The Effect of $NiNO_3$ on Optical Properties for (PVA- PEG) Composites Polymers

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Abstract
The present paper is aimed to modification of the optical properties of poly-vinyl alcohol and poly-ethylene glycol with different concentrations of ($NiNO_3$). The absorption and transmission spectra have been recorded in the wavelength range (200-800)nm . The absorption coefficient and energy gap of the indirect allowed and forbidden transition have been determined, Also, extinction coefficient, index coefficient, real and imaginary part of dielectric constant have been calculated.
Keywords: optical properties, polymer composites, optical constants, polyethylene glycol.

Introduction

The study of the optical absorption spectra in solids provides essential information about the band structure and the energy gap in the crystalline and non-crystalline materials. Analysis of the absorption spectra in the lower energy part gives information about atomic vibrations while the higher energy part of the spectrum gives knowledge about the electronic states in the atom[Omed Ghareb and Sarkawt Abubakr, 2010]. The important increasing for using polymer blending and polymer composites came from results of industrial and large technology development which it was seeing in world and as substitute from traditional engineering materials which its used in industry[Moayad Abd,2008]. The development of polymer systems with high ionic conductivity is one of the main objectives in polymer research. This is because of their potential applications as electrolytes in solid-state batteries, fuel cells, electrochemical display devices/smart windows, photo electrochemical cells etc., due to their high conductivity, high energy density, wide electrochemical stability and easy process ability. The main advantages of polymer electrolytes are their mechanical properties, ease of fabrication of thin films of desirable sizes and their ability to form proper electrode/electrolyte contact in electrochemical devices[U. Sasikala et al, 2012].

Experimental Part

The materials used in the paper is poly-vinyl alcohol and poly-ethylene glycol with different additives of ($NiNO_3$)as a filler.

The electronic balanced of accuracy 10^{-4} have been used to obtain a weight amount of ($NiNO_3$) powder and polymer powder . These mixed by Hand Lay up and the Microscopic Examination used to obtain homogenized mixture . The weight percentages of ($NiNO_3$) are (0 ,5, 10,15) wt%. The casting technique was used to preparation the composites and thickness ranged between (0.015-0.007)mm. The transmission & absorption spectra of (PVA- PEG-$NiNO_3$) composites have been recording in the length range (200-800) nm using double-beam spectrophotometer (UV-1800^{o}A shimedza)

Results and Discussion

Fig. (1): shows absorbance as function of wavelength accident light, we note the intensity of the peak increase as a result of increasing ($NiNO_3$) concentration.

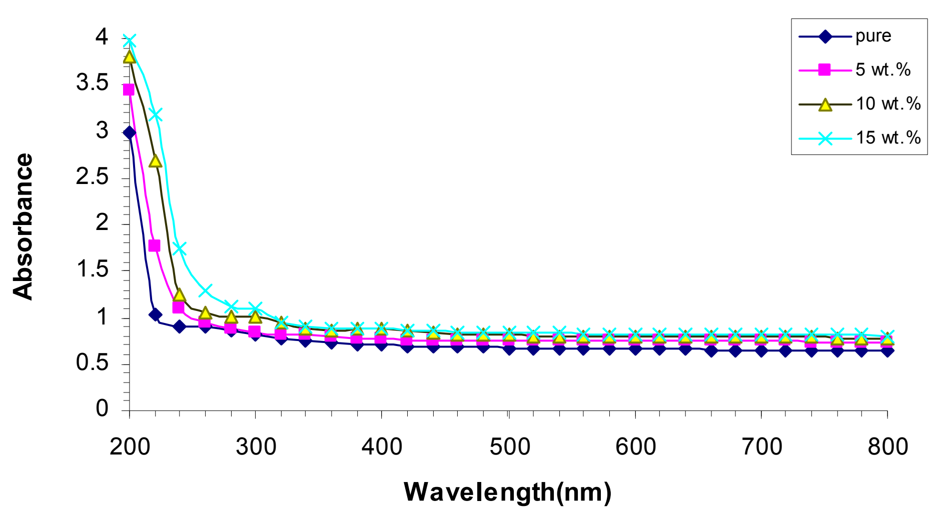

FIG.1
The variation of optical absorbance for composite with wavelength

The absorption coefficient (α) was calculated in the fundamental absorption region from the following equation[Hutagalwng and Lee ,2007]:

$$\alpha = 2.303\frac{A}{d} ....(1)$$

Where: A is absorbance and (d) is the thickness of sample.

Fig. (2): shows the relationship between the absorption coefficient and photon energy of the (PVA-PEG-$NiNO_3$) composites. The change in the absorption coefficient is small at low energies this is indicates the possibility of electronic transitions is a few. At high energy, the change of absorption coefficient is large this

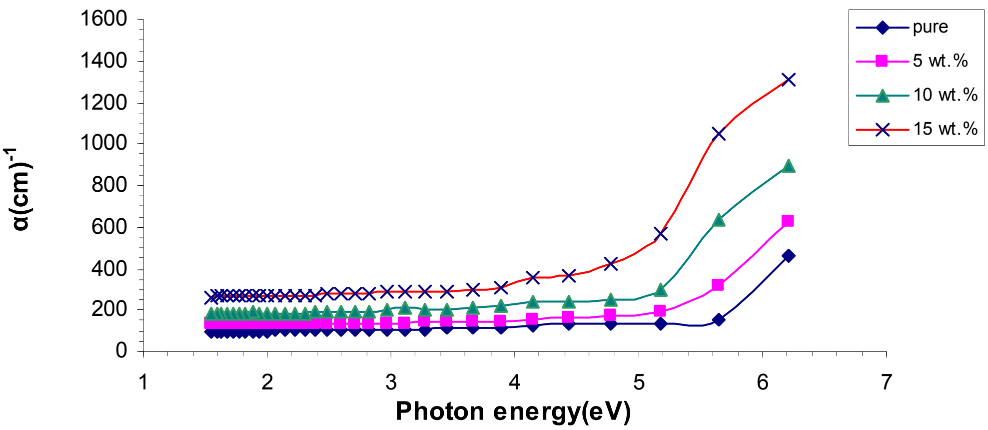

FIG.2
The absorption coefficient for composite with various photon energy

is indicates the large probability of electronic transitions are the absorption edge of the region[S. M Scholz *et al*,2008].The absorption coefficient helps to conclude the nature of electronic transitions, when ($\alpha<10^4 cm^{-1}$) at low energies we expected in this case indirect electronic transitions, the momentum of the electron and photon preserves by phonon helps[B.Thangaraju and P. Kalianna,2000].The forbidden energy gap of indirect transition both allowed, forbidden calculated according to the relationship[A.Kathalingam et.al. , 2007] :

$$\alpha h\nu = A\left(h\nu - E_g\right)^m \text{ ....(2)}$$

Where : hv is the energy of photon , A is proportionality constant, Eg is forbidden energy gap of the indirect transition.

If the value of (m=2) indicates to allowed indirect transition . when the value of (m=3) indicates to forbidden indirect transition. Figures(3 and 4) shows the dependence of the absorption edge $(\alpha h\upsilon)^{1/m}$ of (PVA-PEG-$NiNO_3$) composites of different filler contents ($NiNO_3$) as a function of the energy of the incident light (hυ). The obtained results showed that E_{opt} decreased with increase the ($NiNO_3$) concentration.

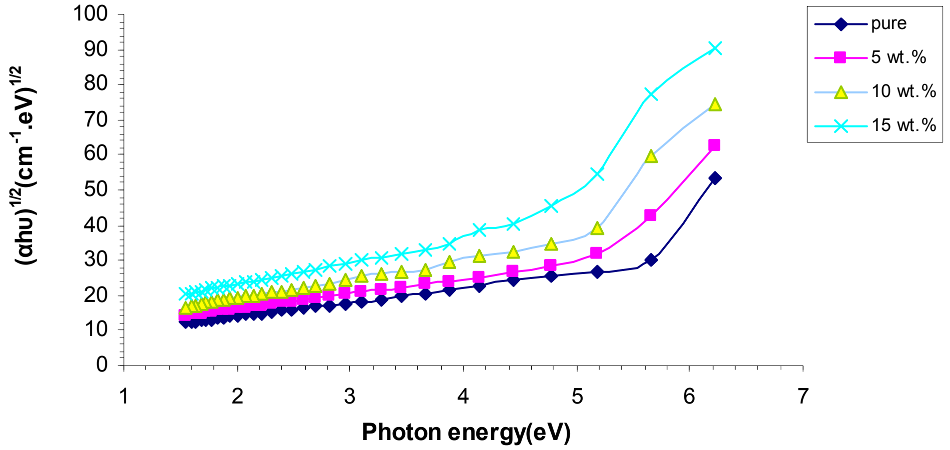

FIG.3

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

This behavior can be attributed to the fact that in heterogeneous composites, the electrical conduction depends on defect and impurities [Soliman . L. I and Sayed. W. M,2002].

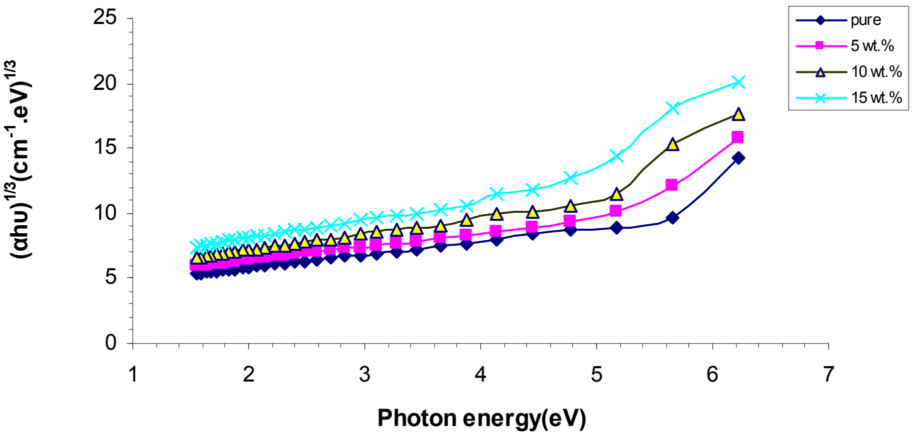

FIG.4

the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of (PVA-PEG-$NiNO_3$) composites.

The extinction coefficient (k) was calculated in the fundamental absorption region from the following equation[H.Frohlich,1958]:

$K = \alpha\,\lambda /4\,\pi$ ………………….(3)

Where : λ wave length of accident light

Fig. (5) shows the relationship between the extinction coefficient and photon energy of the (PVA-PEG-$NiNO_3$) composites we note in low construction of ($NiNO_3$) additive the extinction coefficient small but when increase of ($NiNO_3$) additive the extinction coefficient increasing because of increasing of absorption coefficient (α)

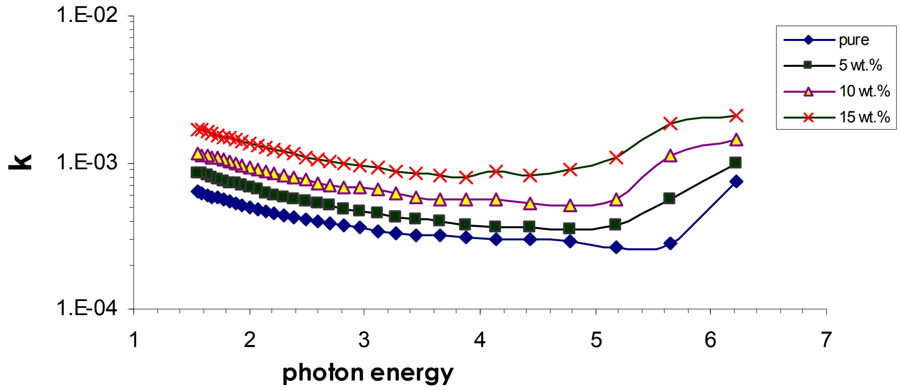

FIG.5
The extinction coefficient for (PVA-PEG-$NiNO_3$) composite with various photon energy

We found refractive index (n) from relation below (A.Zaky and R.Hawley,1970)

$n =((4R/(R-1)^2 - k^2) - (R+1)/(R-1))^{1/2}$ ……………….(4)

Where R: Reflectance , k :Extinction Coefficient

Fig. (6) shows the relationship between refractive index and photon energy of the (PVA-PEG-$NiNO_3$) composites, we note the change in the refractive index where it increase as $NiNO_3$ increases special in range (5-7 eV) photon energy because low wave length in this range , the reason of increase in refractive index of (PVA-PEG-$NiNO_3$) composites to high absorbance for ($NiNO_3$) addition.

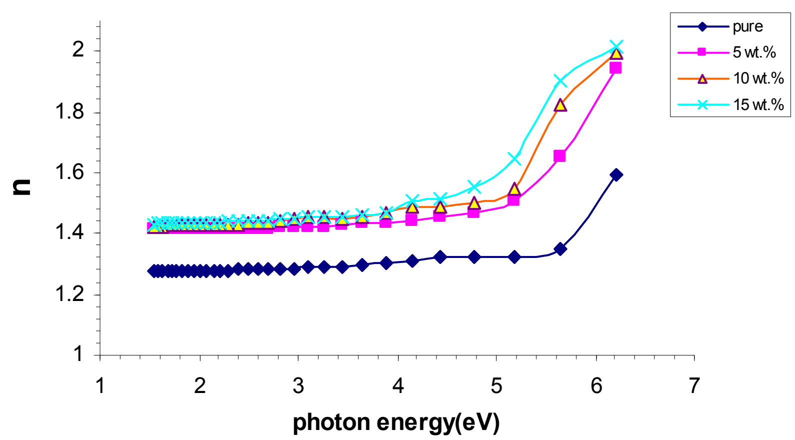

FIG.6
The relationship between refractive index for composite with photon energy

The real part of dielectric constant (ε_1) was calculated from the following equation[S.P.Seth and D.V.Gupta,1981]:

$\varepsilon_1 = n^2 - k^2$ …………………….(5)

Fig. (7) shows the relationship between the variation of real part of dielectric constant and photon energy of the (PVA- PEG-$NiNO_3$) composites we note the real part of dielectric constant depend on refractive index(n) greatly since the extinction coefficient (k) its small in addition of in low construction of ($NiNO_3$) additive the real part of dielectric constant is a small but when increase of ($NiNO_3$) additive the real part of dielectric constant of the (PVA- PEG-$NiNO_3$) increasing because of increasing of absorption coefficient (α).

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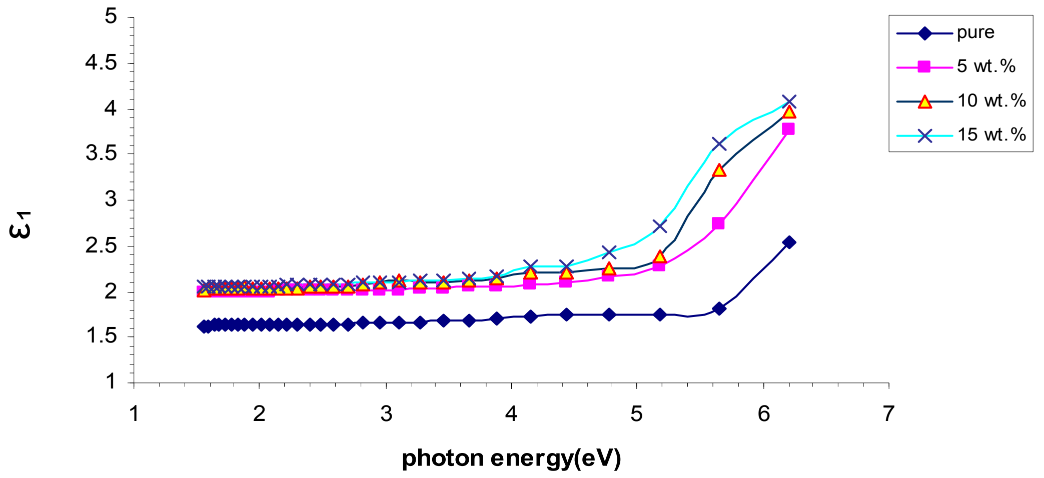

FIG.7
The variation of real part of dielectric constant (PVA-PEG-$NiNO_3$) composite with photon energy

The imaginary part of dielectric constant (ε_2) was calculated from the following equation[H.A.Sarvetnick,1969]:

$\varepsilon_2 = 2nk$……………………..(6)

Fig. (7) shows the relationship between the variation of imaginary part of dielectric constant and photon energy of the (PVA- PEG-$NiNO_3$) composites, we note the imaginary part of dielectric constant depend on refractive index(n) and extinction coefficient (k) in addition of in low construction of ($NiNO_3$) additive the imaginary part of dielectric constant is a small but when increase of ($NiNO_3$) additive the imaginary part of dielectric constant of the (PVA- PEG-$NiNO_3$) increasing .

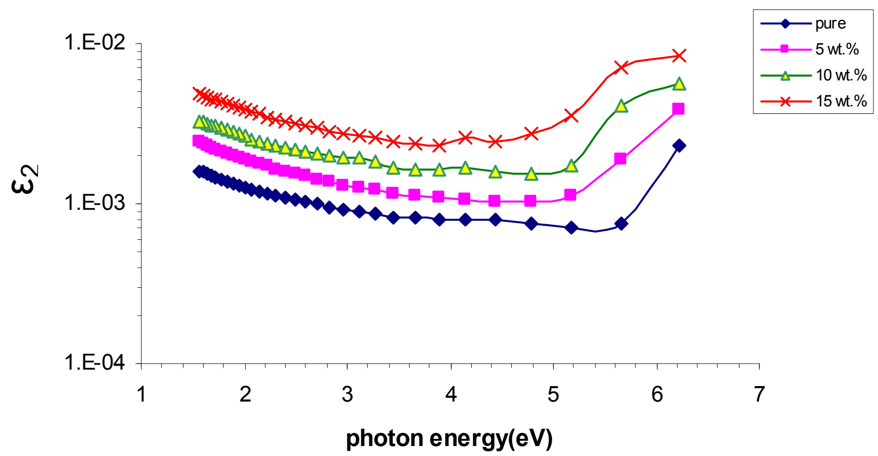

FIG.8
The variation of imaginary part of dielectric constant composite with photon energy

Conclusion

1. The absorption coefficient is increasing with increasing of the filler wt.% content. of $NiNO_3$ additive.
2. The experimental results showed that the absorption coefficient less than $10^4 cm^{-1}$ this is indicates to forbidden and allowed indirect electronic transitions.
3. The forbidden energy gap is decreasing with increasing of the concentration of $NiNO_3$.
4. The extinction coefficient is increasing with increasing of the f concentration of $NiNO_3$ additive.
5. The refractive index is increasing with increasing of the concentration of $NiNO_3$ additive.
6. The Real and Imaginary parts of dielectric constant increasing with increasing of the concentration

of NiNO3 additive.

References

- J.Josshi,Richard L.Lehman,Tomas J.Nosker,"Effect of shear rate and mixer residence times on morphology development and correlation to young's modulus in co-continuous Ps plends",Department of Ceramics and Materials Engineering Rutgers,the State University of NJ 607 Taylor Road,NJ-088541,U.S.A.(2001).
- Moayad abd,"Toughening of High Density Polyethylene with Rubber and Reinforced with Glass fiber" Uni. Of Babylon, College of Engineering,2008.
- Hutagalwng. S. D. and Lee. B. Y. ,2007, Proceeding of the 2nd international conference Nano/Micro Engineered and Molecular systems, January ,Bangkok,Thailand
- Kathalingam. A *.et al* , "Materials Chemistry and physics, 2007,vol.106,No.215.
- Soliman . L. I and Sayed. W. M,2002,"Some physical properties of Vinylpyridine Carbon-Black composites", Cairo, Egypt
- L. Domka, Andrzej Wasicki, Maciej Kozak,"microstructure and Mechanical properties of new HDPE- chalk composites,"Physicochemical problems of mineral processing,37 , pp.141147 (2003) .
- Joy K.Mishra , Keun Joon Hwang,chang Sik Ha," preparation ,Mechanical and Rheoological properties of thermoplastic polyolefin (TPO) Organoclay nano composite with refeence to the effect of Maleicanhydride modified Polypropylene as compatiblizer "Polymer, 46,(2005).
- H.Frohlich, "Theory of Dielectrics",Oxford Uni.Press.1958.
- A.Zaky and R.Hawley, " Dielectric solid",Routlege and kegan paul Ltd,London,Newyerk,1970.
- S.P.Seth,and D.V.Gupta, "Acourse in electrical Engineering Materials" , 2ndEd,Dhanpat Rai and Sons,1981.
- H.A.Sarvetnick, "PVC",Van Nostrand Reinhold Company.1969.
- Omed Ghareb and Sarkawt Abubakr, 2010, "Variation of Optical Band Gap Width of PVA films Doped with Aluminum Iodide", Proceedings of International Conference on Manufacturing Science and Technology, PP.55.
- U. Sasikala, P. Naveen Kumar, V.V.R.N.Rao and A. K. Sharma, 2012, "structural, electrical and parametric studies of PEO based polymer electrolyte for battery applications", international journal of engineering science & advance technology, Vol. 2, No. 33, PP. 722-730.