Thickness Effect on the Optical Properties of PVC-Methyldopa Composite Films

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Abstract

Optical properties of PVC-Methyldopa composite, prepared by using casting technique, with different thickness films have been studied. Parameters such as transmittance, reflectance, energy band gap and absorption coefficient were studied in the spectral rang (٢٠٠-800) nm.

Introduction

Composites containing two materials with differences physical properties exhibit often new properties. The composites can provide improved characteristics not obtain able by any of the original components alone and are used in a wide variety of industrial products [1,2]. Since the discovery of semiconducting polymers, considerable progress has been made in understanding the electronic and optical properties of these materials (3-5). Thickness-dependent changes in the optical properties can be caused by changes in the self-absorption, local film morphology in the region of light emission, and optical interference i.e., microcavity effects (5). Data on optical constants namely Transmittance, Absorbance and optical band gap, *Eg*, of thin semiconductors films are necessary for design and development of thin-film devices for different high power laser and interferometric applications. They are used in various fields including laser visible diodes, coatings, solar cells, IR detectors and ultraviolet filters [6-8].this article disclosed preparing polymer composite of PVC-Methyldopa using casting method and measuring some optical properties.

Experimental

Casting method is used to prepare films of poly(vinyl chloride)-Methyldopa composite in different thickness. The composite was prepared by using Tetrahydrofuran (THF) as a solvent, the composite was stirred for 2 h until to get a homogenous solution. The solution was poured into flat glass plate dishes. Homogeneous films were obtained after drying in air for 48 h at room temperature. The thicknesses of the produced films (80,140,210,250,320)µm were measured using a Digital Caliper Vernier (a micrometer type 2610 A, Germany).

The optical absorbance (A) of the sample was measured as a function of wavelength (λ) ranged from 200 to 600 nm by using computerized Shimadzu Uv-vis 160A-Ultraviolet-spectrophotometer full-scale absorbance up to (2.5). The light sources are halogen lamp and socket-deuterium lamp. The detector is Si-photodiode and all measurements were performed at room temperature. UV/VIS absorption

Result and Discussion

Optical measurements of the transmittance is shown in Fig.(1) which was measured in wavelength range 200-800 nm. This figure shows that the transmittance intensity decreases with the increasing of the film thickness. The reason for this behavior is that the increases of the thickness of surface roughness and density of localized state increases which, reduces the transmittance value.

The transmission spectrum rises and it approximately constant at (٨3%, 76%, 6٧%, ٥٦% and ٤٤%) for the film thickness (٥٠, 1١٠, ١٥٠, 2٠٥ and 2٦٥)µm respectively. It is noticed that the composite films have higher transmission values in the visible range of the spectrum. The labels a, b, c, d and e for thickness ٥٠, 1١٠, ١٥٠, 2٠٥ and 2٦٥µm respectively.

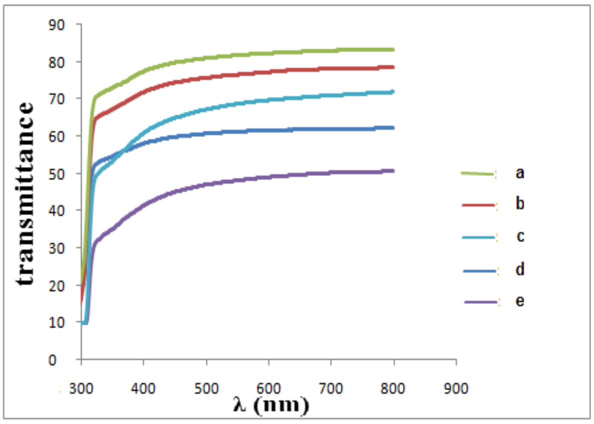

Fig. (1) Transmission spectra polymer composite samples.

Fig. (2) illustrates the reflectance in the wavelength range (200-800) nm for different thickness of polymer composite films. This figure revealed that the reflectance increases with the increasing film thickness. This is due to the increasing optical absorption and the increasing attenuation of incident beam [9].

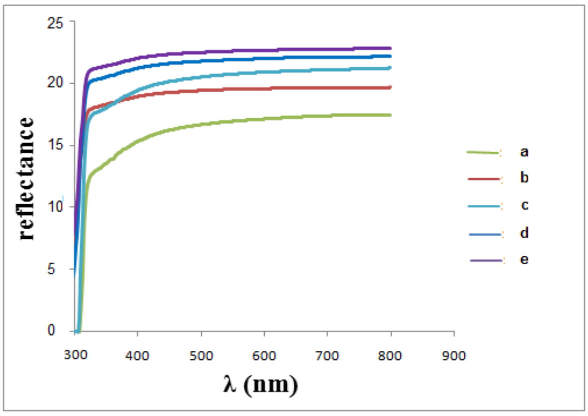

Fig. (2) Reflectance spectra of polymer composite samples.

The optical energy band gap of the films were calculated using the Tauc's relation [10], given by:

$\alpha(h\nu)= B(h\nu-Eg)^{1/2}$ .... (1)

where B is a constant, hν is the photon energy, E_g is the optical energy gap, and α is the absorption coefficient. According to equation (1), in vicinity of fundamental absorption edgeis equal to 1/2, for direct allowed transitions. Thus, the optical energy band gap of the films was determined by plotting $(\alpha h\nu)^2$ versus photon energy (hν), and by extrapolating the curve to αhν = 0 as shown in Fig.(3).

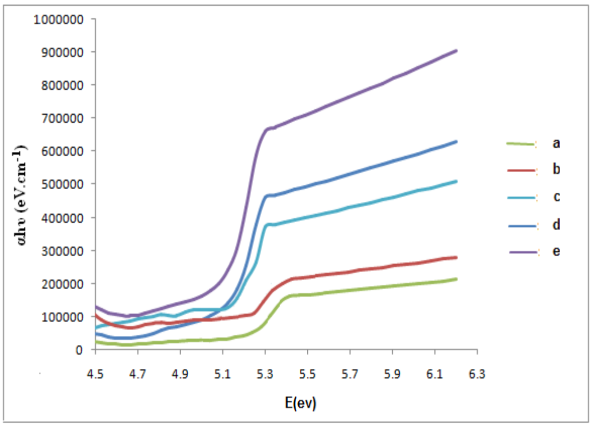

Fig.(3) Optical band gap of polymer composite samples.

The value of optical energy band gap found to be decreasing from 5.24 to 5.06 eV as the film thickness increases from 50 to 265 µm, In general, the density of localized state in the film increases with the film thickness which leads to decrease in the band gap. Such a variation in energy band gap with the increase films thickness has been reported by S. Sonmezoglu et al.[11].

It is assumed that the absorption coefficient (α) near the band edge shows an exponential dependence on photon energy for many materials. This dependence is given as follows [12], where, α_o is a constant and E_u is Urbach energy which is the width of the tail of the localized state associated with the amorphous state in the forbidden band. The plot of ln(α) vs. photon energy (hν) for composite thin films having different thickness is shown in inset graph of Fig.(3). Urbach energy was calculated from the reciprocal gradient of the linear portion of these curves. The energy band gap and Urbach energy values are given in Table (1). The E_u energy values change inversely with the optical band gap. Some defects were formed during the growth of the film and these defects produce localized states in the films. Thus, increase in width of the localized states leads to decreases the optical energy band gap[13].

Table (1)
The energy band gap of the polymer composite.

Polymer	***a***	***b***	***c***	***d***	***e***
Eg (eV)	5.06	5.12	5.15	5.18	5.24

The absorption coefficient (α) of the polymer composite films was determined from transmittance measurements. The calculation of the absorption coefficient of the films in this region was calculated using the following expression: The absorption coefficient (α) =optical density/thickness [14]

$$\alpha(\nu) = \frac{1}{d}\ln\frac{1}{T} = \frac{A}{d} \quad \text{.....................................(2)}$$

Where (d) is the sample thickness, (T) the transmittance and (A) is the absorbance. Fig.(4) shows the dependence of the absorption coefficient on the wavelength for the samples with different thicknesses, the absorption coefficient decrease with the increasing film thickness.

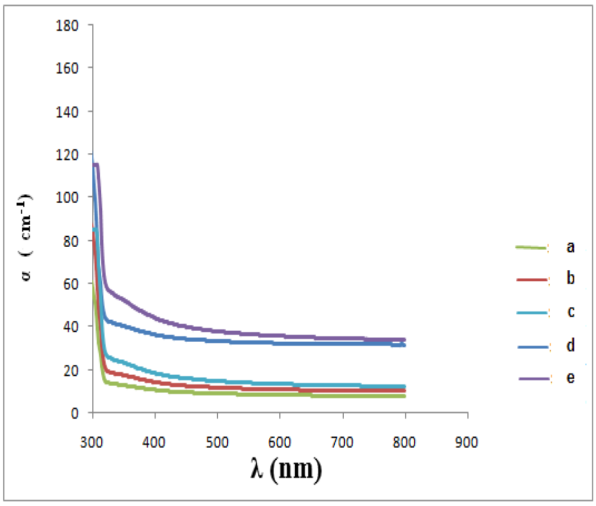

Fig. (4) Absorption coefficient of polymer composite samples.

Conclusion

Films thickness has a great effect on optical properties. Transmittance, optical band gap and absorption coefficint decreases with the increasing

References

[1] Kalisza G., E. Grzankaa, D. Wasikb, A. Swiderska -Srodaa, S. Gierlotkaa, J. Borysiuka, M. Kaminskab, A. Twardowskib and B. PaÃlosza, "Fabrication and Physical Properties of SiC GaAs Nano-Composites", Proceeding sof the 34 International School of Semiconducting Compounds, Jaszowiec., 108, 4; PP.717-722, 2005.

[2] Bahaa H. Rabee "Study of Optical and Mechanical Properties for (PVA-AgCO3) Composites, European Journal of Scientific Research, 57, 4,pp.583-591, 2011.

[3] Friend 2R. H., Gymer, R. W.Holmes A. B., Burroughes, J. H. Marks, R. N. C. Taliani, D. D. Bradley, C. D. Dos Santos A., J. Bredas, Logdlund, L. M. and Salaneck, W. R. Nature London, 397, 121, 1999.

[4] Burroughes, J. H. D. Bradley D. C, Brown A. R., Marks R. N., Mackay, K. R. H. Friend, P. L. Burns, and Holmes A. B., Nature London,. 347, 539, 1990.

[5] Leger J. M. and Carter S. A., Ruhstaller B. H.-G. Nothofer and U. Scherf, H. Tillman and H.-H. Ho¨rhold, Thickness-dependent changes in the optical properties of PPV- and PF-based polymer light emitting diodes,68, 054209, 2003.

[6] Study the effect of thickness on theoptical properties of (sb2o3) thin films preperd by thermal evaporation technique ,suroor n.esmaeel, Journal of college of education, 2001.

[7] Kiriakidis G,Katsarakis N.,Bender M.,Gagaoudakis, E.Cimalla V., InOx thin films, candidates for novel chemical and optoelectronic applications, Mater. Phys. Mech., 1; p83, 2000.

[8] NarasimhaK. Rao, Influence of deposition parameters on optical properties of TiO2 films, Opt. Eng., 41; p.2357, 2002.

[9] Kumar, N[1], Parihar U[1], Kumar R[1], PatelK. J.[2], Panchal C. J[2], Padha N., Effect of Film Thickness on Optical Properties of Tin Selenide Thin Films Prepared by Thermal Evaporation for Photovoltaic Applications, American Journal of Materials Science, 2, 1; pp.41-45, 2012.

[10] TaucT. S., Memth A., J. Non-Cryst. Solids **,** 126, p.569 ;1972.

[11] SonmezogluS.,Arslan, A.Serin T. and . SerinN, "The effects of film thickness on the optical properties of TiO_2–SnO_2 compound thin films", Phys. Scr., 84, 6; pp. 065602-065607, 2011.

[12] Didomenico M., Wemple S.H., Oxygen-octahedra Ferroelectrics I., Theory of Electro-Optical and Nonlinear Optical Effects, Journal of Applied Physics, 40, 2; pp.720, 1969.

[13] Tigau N., Ciupina V., Prodan G., Structural optical and electrical properties of Sb_2O_3 thin films with different thickness, Journal of Optical Advanced Mater,8; pp. 37-42, 2006.

[14] Hasan B.A., Effects of Doping with (Mathylene Blue and Methel Red) on Optical Properties of Polyethyl Methacrylate (PMMA) .Journal of Education College,5,.3; pp. 464-499, 2005**.**

الخلاصة

تم تحضير شرائح البولي فينل كلورايد– مثيل دوبا بسُمك متغير و دراسة الخصائص البصرية مثل معامل الامتصاص والنفاذية والانعكاسية و فجوة الطاقة ضمن المدى الموجي (٢٠٠–٨٠٠) نانومتر.