Effect of addition $AgNO_3$ on some optical properties of polystyrene

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Abstract

In the present work, effect of addition $AgNO_3$ on some optical properties of polystyrene has been studied . for that purpose, many samples has been prepared by adding $AgNO_3$ on the polystyrene by different volume percentages from these salts with polymer and by different thickness.The absorption and transmission spectra has been recorded in the wavelength range (190-1100)nm. The absorption coefficient and energy gap of the indirect, allowed, forbidden transition have been determined.

Keywords: Polystyrene, optical properties, absorption coefficient, energy gap

الخلاصة :

في هذا البحث تم دراسة تأثير إضافة نترات الفضة على بعض الخواص البصرية للبولي ستايرين. ولهذا الغرض تم تحضير نماذج بإضافة $AgNO_3$ إلى البولي ستايرين وبنسب حجمية مختلفة من هذه الأملاح مع البوليمر وبسمك مختلف. تم تسجيل طيفي الامتصاص والنفاذية ولمدى الاطوال الموجية nm(١١٠٠-١٩٠). وحساب معامل الامتصاص و فجوة الطاقة للانتقال غير المباشر المسموح و الممنوع.

الكلمات المفتاحية: بولي ستايرين، خواص بصرية، معامل الامتصاص، فجوة الطاقة.

1- 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(Blyth A.R.,(1979); Ramos M.V.,(2005)),.Researches, generally, have demonstrated that conductive polymers can be used as energy storage element in:(Seanor D.A, (1982); Alvarez M. P.,(2008)):

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(Harun M. H.,(2009); Al-Ramadhan. Z.,(2008)) $AgNO_3$concentration. Figure (5) shows the relationship between the $(\alpha h\nu)^{1/3}$ $(cm^{-1}.eV)^{1/3}$ and photon energy of pure polymer (PS), the same way we obtain to the forbidden energy 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 P. and Sacher P. (1986)). It is also very useful for X-ray nonochromaters and for the study of fundamental properties and defect in crystal(Reale L,(2008)).

2- Experiment :

The materials used in the paper is polystyrene as matrix and $AgNO_3$as a filler. The electronic balanced of accuracy 10^{-4} have been used to obtain a weight amount of $AgNO_3$concentration powder and polymer powder. These mixed by Hand Lay up and the microscopic examination used to obtain homogenized mixture. The volume percentages of $AgNO_3$ which equivalent weight percentages are (0 , 14.6 , 28.5) vol%. The hot press method is used to press the powder mixture. The mixture of different $AgNO_3$ 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 shape of a diameter about 30mm and thickness ranged between (1.75-2.2). The transmission & absorption spectra of PS- $AgNO_3$ composites have been recording in the length range (190-1100) nm using double-beam spectrophotometer (UV-210^{o}A shimedza).

3-Results and Discussion

The absorption coefficient (α) was calculated in the fundamental absorption region from the following equation(Hutagalwng.S.D. and Lee.B.Y.,(2007)):

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

Where : A absorbance , d the thickness of sample.

Figure (1) shows the relationship between the absorption coefficient and photon energy of the PS- $AgNO_3$ 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 (Scholz. S.M, Carrot.G and Hilborn.J, (2008)). 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(Thangaraju B. and Kalianna P.,(2000)).

The results showed that the values of absorption coefficient of the PS- $AgNO_3$ composites less than $10^4 cm^{-1}$ which indicates to the indirect electronic transition .

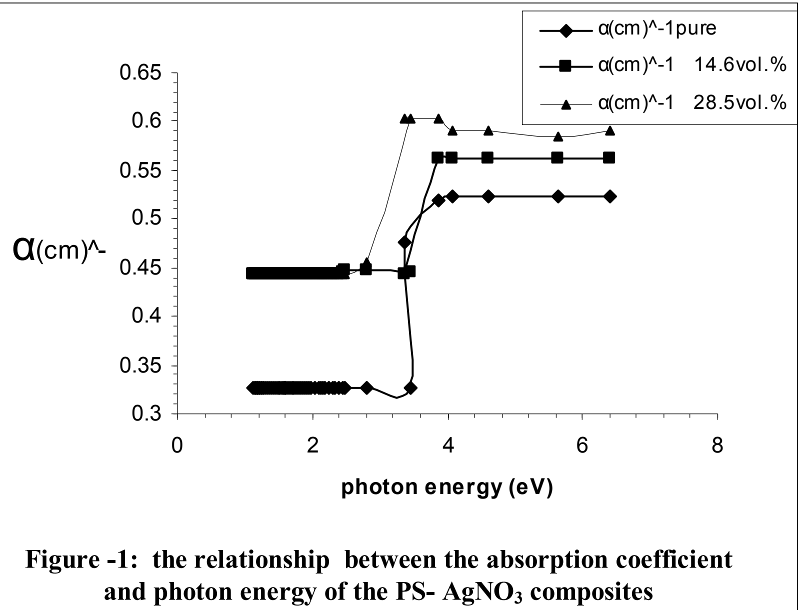

Figure -1: the relationship between the absorption coefficient and photon energy of the PS- $AgNO_3$ composites

The forbidden energy gap of indirect transition both allowed, forbidden calculated according to the relationship(Kathalingam A, (2007)):

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

Where : hν the energy of photon , A proportionality constant, E_g forbidden energy gap of the indirect transition.

If the value of (m=2) indicates ten allowed indirect transition . when the value (m=3) indicates to forbidden indirect transition. Figure (2) shows the relationship between $(\alpha h\nu)^{1/2}$ $(cm^{-1}.eV)^{1/2}$ and the photon energy of pure polymer (PS) , with take over part of the straight cut oriented axis at the point $(\alpha h\nu)^{1/2}=0$ will get the value of forbidden energy gap of the allowed indirect transition , which equal (3.2eV). Figure (3) and figure (4) represents the same relationship but to the polymer filled with ($AgNO_3$) with volume percentages of $AgNO_3$ are(14.6 , 28.5) vol% ,the same way we can be obtained on the value of forbidden energy gap of allowed indirect transition which equal (2.9eV) for 14.6 vol%, $AgNO_3$and (2.3eV) for 28.5 vol.% $AgNO_3$.

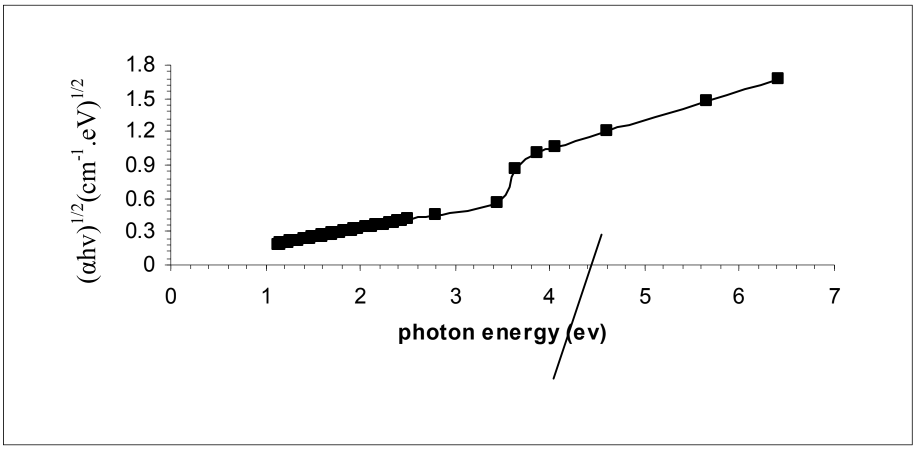

Figure -2 : the relationship between $(\alpha h\nu)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of pure polymer (PS).

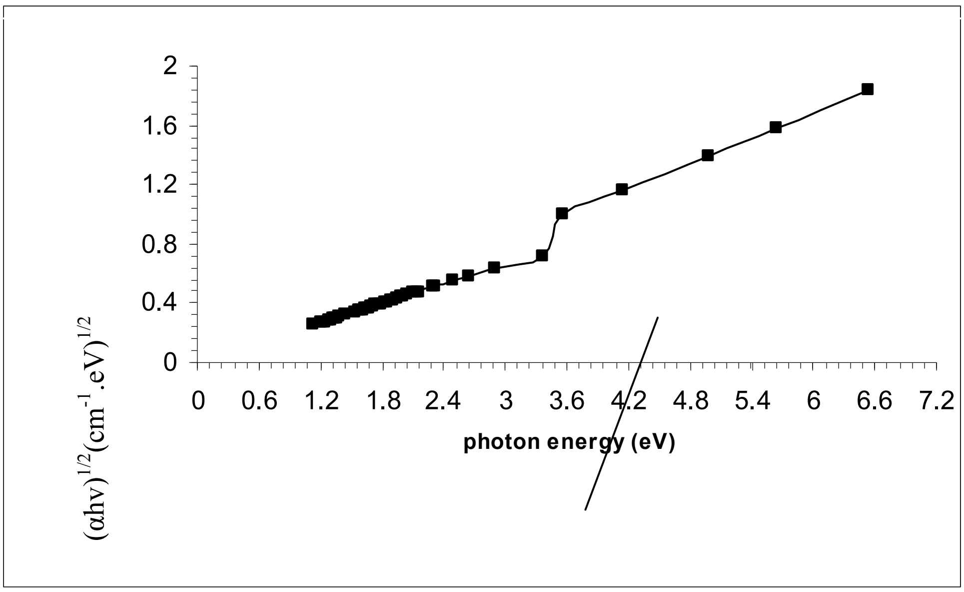

Figure -3: the relationship between $(\alpha h\nu)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PS- $AgNO_3$ composites for 14.6 vol.% $AgNO_3$

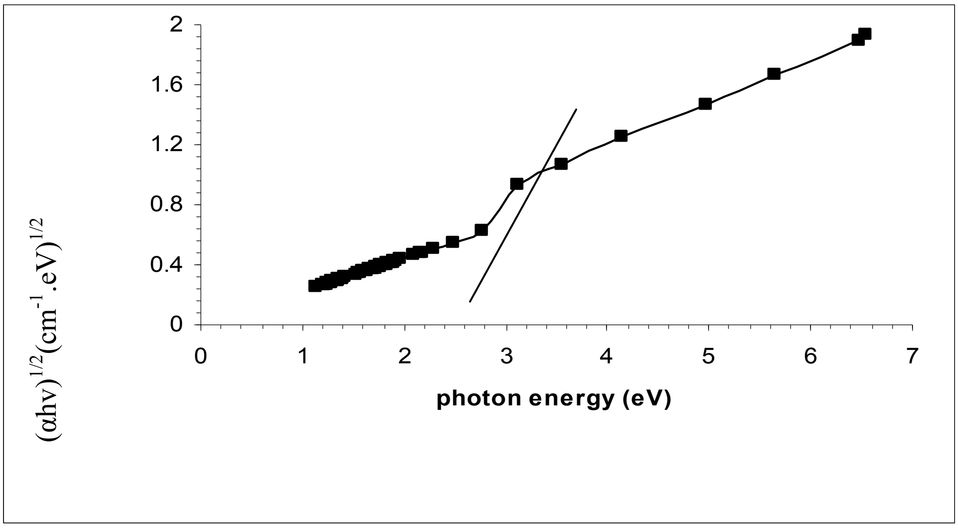

Figure -4: the relationship between $(\alpha hv)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PS- $AgNO_3$ composites for 28.5 vol.% $AgNO_3$

We note that the value of the forbidden energy gap decreases with increasing $AgNO_3$concentration.. Figure(5) shows the relationship between the $(\alpha hv)^{1/3}$ $(cm^{-1}.eV)^{1/3}$ and photon energy of pure polymer (PS) , the same way we obtain to the forbidden energy gap of forbidden indirect transition which equal (3.03eV).

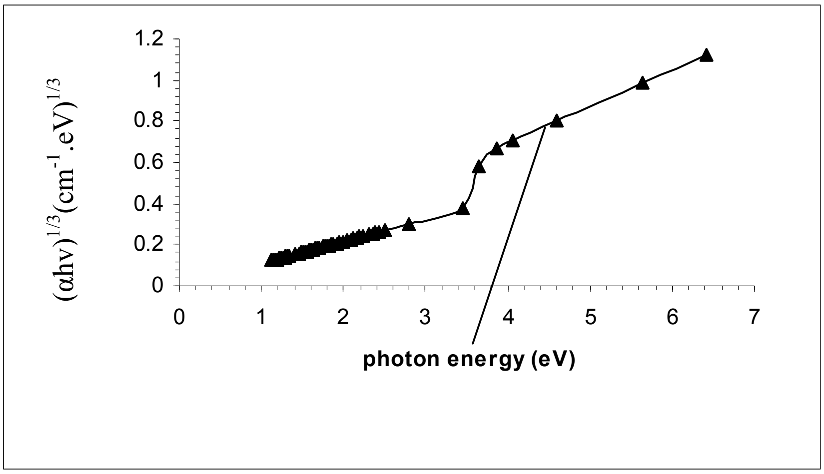

Figure -5 : the relationship between $(\alpha hv)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of pure polymer (PS).

Figure (6) and figure (7) represents the same relationship but to the polymer filled with ($AgNO_3$) with volume percentages of $AgNO_3$ are (14.6 , 28.5) vol%, the same way we can be obtained on the value of the forbidden energy gap of the forbidden indirect transition which equal(2.82eV) for14.6vol.% $AgNO_3$ and (2.19eV) for 28.5 vol%. we note that the value of the energy gap decreases with increasing $AgNO_3$ concentration (Soliman.L.I and Sayed.W. M,(2002)).

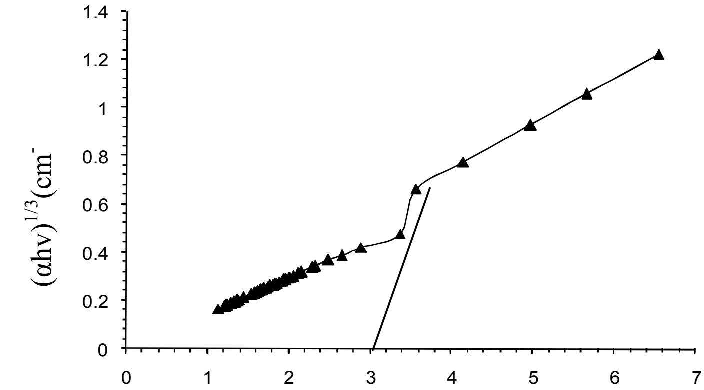

Figure -6: the relationship between $(\alpha h\nu)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of of PS- $AgNO_3$ composites for 14.6 vol.% $AgNO_3$.

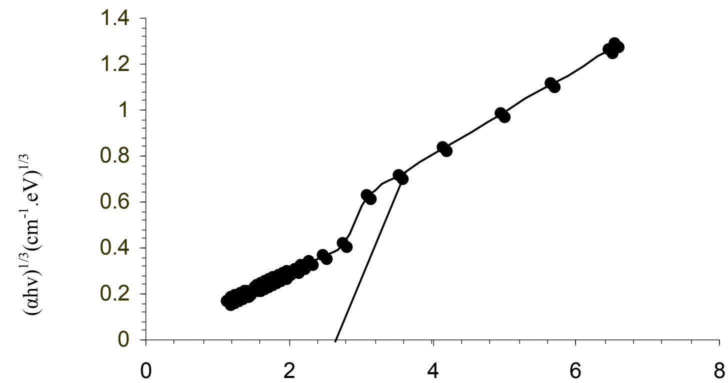

Figure -7 : the relationship between $(\alpha h\nu)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of of PS- $AgNO_3$ composites for 28.5 vol.% $AgNO_3$.

4-Conclusions :

1. The absorption coefficient is increasing with increasing of the filler vol.% 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 $AgNO_3$additive change not the nature of electronic transfers of PS samples.
4. The forbidden energy gap is decreasing with increasing of the filler vol.% content.

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