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Effect of ($FeSO_4$) Doping on Optical Properties of PVA and PMMA Films

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Abstract
Films of pure PVA , PMMA and PVA, PMMA doped by ($FeSO_4$) have been prepared using casting method. Transmission and absorption spectra have been recorded in the wavelength range (300-900) nm. the study of the optical properties of the deposited films have done in order to identify the possible change that happen to the PVA, PMMA films due to doping. Optical constants like refractive index , extinction coefficient calculated and correlated with doping.
Keywords: PVA,PMMA , casting method, optical properties, Effect of ($FeSO_4$) Doping.

Introduction

Polymer materials present an increasing interest for the optical data processing technologies [1]. They have attracted the scientific and technological researchers, because of their wide applications. This is mainly due to the lightweight, good mechanical strength, optical properties which makes them to be multifunctional materials. In recent years, the doped polymers have been the subjects of interest for both theoretical and experimental studies, because of their physical and chemical properties needed for specific application, this may be obtained by adding or doping with some elements. It was observed that doping a polymer with metal salts has a significant effect on their physical properties including optical, thermal, electrical properties. These changes in physical properties, depends on the chemical nature of the dopant and the way in which they interact with the host polymer [2]. Poly (vinyl alcohol) (PVA) is a polymer that has been studied intensively due to its several interesting physical properties, which are useful in technical applications including biochemical and medical. (PVA) has been widely used as a solid polymer electrolyte (SPE) as a steric stabilizer for producing conducting polymer dispersions. PVA is also used as a hydrogel, it is known to form blue complexes with iodine [3].

Poly methyl methacylatc (PMMA) have been widely used due to attractive physical and optical properties decisive about its broad applications. This is the thermoplastic material with a good tensile strength and hardness, high rigidity, transparency, good insulation properties and thermal stability dependent on toxicity [4-6].

It can be as on composite material act as optical diffuser in a liquid crystal display backlighting unit [4], as a photonic material due to its low optical absorption, simple synthesis and low cost [7], as a gel polymer electrolytes due to its reasonable conductivity, high mechanical strength, stability over a wide range of temperature and elector chemical window [8].

The aim of this work is to study the effect of doping by ($FeSO_4$) with percentages (3%) on optical characteristics of PVA and PMMA which was prepared by using solvent casting method.

Experimental details

Poly (vinyl alcohol) (molecular weight 10000 g/mol) were used as a matrix polymeric material in this research supplied by (BDH chemicals ,99.5%) the aqueous solution of this polymer were prepared by dissolving PVA and ($FeSO_4$) in a mixed of deionzed water and stirred by magnetic stirrer for about one hour until PVA was completely dissolved.

Poly (methyl methacrylate) and ($FeSO_4$) used in this study were obtained from (sigma-aldrich ,Germany, 99.5), chloroform has purity of 99.8% (HPLC was used as a common solvent for both PMMA and ($FeSO_4$) pure PMMA and ($FeSO_4$)were dissolved separately in chloroform for 4 hour at room temperature. Appropriate mixtures of PVA , PMMA and 3% ($FeSO_4$) weight solutions were mixed . The solution was poured into flat glass plate dishes . Homogenous films were obtained after drying in an oven for 24 hours at 313K .The thickness of the produced films was 25µm and average area (2x2 cm^2).

The absorbance and transmittance measurements were carried out using a Shimadzu UV⁄VIS-160A double bean spectrophotometer in the wavelength range (300-900) nm.

Results and discussions

The optical transmission spectra as a function of wavelength in the range of (300-900)nm is shown in Fig. (1). all the films showing the same behavioun but the transmittance was decrease as the doping and the transmittance of PVA is higher than transmittance of PMMA.

The behavior of Absorptance curves of all sample in Fig. (2), It is obvious that its behavior is opposite to that of the transmittance spectrum . and It was found that the absorptance of pure PMMA is higher than

absorptance of pure PVA and the absorptance increases after doping with ($FeSO_4$).

From the plot of reflectance spectra Fig. (3) for the samples. The films prepared at (Pure PMMA , PMMA:3% $FeSO_4$) have higher reflectance value than those prepared at (Pure PVA , PVA:3% $FeSO_4$). The refractive index is a suitable state parameter directly correlated to the material density. Fig. (4) Shows the variation of the refractive index with the photon energy. The refractive index of these films is slightly increases with doping. The refractive index measurements can have a correlation with the electrical properties of the prepared films. The refractive index (n_o) can be determined from the reflectance (R) using the relation [9]:

$$n_o = \left(\left[\frac{4R}{(R-1)^2} - K_\circ \right]^{1/2} - \frac{R+1}{R-1} \right) \quad \text{---------- (1)}$$

Extinction Coefficient (k_o) represents the imaginary part of complex refractive index and it can be defined as the amount of energy losing as a result of interaction between the light and the charge of medium[10]. The extinction coefficient (k_o) is directly proportional to the absorption coefficient as see in relation [9]:

$$k_o = \frac{\alpha \lambda}{4 \pi} \quad \text{---------- (2)}$$

Where : α is the absorption coefficient and (λ) is the wavelength of the incident photon. Fig. (5) Shows the variation in (k_o) as a function of the photon energy .

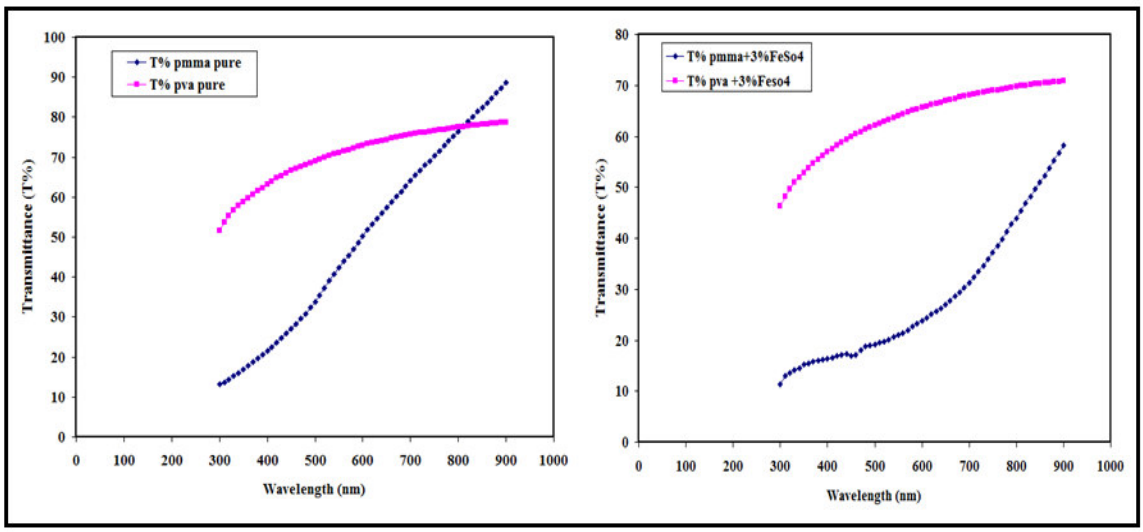

Fig. (1)Transmission Spectra of (PVA , PMMA: FeSO4).

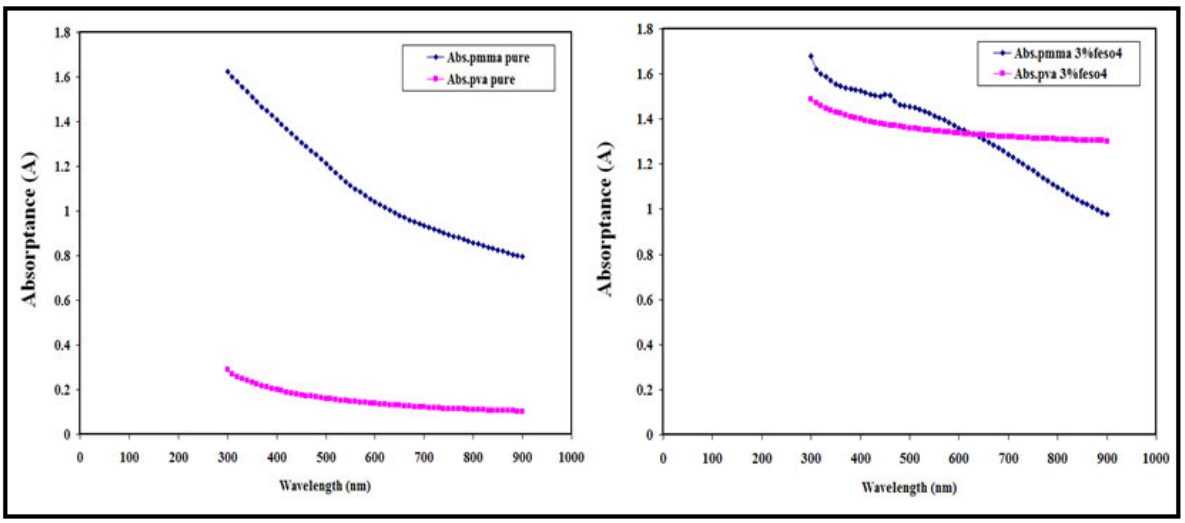

Fig. (2) Absorptance Spectra of (PVA , PMMA: FeSO4).

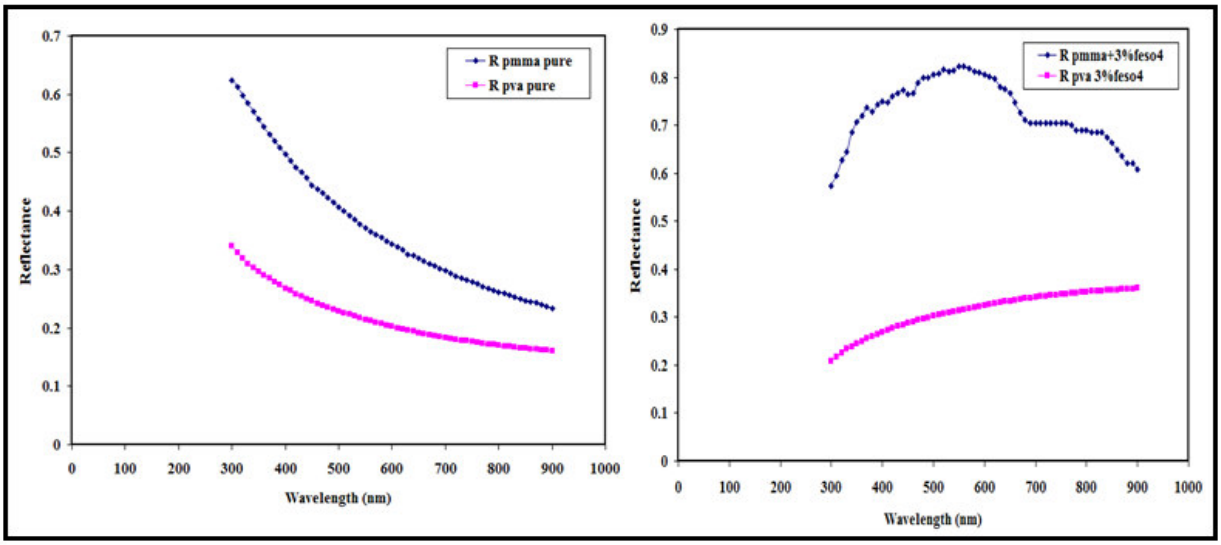

Fig. (3) Reflectance Spectra of (PVA , PMMA: FeSO4).

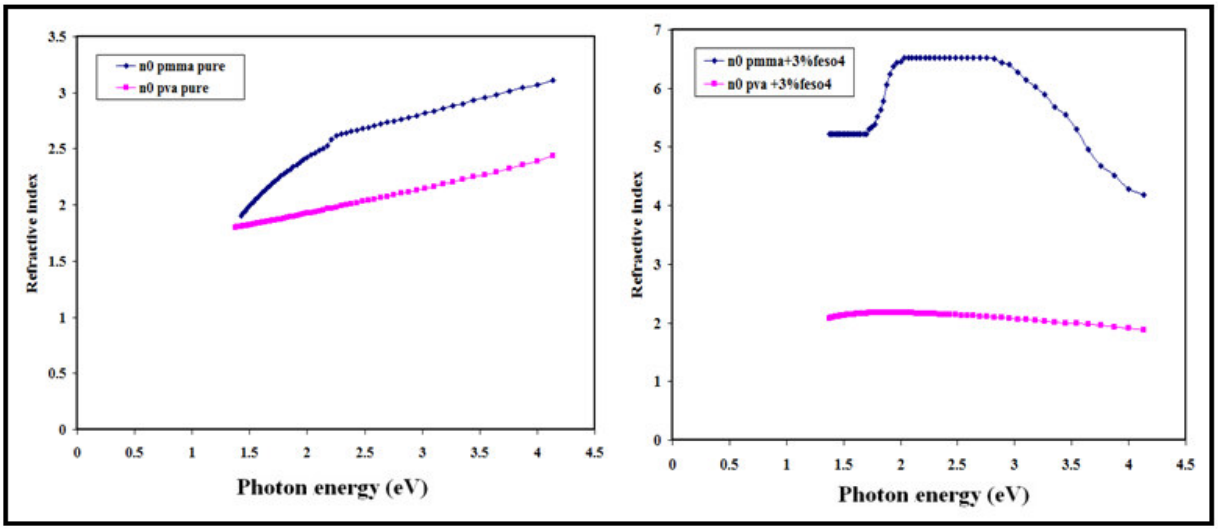

Fig. (4) Refractive Index of (PVA , PMMA: FeSO4).

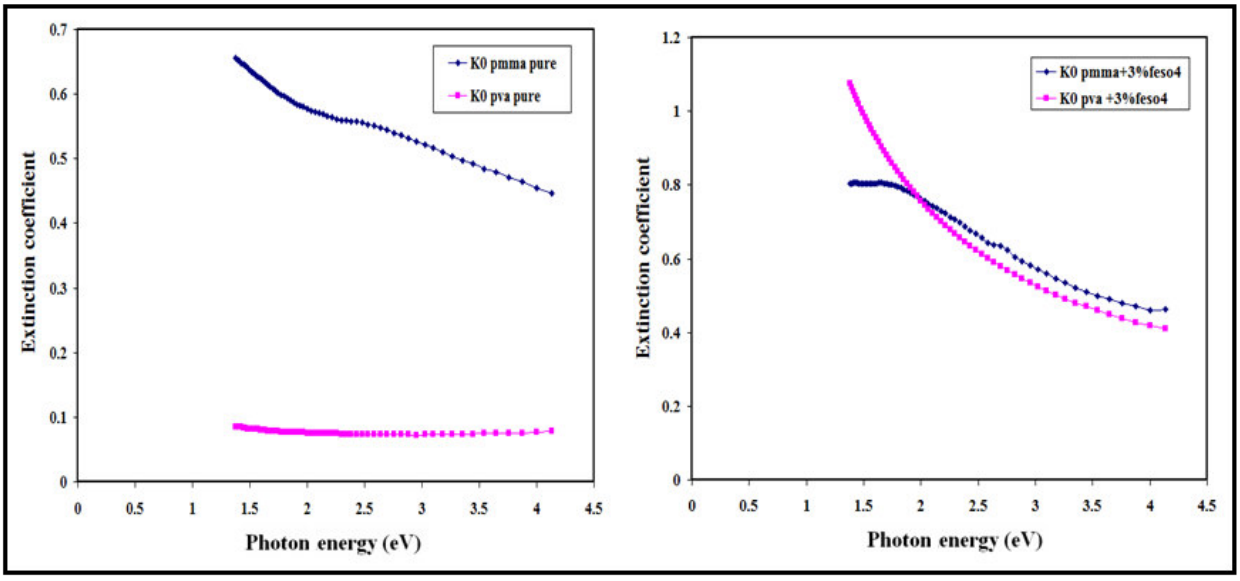

Fig. (5) Extinction Coefficient of (PVA , PMMA: FeSO4).

Conclusions

Pure PVA , PMMA and (FeSO4) doped PVA , PMMA have been prepared successfully by casting method, the calculated values of the optical parameters illustrated that there was The films prepared at (Pure PMMA , PMMA : 3% FeSO4) have higher reflectance value than those prepared at (Pure PVA , PVA: 3% $FeSO_4$).

References

1. V. Kuncser, M. Bulinski, S. Krautwald, H. Franke, F. E. Wagner, D. Cristea, P. Palade and C. Plapcianu, G. Filoti,(2006) "Optical and electronic properties of (Fe+Sb): PVA for real time holography", Journal of optoelectronics and advanced materials, 8 (3), 1225 – 1229.
2. R.F. Bhajantri, V. Ravindrachary , A. Harisha , Vincent Crasta, Suresh P. Nayak and Boja Poojary, (2006) ,"Microstructural studies on $BaCl_2$ doped poly vinyl alcohol", Polymer, 47(10), 3591–3598. DOI: 10.1016/j.polymer.2006.03.054
3. R. F. Bhajantri, V. Ravindrachary, Ismayil, A. Harisha and Manjunath Pattabi, (2008), 11th International conference on Advanced Materials , Rio de Jaaneiro Brazil ,September 20-25.
4. B. Zhang and F. D. Blum, (2002) ,"Thermogravimetric Studies of Adsorbed PMMA", *Polymer Preprints,* 43(1)**,** 484-485 . http://scholarsmine.mst.edu/faculty_work/1845
5. B. Zhang and F.D. Blum,(2003) "Thermogravimetric Study of Ultra-thin PMMA Films on Silica: Effects of Tacticity", Thermochimica Acta, 396, 211-217.
6. H. Kaczmarek and H. Chaberska, (2006) "The influence of UV-irradiation and support type on surface properties of poly(methyl methacrylate) thin films," Applied Surface Science, vol. 252, no. 23, pp. 8185–8195. doi:10.1016/j.apsusc.2005.10.037
7. G. H. Kim,(2005) " A PMMA composite as an optical diffuser in a liquid crystal display backlighting unit (BLU)", European Polymer Journal, 41 (8) 1729–1737. doi:10.1016/j.eurpolymj.2005.02.029
8. V. Prajzler, V. Jerabek, O. Lyutakov, I. Huttel, J. Spirkova, V. Machovic, J. Oswald, D. Chvostova and Zavadil, (2008) ," Optical Properties of Erbium and Erbium/Ytterbium Doped Polymethylmethacrylate" Acta Polytecnica, 48 (5), 14-21 . http://ctn.cvut.cz/ap/
9. A. K. Baker and P. E. Dyer, (1993) "Refractive-index modification of polymethylmethacrylate (PMMA) thin films by KrF-laser irradiation," Applied Physics A, vol. 57, no. 6, pp. 543–544. doi:10.1007/BF00331756
10. Firas Hashem Ahmed (2003)AL-Mustansiriay University, Thesis.

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