The Effect of LiF Additives on Some Optical Properties of (HDPE-LiF) Composites

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Abstract

In the present work ,the effect of adding Lithium Fluoride on some optical properties of High Density Polyethylene has been studied . For that purpose , many samples have been prepared by adding Lithium Fluoride to the High Density Polyethylene with different weight percentages of this salts with polymer and with different thickness .The absorption and transmission spectra have been recorded in the wavelength range (190-1100)nm . The absorption coefficient and energy gap of the indirect allowed and forbidden transition have been determined. The results showed that the absorption coefficient increases and energy gap of the indirect allowed and forbidden decreases with increase the weight percentage of Lithium Fluoride.

الخلاصة

تم في هذا البحث دراسة تأثير إضافة فلوريد الليثيوم على بعض الخواص البصرية للبولي اثيلين عالي الكثافة . ولهذا الغرض تم تحضير نماذج بإضافة فلوريد الليثيوم إلى البولي اثيلين عالي الكثافة وبنسب وزنية مختلفة من هذه الأملاح مع البوليمر وبسمك مختلف.تم تسجيل طيفي الامتصاص و النفاذية و لمدى الاطوال الموجيةnm(190−1100). و حساب معامل الامتصاص و فجوة الطاقة للانتقال غير المباشر المسموح و الممنوع. . وبينت النتائج ان معامل الامتصاص يزداد وفجوة الطاقة للانتقال غير المباشر المسموح والممنوع تقل مع زيادة النسبة الوزنية لفلوريد الليثيوم.

Introduction

In general the interaction of electromagnetic radiation (light) with matter is controlled by three properties, the specific conductivity, the electric conductive capacity and the magnetic inductive capacity. These properties are related to the refractive index and the absorption index of the medium. All material bodies possess a number of critical frequencies at which radiation is in resonance with some internal variation of the body. At these critical frequencies such bodies are strong absorbs of radiation, even if they are transparent to radiation on either side of the critical frequency. Among the optical properties reaction, reflection and scattering of light are the most important [Majdi K. *et.al*.,1997]. Filled polymer composites have a wide range of industrial applications-they are used in anti-static materials, self regulating heaters, over current and over temperature protection devices, and materials for electromagnetic radiation shielding[Bhattacharya *at al*, 2008]

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[Heath and Sacher, 1986]. This work deals with results of the effect of LiF on the some optical properties of High Density Polyethylene.

Experiment

The materials used in the papar is High Density Polyethylene as matrix and Lithium fluoride as a filler.

The electronic balanced of accuracy 10^{-4} has been used to obtain a weight amount of LiF powder and polymer powder . These are mixed by Hand Lay up and the Microscopic Examination used to obtain homogenized mixture . The weight percentages of LiF are (0 ,45 and 62) wt.%. The Hot Press method is used to press the powder mixture. The mixture of different LiF percentages have been compacted at temperature 110^{o}C under a pressure 100 Par for 10 minutes . It is cooled to room temperature , the samples were disc shaped of a diameter about 30mm and thickness ranged between (1.83-2.2)mm. The transmission & absorption spectra of HDPE-LiF composites have been recorded in the wavelength range (190-1100) nm using double-beam spectrophotometer (UV-210°A shimedza).

Results and Discussion

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

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

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

Figure (1) shows the relationship between the absorption coefficient and photon energy of the HDPE-LiF composites. We note the change in the absorption coefficient is small at low energies, this indicates the possibility of electronic transitions is small. At high energy , the change of absorption coefficient is large this indicates the

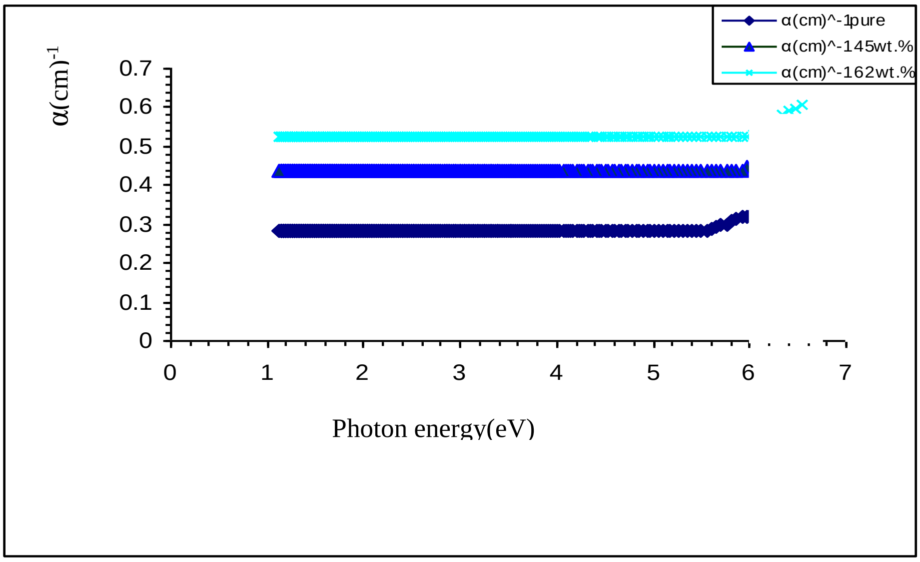

Figure (1) the relationship between the absorption coefficient and photon energy of the HDPE-LiF composites

large probability of electronic transitions at the absorption edge of the region [Scholz *et al*,2008]. The absorption coefficient helps to conclude the nature of electronic transitions, when the absorption coefficient values are high ($\alpha > 10^4 cm^{-1}$) at high energies we expect direct electronic transitions ,and the energy and momentum of the electron and photon are persevered, when the values of absorption coefficient are low($\alpha < 10^4 cm^{-1}$) at low energies we expect are indirect electronic transitions, the momentum of the electron and photon preserved by phonon helps[Thangaraju and Kalianna,2000]. The results show that the values of absorption coefficient of the HDPE-LiF composites are less than $10^4 cm^{-1}$ which indicates the indirect electronic transition. The forbidden energy gap of indirect transition both allowed, forbidden is calculated according to the relationship[Kathalingam *et.al.*,2007]:

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

Where : hv is the energy of photon , A is the proportionality constant and E_g is the forbidden energy gap of the indirect transition.
The value of (m=2) indicates allowed indirect transition . The value (m=3) indicates to forbidden indirect transition. Figure (2) shows the relationship between $(\alpha hv)^{1/2}$ $(cm^{-1}.eV)^{1/2}$ and the photon energy of pure polymer (HDPE) , with taking the

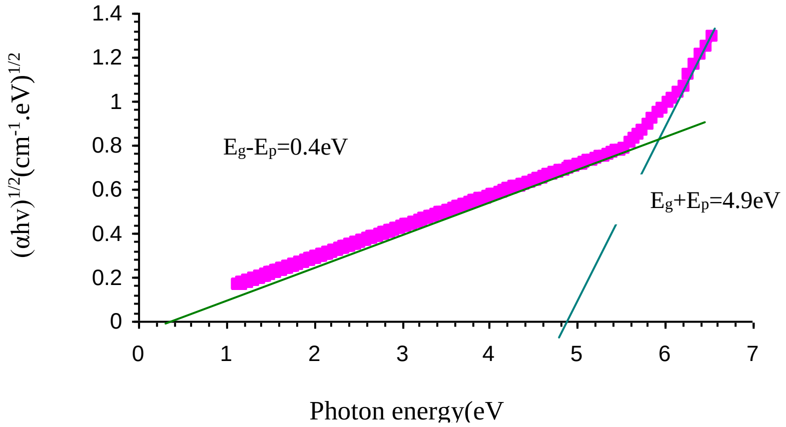

Figure (2) the relationship between $(\alpha hv)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of pure polymer (HDPE).

value the straight line 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 equals (5.3eV). Figure (3) and figure (4) represent the same relationship but to the polymer filled with (LiF) with weight percentages of LiF are (45 , 62) wt.% , the same way

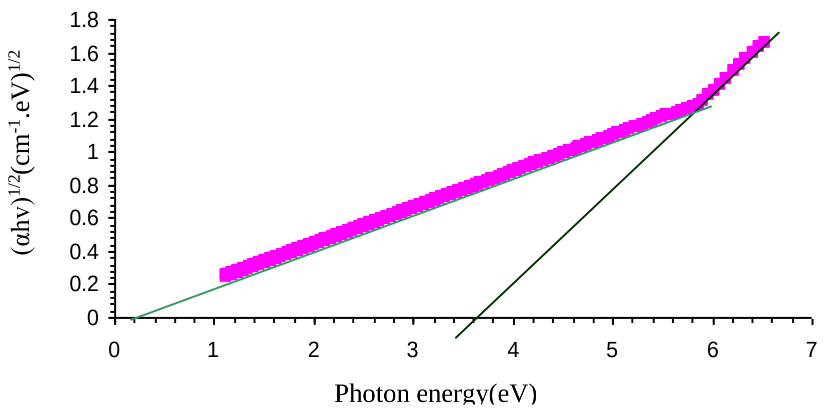

Figure (3) the relationship between $(\alpha hv)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of HDPE-LiF composites for 45 wt.% LiF

we can be obtained on the value of forbidden energy gap of allowed indirect transition which equal(3.94eV) for 45 wt.% LiF, and(3.7eV)for 62 wt.% LiF . we note that

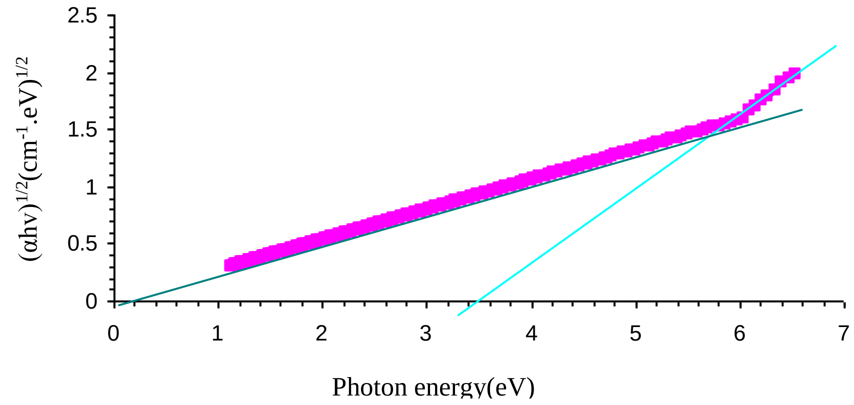

Figure (4) the relationship between $(\alpha h\nu)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of HDPE-LiF composites for 62 wt.% LiF

the value of the forbidden energy gap decreases with increasing LiF concentration.. Figure(5) shows the relationship between the $(\alpha h\nu)^{1/3}$ $(cm^{-1}.eV)^{1/3}$ and photon energy of pure polymer (HDPE), by the same way we obtain the forbidden energy gap of

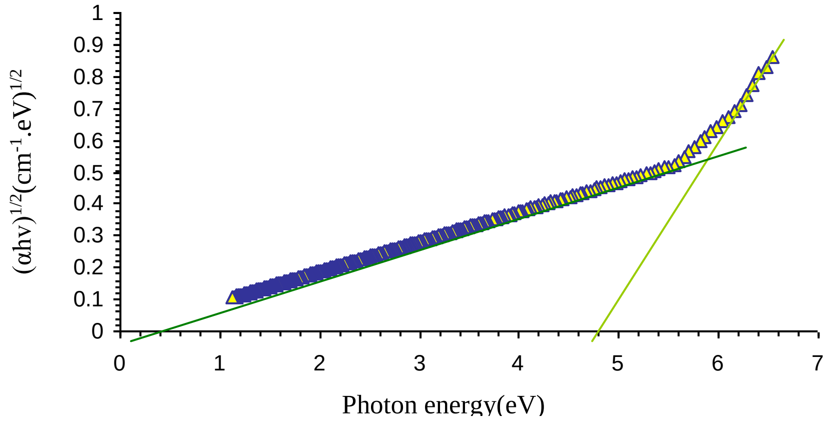

Figure (5) the relationship between $(\alpha h\nu)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of pure polymer (HDPE).

indirect transition which equal (5.2eV) . Figure (6) and figure (7) represent the same relationship but to the polymer filled with (LiF) with weight percentages of LiF of (45,62) wt.%, by the same way we can obtain the value of the forbidden

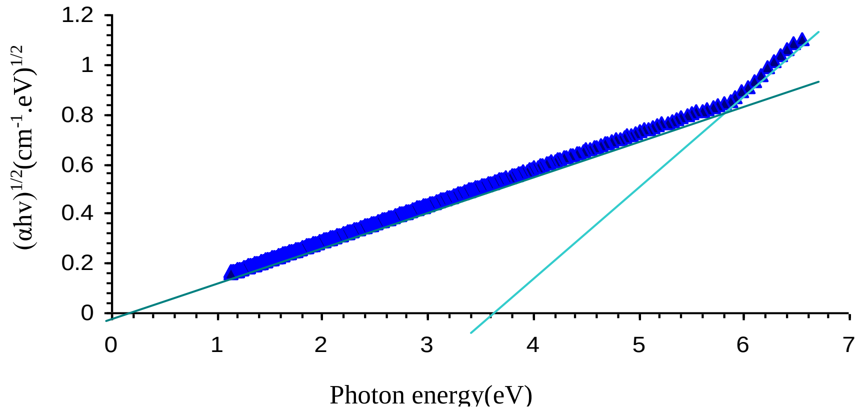

Figure (6) the relationship between $(\alpha h\nu)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of of HDPE-LiF composites for 45 wt.% LiF

forbidden energy gap of the forbidden indirect transition which equals (3.87eV) for 45wt.% LiF, and (3.64eV) for 62 wt.% LiF we note that the value of the energy

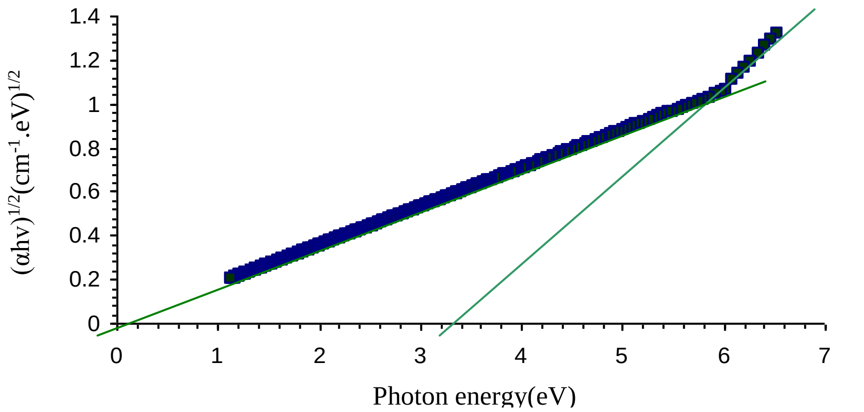

Figure (7) the relationship between $(\alpha h\nu)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of of HDPE-LiF composites for 62 wt.% LiF

gap decreases with increasing LiF concentration[Soliman and Sayed,2002].

Conclusion

1. The absorption coefficient increase with increasing of the filler vol.% content.
2. The experimental results show that the absorption coefficient is less than $10^4 cm^{-1}$, this indicates forbidden and allowed indirect electronic transitions.
3. The forbidden energy gap decreases with increasing of the filler wt.% content.

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