Electronic Transitions For PMMA Filled With Lithium Fluoride Additive

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Abstract

In the present work , effect of addition Lithium Fluoride on some optical properties of poly-methyl methacrylate has been studied . for that purpose , many samples has been prepared by adding Lithium Fluoride on the poly-methyl methacrylate by different weight percentages from these salts with polymer and by different thickness .The absorption and transmission spectra has been recorded in the wavelength range (300-1100)nm . The absorption coefficient and energy gap of the indirect, allowed, forbidden transition have been determined.

الخلاصة

في هذا البحث تم دراسة تأثير إضافة فلوريد الليثيوم على بعض الخواص البصرية للبولي مثيل ميثاكريلايت. ولهذا الغرض تم تحضير نماذج بإضافة فلوريد الليثيوم إلى البولي مثيل ميثاكريلايت وبنسب وزنية مختلفة من هذه الأملاح مع البوليمر وبسمك مختلف.تم تسجيل طيفي الامتصاص و النفاذية و لمدى الاطوال الموجية (300-1100)nm. و حساب معامل الامتصاص و فجوة الطاقة للانتقال غير المباشر المسموح و الممنوع.

Introduction

Polymers have traditionally been considered as insulating materials by chemists and physicists alike . A conducting polymer is chewable and desirable . A light weight ready moldable , desirable conductive material has long been recognized as a worthwhile goal to work

for[1,2].Researches, generally, have demonstrated that conductive polymers can be used as energy storage element in:[3,4]
1- Capacitors and Secondary batteries .
2- As semiconductor material in schottky diode.
3- Insulated gate field effect transitions (FET) and light emitting diodes.
4- As conductive layer for electromagnetic shelding (EMI) and electrostatic protection.

In the recent years conjugated conducting polymers have been the main focus of research throughout the world . Since the discovery led by 2000 chemistry Nobel winners, Shirakawa, MacDiarmid and Heeger , the perception that plastic could not conduct electricity has changed Nowadays, conducting polymers also known as conductive plastics are being developed for many uses such as corrosion inhibitors, compact capacitors, antistatic coating, electromagnetic shielding and smart windows; which capable to vary the amount of light to pass[5,6] .

LiF material is extensively used because of interesting optical properties (high band gap, transparent to uv-visible light, low refractive index) which are considered for various optical applications such as windows, prism and lenses in the vacuum uv, visible and infrared here desired transmission in the 0.104µm-7µm range[7]. It is also very useful for X-ray nonochromaters and for the study of fundamental properties and defect in crystal[8]. This paper deals with results of the effect of LiF on the some optical properties of poly-methyl methacrylate.

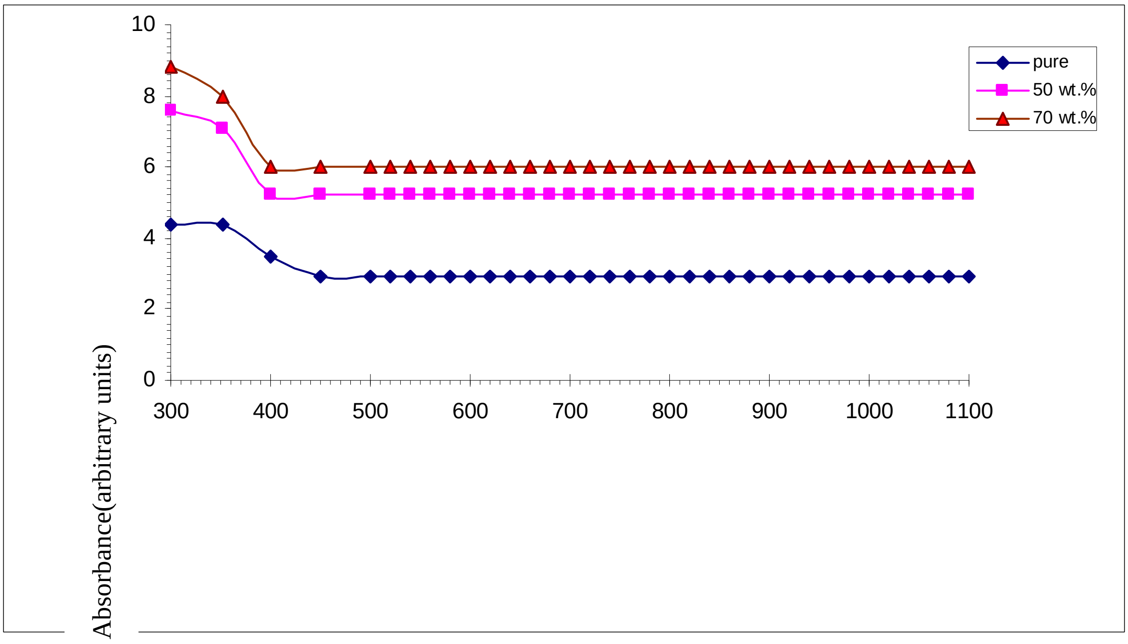
Experiment

The materials used in the papar is poly-methyl methacrylate as matrix and Lithium fluoride as a filler.

The electronic balanced of accuracy 10^{-4} have been used to obtain a weight amount of LiF powder and polymer powder .These mixed by Hand Lay up and the Microscopic Examination used to obtain homogenized mixture .The volume percentages of LiF which equivalent weight percentages are (0 ,50 , 70) wt%. The Hot Press method is used to press the powder mixture. The mixture of different LiF percentages have been compacted at temperature 145^{o}C under a pressure 100 par for 10 minutes . Its cooled to room temperature , the samples were disc shap of a diameter about 30mm and thickness ranged between (1.75-2.2). The transmission & absorption spectra of PMMA-LiF composites have been recording in the length range (300-1100) nm using double-beam spectrophotometer (UV-210^{o}A shimedza).

Results and Discussion

The optical absorbance as a function of the wavelength of the incident light for PMMA-LiF composites of various filler contents is shown in figure (1) . The figure shows that the intensity of the peak increased as a result of filler addition but no shift in the peak position, i.e. adding different amounts of filler to pure polymer do not change the chemical structure of the material but new physical mixture is formed.



Figure(1): Optical Absorbance for PMMA composite with various LiF concentration.

The absorption coefficient (α) was calculated in the fundamental absorption region from the following equation[9]:

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

Where : A is absorbance , d is the thickness of sample.

Figure (1) shows the relationship between the absorption coefficient and photon energy of the PMMA-LiF composites we note 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 is indicates the large Probability of electronic transitions are the absorption edge of the region [10]. The absorption coefficient helps to conclude the nature of electronic transitions, when the high absorption coefficient values ($\alpha > 10^4 cm^{-1}$) at high energies we expected direct electronic transitions ,and the energy and momentum preserve of the electron and photon , when the values of absorption coefficient is low($\alpha<10^4 cm^{-1}$) at low energies we expected in this case indirect electronic transitions, the momentum of the electron and photon preserves by phonon helps[11].

The results showed that the values of absorption coefficient of the PMMA-LiF composites less than $10^4 cm^{-1}$ which indicates to the indirect electronic transition . .

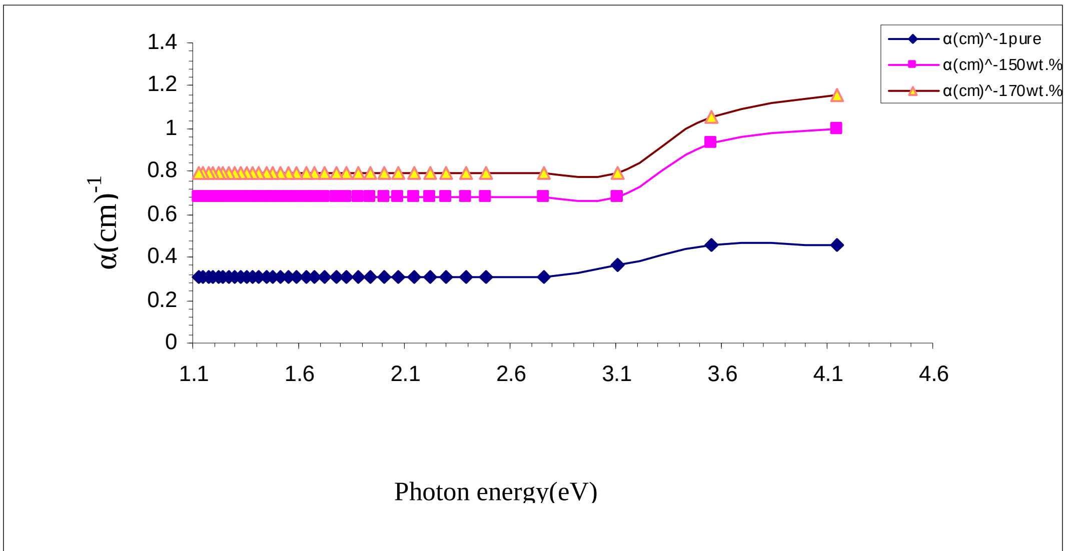


Figure (2) the relationship between the absorption coefficient and photon energy of the PMMA-LiF composites

The forbidden energy gap of indirect transition both allowed, forbidden calculated according to the relationship[12] :

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

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 ton allowed indirect transition . when the value (m=3) indicates to forbidden indirect transition. Figure (3) shows the relationship between $(\alpha hv)^{1/2}$ $(cm^{-1}.eV)^{1/2}$ and the photon energy of pure polymer (PMMA), with

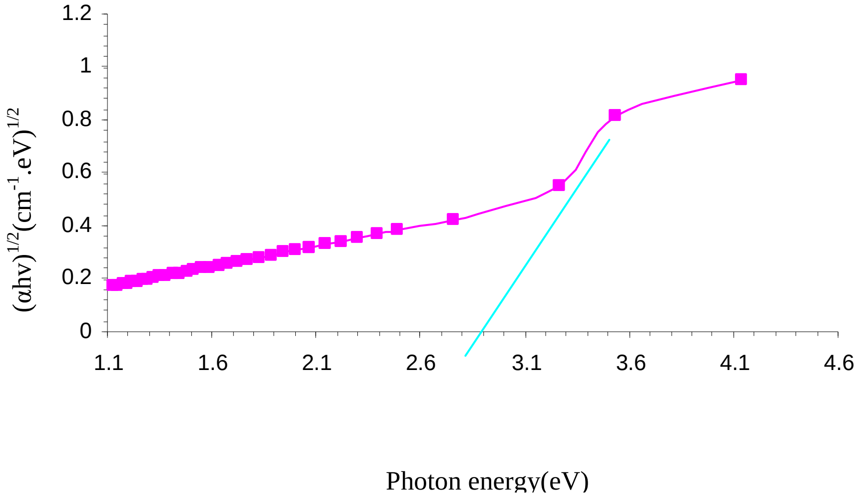


Figure (3) the relationship between $(\alpha hv)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of pure polymer (PMMA).

take over part of the straight cut oriented axis at the point $(\alpha hv)^{1/2}=0$ will get the value of forbidden energy gap of the allowed indirect transition , which equal (2.82eV). Figure (4) and figure (5) represents the same relationship but to the polymer filled with (LiF) with volume percentages of LiF are(50 , 70) wt.% ,the same way we

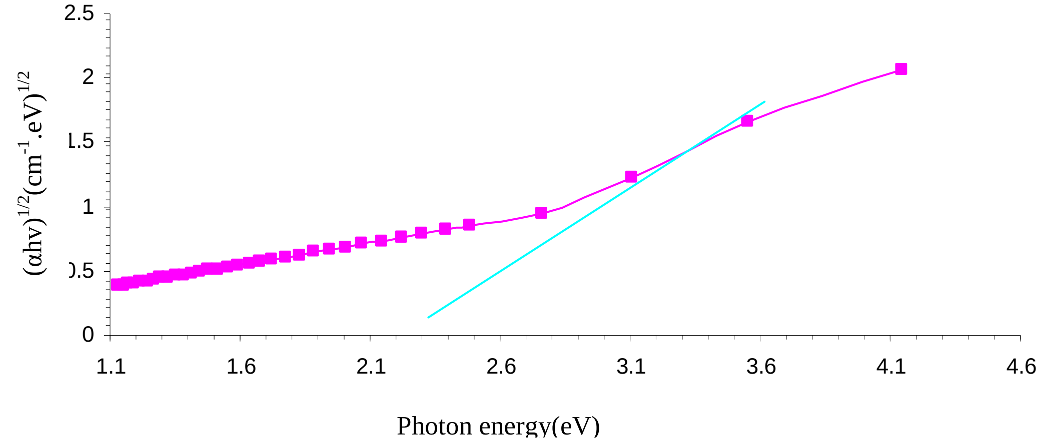


Figure (4) the relationship between $(\alpha h\nu)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PMMA-LiF composites for 50wt.% LiF

can be obtained on the value of forbidden energy gap of allowed indirect transition which equal (2.23eV) for 50wt.% LiF, and (2eV) for 70wt.% LiF.   .

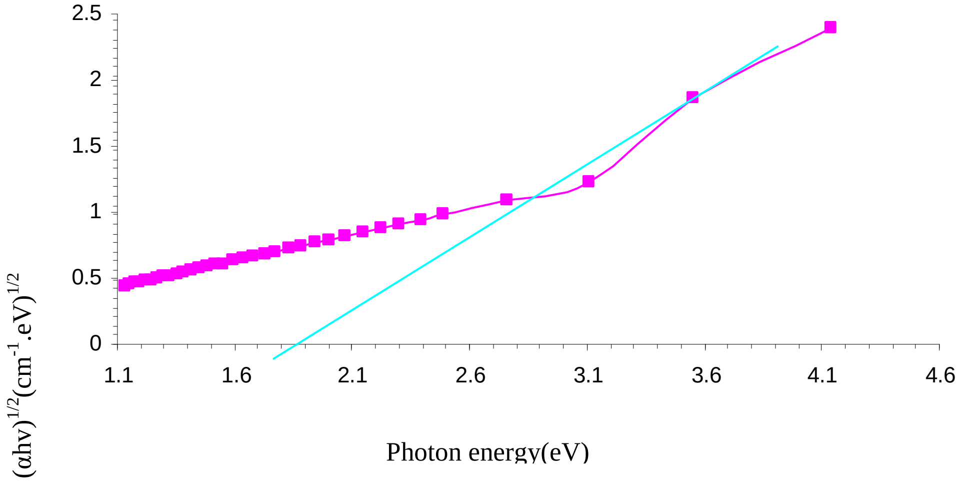


Figure (5) the relationship between $(\alpha h\nu)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PMMA-LiF composites for 70wt.% LiF we note that the value of the forbidden energy gap decreases with increasing LiF concentration.. Figure(6) shows the relationship between the $(\alpha hv)^{1/3}$ $(cm^{-1}.eV)^{1/3}$ and photon energy of pure polymer (PMMA) , the same way we obtain to the forbidden energy

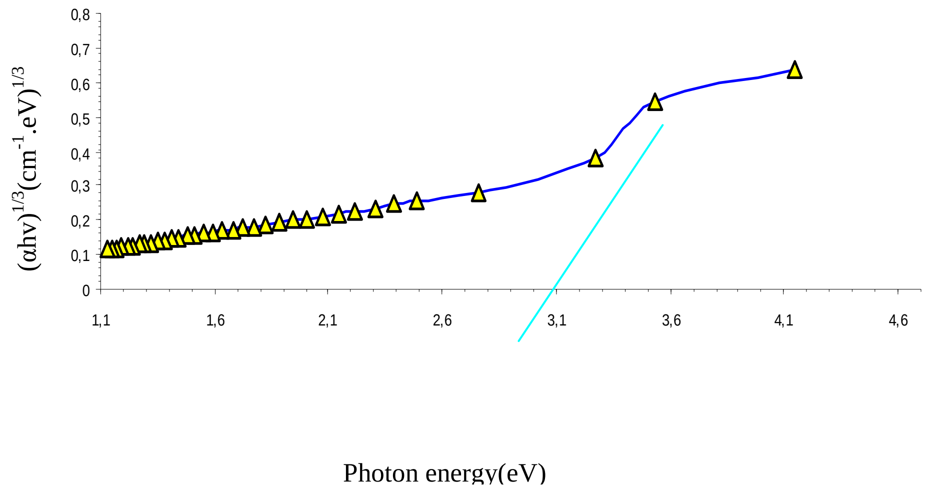
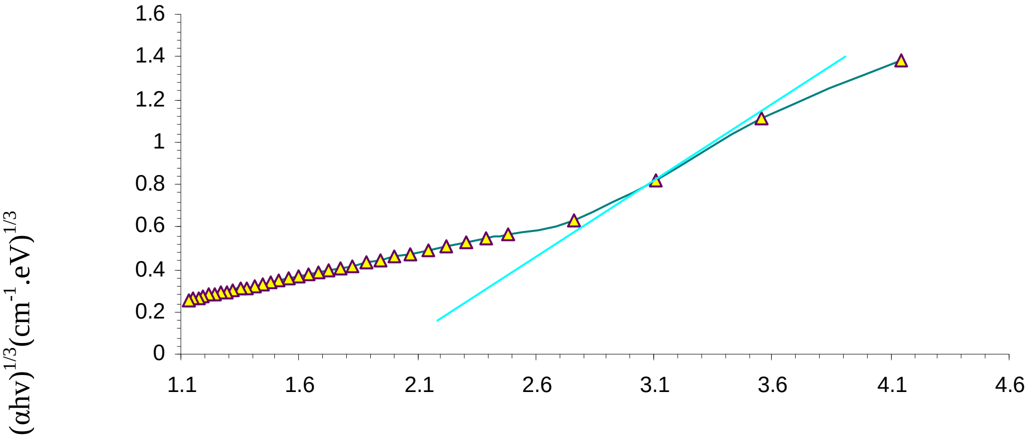


Figure (6) the relationship between $(\alpha hv)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of pure polymer (PMMA).

gap of forbidden indirect transition which equal (2.8eV). Figure (7) and figure (8) represents the same relationship but to the polymer filled with (LiF) with volume percentages of LiF are (50 , 70) vol% ,the same way we can be obtained on the value of the forbidden energy gap of the forbidden indirect transition which equal (2eV) for 50wt.% LiF and (1.9eV) for 70wt.%. we note that the value of the energy gap decreases with increasing LiF concentration[13]



Photon energy(eV)

Figure (8) the relationship between $(\alpha hv)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of of PMMA-LiF composites for 50wt.% LiF

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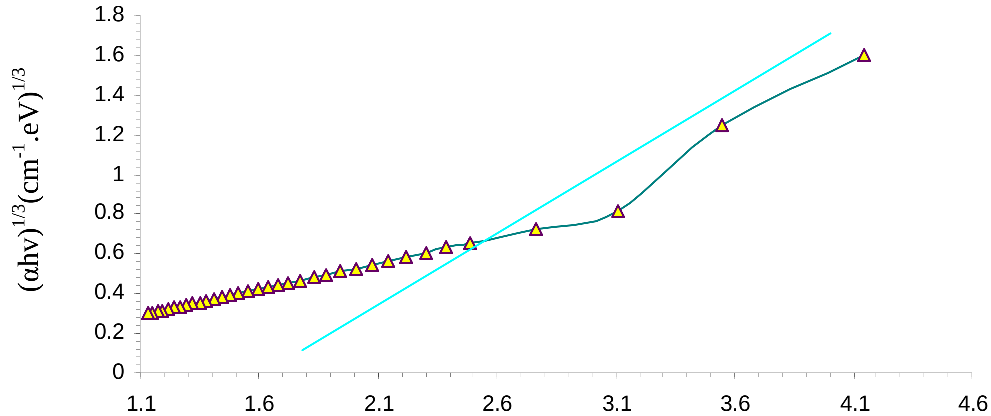

Photon energy(eV)

Figure (8) the relationship between $(\alpha hv)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of of PMMA-LiF composites for 70wt.% LiF

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Conclusion

1. The absorption coefficient is increasing with increasing of the filler wt.% content.
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 LiF additive change not the nature of electronic transfers of PMMA samples.
4. The forbidden energy gap is decreasing with increasing of the filler wt.% content.

References

1-Blyth A. R., (1979),"Electrical properties of polymers", London-New York,.

2- Ramos M. V. et .al , 2005," conductive polymer- copmposite Sensor for Gas Detection ", Newzeland.

3- Seanor D.A., (1982)"Electrical properties of polymers", New York.

4- Alvarez M. P. et.al, 2008, " Submicron Copper- Low- Density polyethylene conducting composites : Structural, Electrical and percolation Threshold" ,Chile.

5-Harun M. H. et. al, 2009,"Temperature dependence of A.C electrical conductivity of PVA-PPY-FeCl3 composite polymer flims", Malaysia , Malaysian polymer Jounal (MPJ), Vol. 3, No. 2 , p(24-31) .

6- Al-Ramadhan. Z. , 2008,"Effect of Nickel salt on electrical properties of polymethylmethacrylate" , Al-Mustansiriyah Uni..

7- Heath P. and Sacher P.,1986 ,"Quality crystals and optics for laser applications", Applied opt. , vol. 15 , No. 937.

8-Reale L. et al ,2008, "X-ray microscopy of plan cells by using LiF crystal", microscopy research and technique.

9- Hutagalwng. S. D. and Lee. B. Y. ,2007, Proceeding of the 2nd international conference Nano/Micro Engineered and Molecular systems, January ,Bangkok,Thailand.

10-Scholz. S.M, Carrot.G and Hilborn.J ,2008, "Optical properties of Gold- Containing poly (Acrylic Acid) composites" , Lausanne, Switzerland.

11-Thangaraju B. , Kalianna P. ,2000,Cryst. Res. Techon., vol. 35, No.71.

12-Kathalingam A.*et al*,2007, "Materials Chemistry and physics, vol.106,No.215.

13-Soliman . L. I and Sayed. W. M,2002,"Some physical properties of Vinylpyridine Carbon-Black composites", Cairo, Egypt.