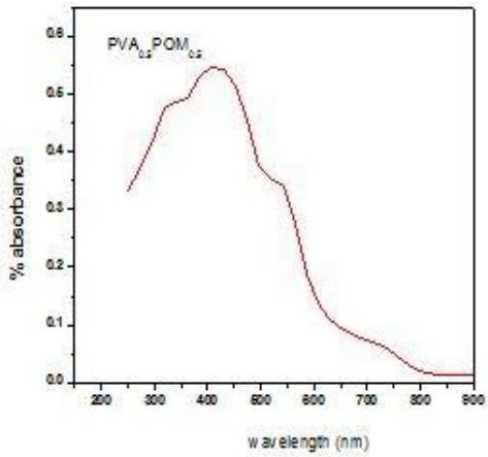

Fig2d

4. CONCLUSION

$PVA_{(1-X)}POM_X$blend films were grafted using Solution casting technique. X-ray diffraction of the blend sample revealed that the semi crystalline structure of PVA is essentially sustained and addition of Fe_2O_3nano particle increases the crystallinity of the samples. The analysis of absorption reflects the long transmission in the visible region decreases with the addition of Fe_2O_3.The optical band gap can be tuned to a particular value as per the application by controlling the value of x.

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AUTHORS' BIOGRAPHY

Rajkumar P.R., is working as Assistant Professor in Chemistry, MES College of Engineering Kuttippuram,Kerala since 2011 and is Research Scholar in Bharathiar University Coimbatore.

K.P.Subhashchandran, is Principal of Sri Vyasa NSS College Wadakkanchery Thrissur and also the research supervisor of Bharathiar University Coimbatore.