Study of Optical Properties of ($PVA-ZnCl_2$) Composites

Moneer Ali Lilo
Al- Muthanna, University, College of Science, Department of Physics
Ahmed Hashim
Babylon University, College of Education For Pure Science, Department of Physics

Abstract

The aim of this worke, perpetration of ($PVA-ZnCl_2$) composites and study the optical properties of different concentrations of zinc chloride. The samples were prepared by using casting method. The optical properties (transmission and absorption spectra) measured in the wavelength from 200nm to 800 nm. The experimental results showed that the absorbance, absorption coefficient ,indirect energy band gap, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increasing the zinc chloride concentration.

Keywords: polymer, optical properties, Zinc chloride, composites.

الخلاصة

الهدف من هذا ألبحث تحضير متراكبات ($PVA-ZnCl_2$) ودراسة الخواص البصرية ولتراكيز مختلفة من كلوريد الزنك. النماذج حضرت بطريقة الصب. الخواص البصرية (طيفي النفاذية والامتصاصية) قيست ضمن طول موجي من*200nm* الى*nm 800*. النتائج التجريبية اوضحت بان الامتصاصية، معامل الامتصاص، فجوة الطاقة غير ألمباشرة معامل ألخمود معامل ألانكسار ثابتا العزل الكهربائي الحقيقي والخيالي تزداد مع زيادة تركيز كلوريد الزنك.

Introduction

Polymer material is widely being used in various devices as insulating material and for optoelectronic applications. This is due to their unique properties such as light weight, high flexibility, and ability to be fabricated at low temperature and low cost (Lyly Nyl *et al.,* 2012). In recent years, polymers with different optical properties have been attracted much attentions due to their applications in the sensors, light-emitting diodes, and others. The optical properties of these materials can be easily tuned by controlling contents of the different concentrations (Tariq, 2010). The doped polymers may present useful applications in integrated optics or in real time holography. In order to tailor materials with improved properties within the doped polymer class, it is necessary to understand and control the electronic mechanisms involved in the optical behavior (Bulinski, *et al.,* 2003). Optical properties of polymers constitute an important aspects in study of electronic transition and the possibility of their application as optical filters, a cover in solar collection, selection surfaces and green house. The information about the electronic structure of crystalline and amorphous semiconductors has been mostly accumulated from the studies of optical properties in wide frequency range. The significance of amorphous semiconductors is in its energy gap (Gabriel and Abdel-Karim , 2011).

Materials and Methods:

Polyvinyl alcohol solution was prepared by dissolving it in distilled water by using magnetic stirrer in mixing process to get homogeneous solution at 90 C^o, then the solution was cooled at room temp. , the gravimetric ratios from $ZnCl_2$ (2, 4 and 6) wt. % were added and mixed for 10 minute to get more homogenous solution.

Casting Method was applied by using Petri dish that leaved to dry at room temperature for three days. The dried film was then removed easily by using tweezers clamp.

The absorption coefficient(α) is calculated by using the following equation (Nahida & Marwa. 2011):

$\alpha = 2.303A/t$ ………………… (1)

where A is absorption and t is the thickness of film .

The optical energy gap and electronic transition obtained from this equation :

$\alpha h\upsilon = B(h\upsilon - E_g)^r$ ……………..(2)

The refractive index is calculated by using the following formula :

$n = [4R/(R-1)^2 - (R+1/R-1)]^{1/2}$ …………(3)

The extinction coefficient is obtained by the relation :

$k = \alpha\lambda/4\pi$ …………….(4)

Real and imaginary dielectric constant is calculated from the equations :

$\varepsilon_1 = n^2 - k^2$ …………….(5)

$\varepsilon_2 = 2nk$ ……………(6)

Results and Discussion

Figure(1) shows the variation of absorbance as a function of wavelength of (PVA-$ZnCl_2$) composites.

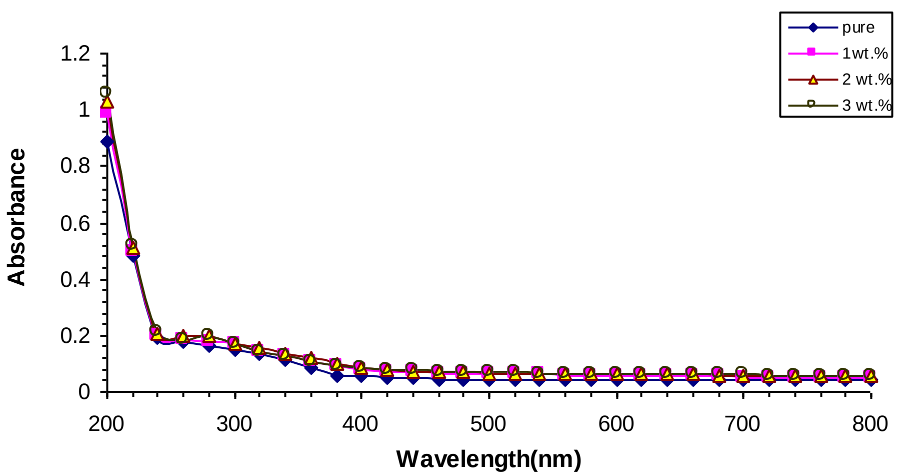

FIG.1

The variation of optical absorbance for (PVA-$ZnCl_2$) composite with wavelength

The figure shows that the absorbance of (PVA-$ZnCl_2$) composites decreases with increase wavelength. This behavior can be attribute to the decrease of optical band gap. Also, the absorbance increases with increase the zinc chloride concentration which related to absorption of zinc chloride particles.

The effect of adding the zinc chloride on absorption coefficient of polyvinyl alcohol is shown in figure(2). The absorption coefficient is defined as the ability of material to attenuate the light of a given wavelength per unit length (Nahida & Marwa. 2011). From this figure, the absorption coefficient increases with increase the weight percentages of zinc chloride is attributed to decreasing energy gap (Nahida & Marwa. 2011).

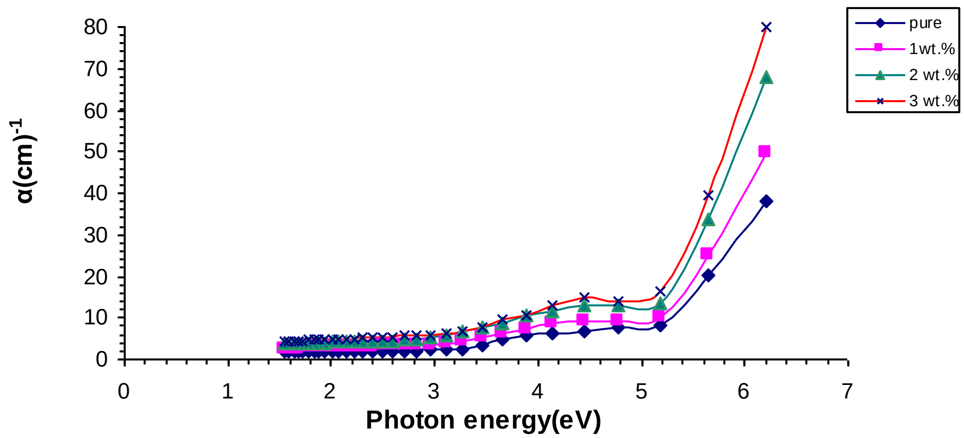

FIG.2

The absorption coefficient for (PVA-$ZnCl_2$) composite with various photon energy

Figures (3 and 4) show the relationship between $(\alpha h\upsilon)^{1/2}$ and $(\alpha h\upsilon)^{1/3}$ with hυ to calculate energy band gap according to Eq.(2). The indirect energy band gap decreases with increase the zinc chloride concentration, this related to increase the localized states which directly affects the decrease in the optical energy gap of the polyvinyl alcohol (Hamed *et al.,* 2012).

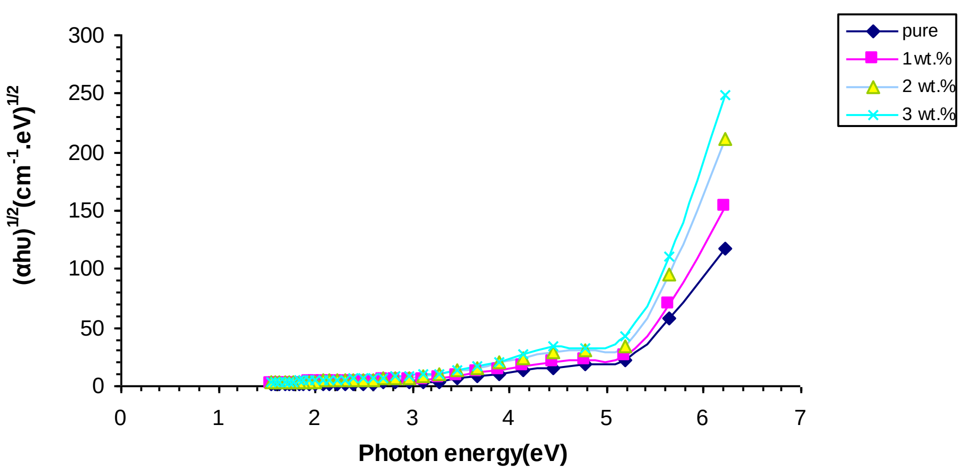

FIG.3

The relationship between $(\alpha h\upsilon)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PVA-$ZnCl_2$ composites.

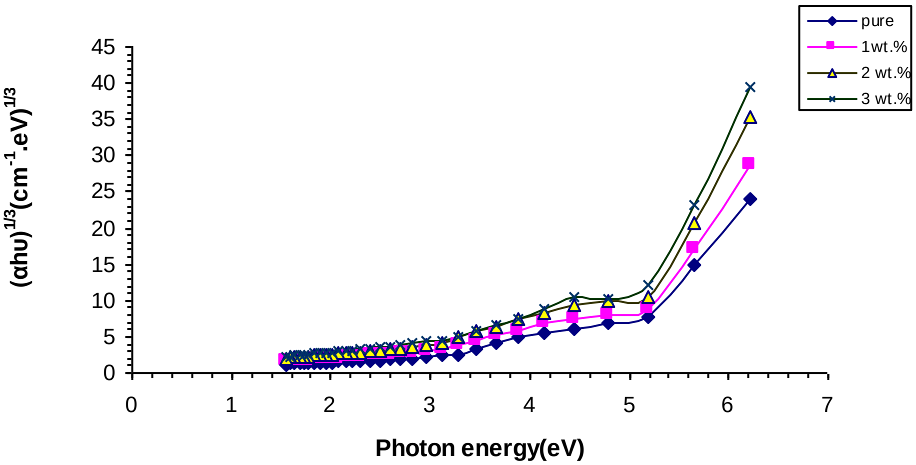

FIG.4
the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of $PVA\text{-}ZnCl_2$ composites.

The variation of extinction coefficient of composites with photon energy is shown in figure(5). The figure shows that the extinction coefficient of ($PVA\text{-}ZnCl_2$) composites increases with increase the zinc chloride concentration, this attribute to decrease the energy band gap with increase the zinc chloride concentration (Nahida & Marwa. 2011).

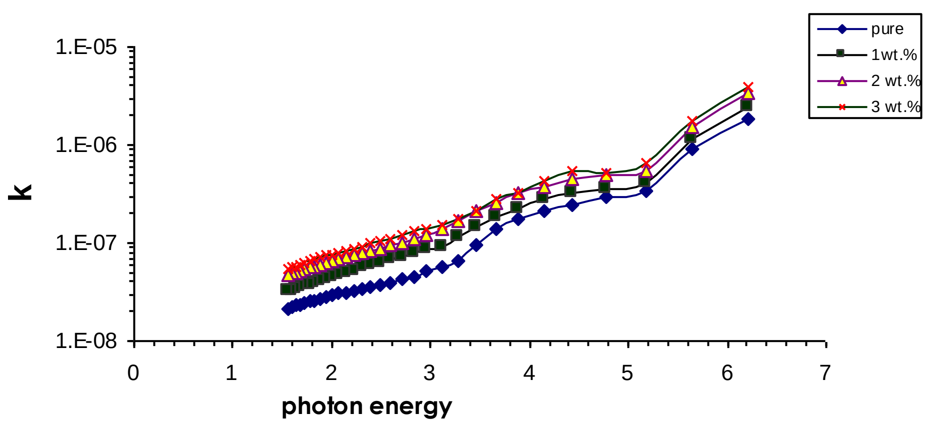

FIG.5
The extinction coefficient for ($PVA\text{-}ZnCl_2$) composite with various photon energy

Figure(6) shows variation of refractive index of ($PVA\text{-}ZnCl_2$) composites as a function of photon energy. From this figure, we can see the refractive index increases with increasing zinc chloride weight percentages which related to increase the reflection with increase zinc chloride concentration because increase the density (Tariq, 2010).

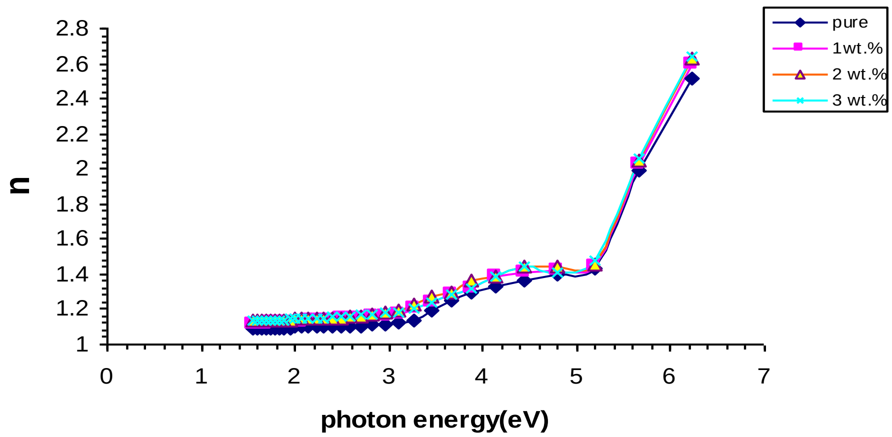

FIG.6

The relationship between refractive index for (PVA-$ZnCl_2$) composite with photon energy

The variation of real (ε_1) and imaginary(ε_2) parts of dielectric constants of composites with photon energy are shown in figures (7 and 8). These figures show the real and imaginary parts of dielectric constants are increase with increasing the zinc chloride concentration, this behavior attribute to the variation of real part depends on refractive index because of small values of extinction coefficient and the imaginary part depends on the extinction coefficient values which are related to the variation of absorption coefficients(Nahida & Marwa. 2011, NICOLAE . 2008).

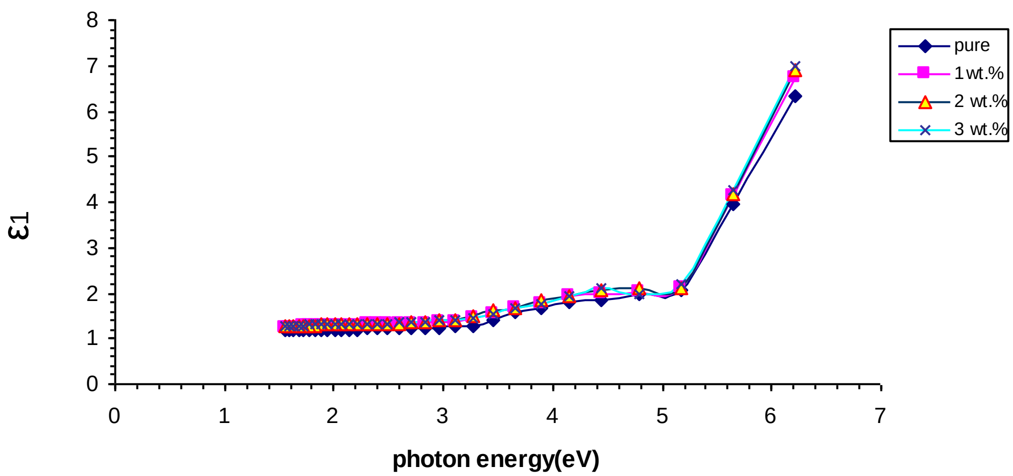

FIG.7

The variation of real part of dielectric constant (PVA-$ZnCl_2$) composite with photon energy

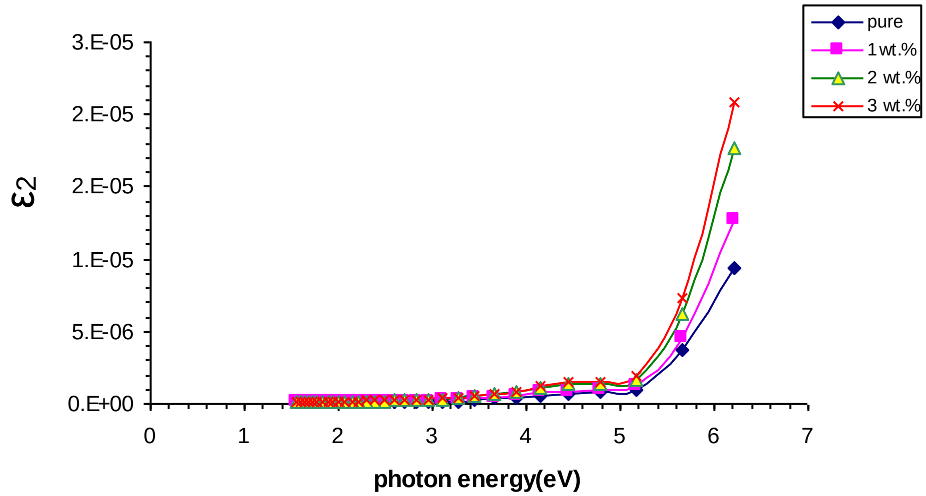

FIG.8

The variation of imaginary part of dielectric constant($PVA-ZnCl_2$) composite with photon energy

Conclusions

The results showed that the absorption coefficient of ($PVA-ZnCl_2$) composites less than 10^4 cm^{-1} this is indicate to composites have forbidden and allowed indirect electronic transition. The energy band gap of ($PVA-ZnCl_2$) composites decreases with increase zinc chloride concentration. The optical constants(coefficient ,indirect energy band gap, extinction coefficient, refractive index and real and imaginary parts of dielectric constants) are increasing with increase the zinc chloride weight percentages.

References

Bulinski, M.; Kuncser, V.; Cristea, D.; Plapcianu, C.; Krautwald, S.; Franke, H.; Wagner, F. E.; Filoti, G.2003, "optical and electronic properties metal doped polymers for integrated optics", J. of Optoelectronics and Advanced Materials Vol. 5, No. 1, p.331 - 335.

Gabriel Pinto and Abdel-Karim Maaroufi, 2011, "Critical filler concentration for electroconductive polymer composites", Society of Plastics Engineers (SPE), 10.1002/spepro.003521.

Hamed M. Ahmad, Sabah H. Sabeeh, Sarkawt A. Hussen, 2012, " Electrical and Optical Properties of PVA/LiI Polymer Electrolyte Films", Asian Transactions on Science & Technology, Vol. 1, No.6, p.16-20.

Lyly Nyl Ismail, Habibah Zulkefle, Sukreen Hana Herman, and Mohamad RusopMahmood, 2012, "Influence of Doping Concentration on Dielectric, Optical, and Morphological Properties of PMMA Thin Films", J. of Advances in Materials Science and Engineering, doi:10.1155/2012/605673.

Nahida. J. H. & Marwa. R. F, 2011, Study of the Optical Constants of the PMMA/PC Blends, Eng. & Tech. Journal ,Vol.29, No.4.

Nicolae Þigău, 2008, " Structural Characterization And Optical Propertiesof Annealed Sb2s3 Thin Films", Rom. Journ. Phys., Vol. 53, P. 209–215, Bucharest.

Tariq J. Alwan, 2010, "Refractive Index Dispersion and Optical Properties of Dye Doped Polystyrene Films", Malaysian Polymer Journal, Vol. 5, No. 2, p. 204-213.