Study of the Effect of Berry Paper Mulberry on Optical Properties of Poly Methyl Methacrylate

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Abstract:

In this work, study the optical properties of composites consisting of poly Methyl Methacrylate and Berry Paper Mulberry. The samples of composites were prepared using casting method .The Berry Paper Mulberry (BPM) was added by different concentrations are (0, 2, 4 and 6)wt.%. The optical properties of composites have been studied in the wavelength range (200-800)nm. The absorption coefficient ,energy gap, refractive index, extinction coefficient and dielectric constants have been determined. The results show that the optical constants change with increase of BPM concentrations .

Key words: polymer , PMMA, Berry Paper Mulberry , Optical properties.

1.Introduction:

The stability of polymer thin films on solid substrates is of great technological importance in applications ranging from protective coatings to paintings, semiconductors, and optoelectronic devices[1,2]. Optical polymers have attracted considerable attention in recent years because of their important industrial applications. Poly Methyl Methacrylate (PMMA) is one of the earliest and best known polymers. Poly Methyl Methacrylate was seen as a replacement for glass in a variety of applications and is currently used extensively in glazing applications. The material is one of the hardest polymers, and is rigid, glass-clear with glossy finish and good weather resistance. Poly Methyl Methacrylate is naturally transparent and colorless. The transmission for visible light is very high. Polymeric composites of PMMA are known for their importance in technical applications [3]. Studies of doping transition metal halides into PMMA are important for determining and controlling the operational characteristic of the different PMMA composites. The addition of transition metal halides to the PMMA network will cause a remarkable change in their properties [4,5]. PMMA also has attracted high attention for optical applications. This is because it has excellent transparency [6–11]. .In the study of physical properties of polymers, the optical absorption spectrum is one of the most important tools for understanding band structure, electronic properties, and optical constants (refractive and absorption indices) of pure and doped polymers.

Material and Methods:

The polymer (PMMA) was dissolved in chloroform by using magnetic stirrer in mixing process to get homogeneous solution. The concentrations of BPM (size of BPM is (80-100)μm) are (0,2, 4 and 6) weight percentages (wt.%) were added and mixed for 10 minute, after which solution was transferred to clean glass

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petri dish of (5.5cm) in diameter placed on plate form. The dried film was then removed easily by using tweezers clamp. The polymer systems were evaluated spectra photo metrically by using UV/160/Shimadzu spectrophotometer.

Absorptance (A) is defined as the ratio between absorbed light intensity (IA) by material and the incident intensity of light (I_o).

$A = IA / I_o$ …….. (1)

The transmittance (T) is given by reference to the intensity of the rays transmitting from the film(I) to the intensity of the incident rays on it (I_o) ($T=I/ I_o$), and can be calculated by [12]:

$T = \exp(-2.303A)$ …………. (2)

And Reflectance (R) can be obtained from absorption and transmission spectra in accordance with the law of conservation of energy by the relation [12]:

$R + T + A = 1$ …………… (3)

Absorption coefficient (α) is defined as the ability of a material to absorb the light of a given wavelength

$\alpha=2.303A/t$ ………. (4)

Where A: is the absorption of the material and t: is the sample thickness in cm.

According to the generally accepted non-direct transition model for amorphous semiconductors proposed by:

$\alpha h\upsilon = B(h\upsilon - E_g)^r$ ....(5)

Where B is a constant related to the properties of the valance band and conduction band, $h\upsilon$ is the photon energy , E_g is the optical energy band gap, r=2,or3 for indirect allowed and indirect forbidden transition[13].

The Refractive index (n), the index of refraction of a material is the ratio of the velocity of the light in vacuum to that of the specimen [13]:

$R= ((n-1)^2+k^2)/ ((n+1)^2+k^2)$ …. (6)

When the ($k \rightarrow 0$)

$R= (n-1)^2/ (n+1)^2$ ………… (7)

$n= (1+R^{1/2})/ (1-R^{1/2})$ ……… (8)

The extinction coefficient (k) was calculated using the following equation:

$K=\alpha\lambda/4\pi$ ………… (9)

Dielectric constant is defined as the response of the material toward the incident electromagnetic field. The dielectric constant of compound (ε) is divided into two parts real(ε_1), and imaginary (ε_2).The real and imaginary parts of dielectric constant can be calculated by using equations [13]

$\varepsilon_1 =n^2-k^2$ (real part) …..... (10)

$\varepsilon_2 =2nk$ (imaginary part) …… (11)

3.Results and Discussion:

3.1 The absorbance of composites

Fig. (1) shows the relationship between absorbance of PMMA-BPM composite and wave length, from the figure, it was appeared that the absorbance tends to decrease with increasing the wavelength in UV region, this behavior attributed to the absorbance of polymer in high energies[14].

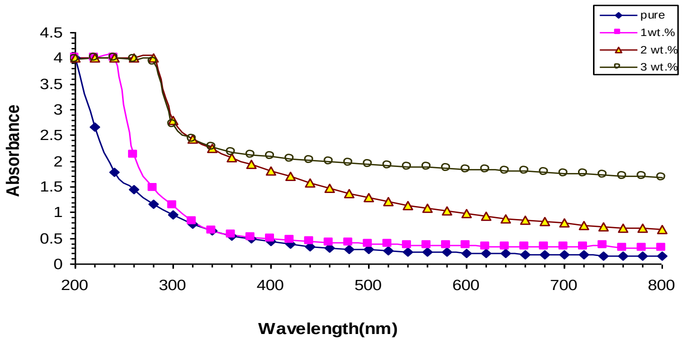

FIG. 1 The relationship between absorbance and the wave length of PMMA-BPM

3.2 The absorption coefficient and energy band gap

Fig.(2) shows the variation of absorption coefficient of composites for different concentrations of impurities. The composites have a low absorption coefficient at a small photon energy, also, the absorption coefficient is increased with increasing the concentrations of BPM, this due to increase the absorbance of composites with increasing the weight percentages of BPM[15].

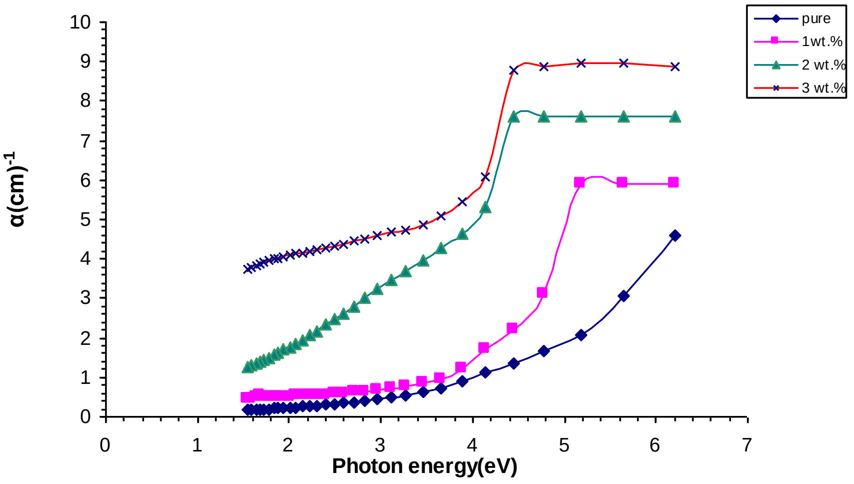

FIG. 2 The absorption coefficient of PMMA-BPM composite with photon energy

Fig. (3) and Fig. (4) represented the indirect transition(allowed and forbidden) were calculated by using Eq.5, the energy gab values dependence in general on the crystal structure of the composites and the arrangement and distribution way of atoms in the crystal lattice. From these figures we can see that the energy band gap is decreased with increasing the BPM concentrations, the behavior of energy band gap with BPM concentration attributed to decrease the distance between valance band and conduction band[15].

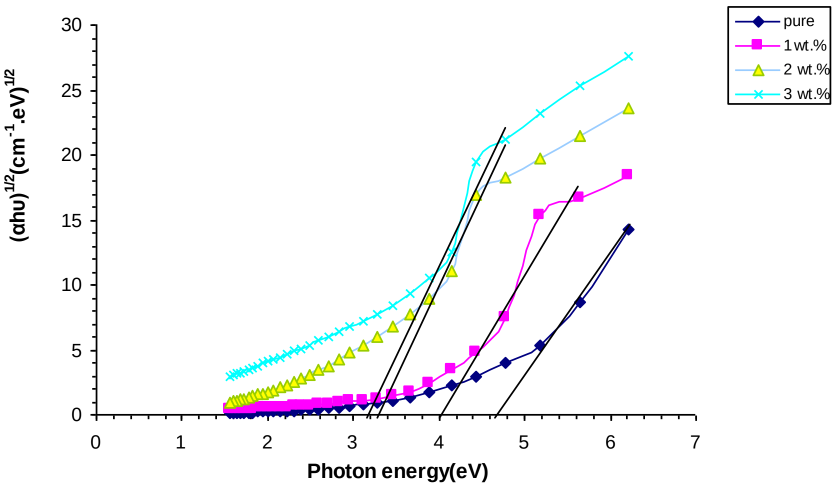

FIG.3 relationship between $(\alpha\, h\upsilon)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of PS-PMMA composites.

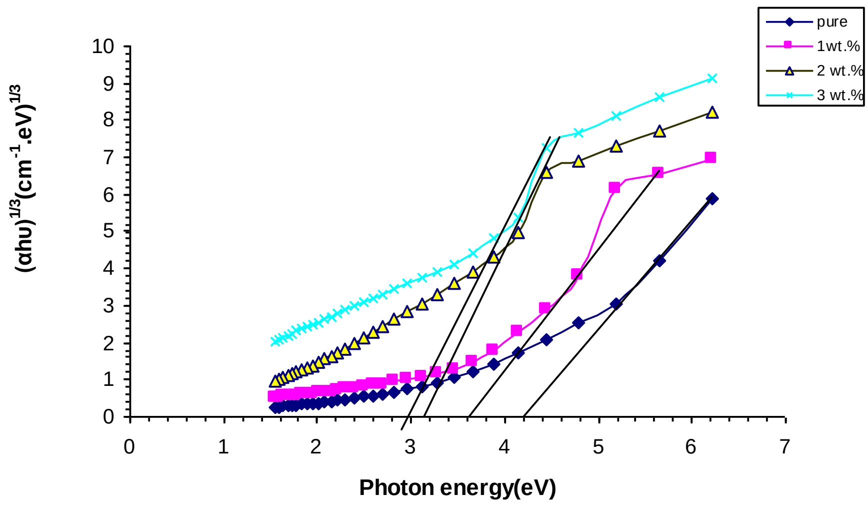

FIG.4 the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of PMMA-BPM composites

3.3Refractive Index and Extinction Coefficient of (PMMA-BPM) composites

Fig. (5) shows the variation of refractive index(n) with of the composite with photon energy, the values of refractive index are increased with increasing photon energy. This increase of refractive index of composites with increase the BPM concentration related to increase the density of composites[16]. Fig. (6) shows the variation of the extinction coefficient(k) with the photon energy. This figure shows the high value of extinction coefficient at high energies of photon, also the extinction coefficient(k) is increased with increasing the BPM concentration. The behavior of extinction coefficient related to absorption coefficient according to Eq.9[16].

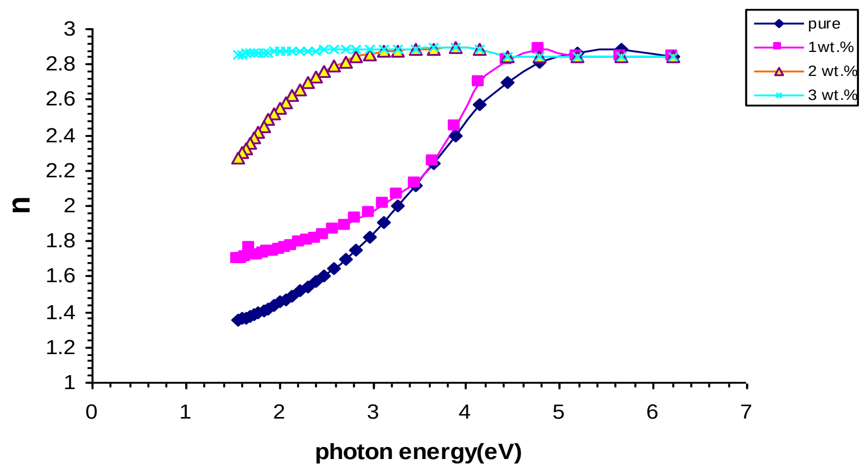

FIG.5 The relationship between refractive index for (BPA-PMMA) composite with photon energy

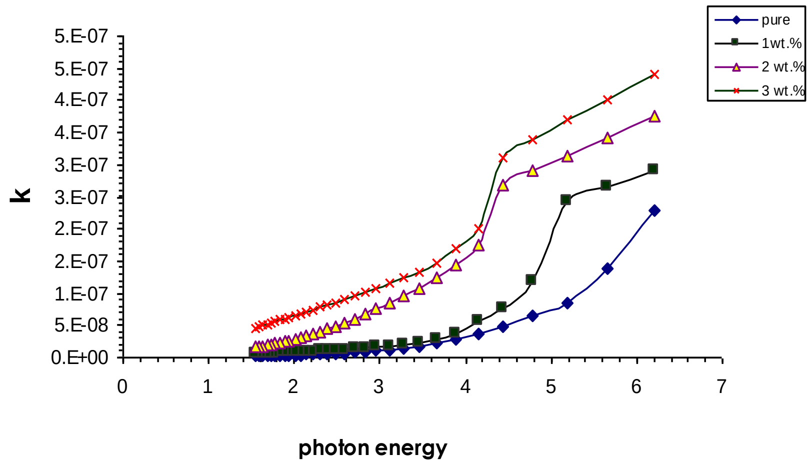

FIG.6: The extinction coefficient of PMMA-BPM composite with various photon energy

3.4dielectric constants of (PMMA-BPM) composites

Fig.(7) and Fig.(8) show the variation of the real and imaginary parts of the dielectric constant with photon energy at different concentrations of BPM respectively. The increase of the real and imaginary parts of dielectric constants with

increasing the weight percentages of BPM attributed to increase the density of composites and number of carries charges[15].

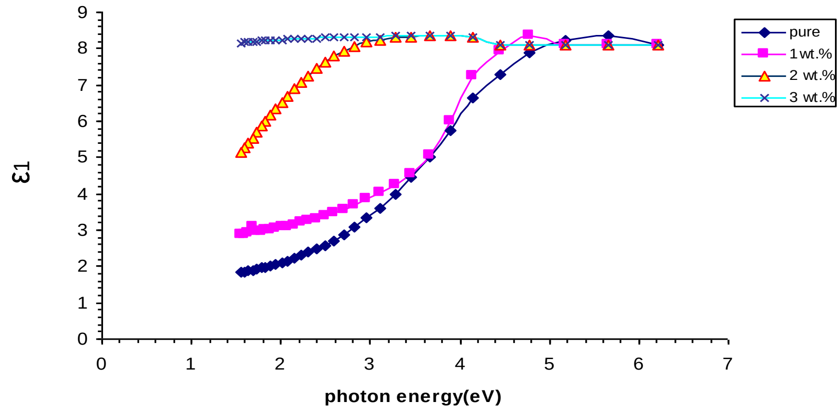

FIG.7 The variation of real part of dielectric constant PMMA-BPM with photon energy

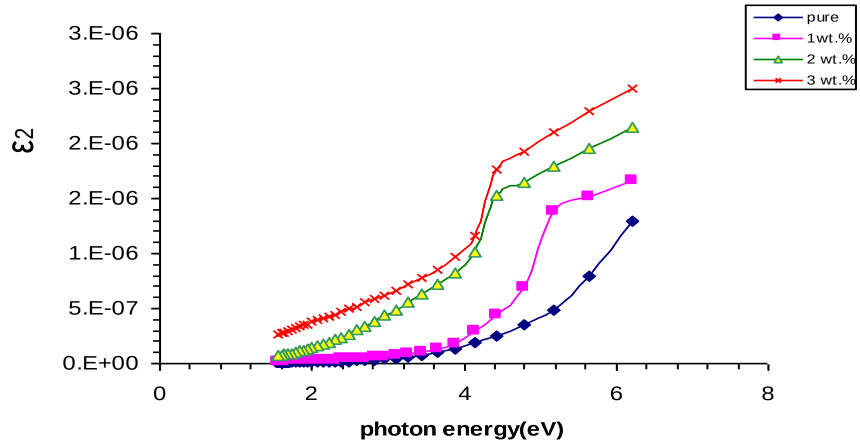

FIG. 8 The Variation Of Imaginary Part Of Dielectric Constant Of PMMA-BPM Composite With Photon Energy

4. Conclusion:

- The absorbance of (PMMA-BPM) is increased with increasing the BPM concentrations.
- The composites have indirect energy band gap which decrease with increasing the BPM concentrations.
- The optical constants(absorption coefficient, refractive index, extinction coefficient and real and imaginary dielectric constants) are changed with increasing weight percentages of BPM.

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دراسة تاثير ورق الكرز على الخواص البصرية للبولي مثيل ميثاكريلايت

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الخلاصة:

في هذا البحث تم دراسة الخواص البصرية للمتراكبات المتكونة من بولي مثيل ميثاكريلايت وورق الكرز. النماذج تم تحضيرها باستخدام طريقة الصب. وتم اضافة تراكيز مختلفة من ورق الكرز هي (0, 2, 4 and 6)wt.%. الخواص البصرية للمتراكبات درست ضمن مدى طول موجي(200-800)nm. وحسب معامل الامتصاص، فجوة الطاقة، معامل الخمود، معامل الانكسار وثوابت العزل الكهربائي. بينت النتائج تغير الثوابت البصرية مع زيادة تراكيز ورق الكرز.