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Studying the Optical Properties of (PVA-PEG-KBr) Composite

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Abstract: ***In this work, samples of (PVA-PEG-KBr) composites were prepared by using casting method. The effects of addition of (KBr) concentration on the optical properties of (PVA-PEG) composite have been studied in the wavelength range (200-800) nm. The absorption coefficient, energy gap, refractive index and extinction coefficient have been determined. The results show that the optical constants change with the increase of KBr concentrations.***

Keywords: composites, KBr, optical properties

1. Introduction

Recently, studies on the electrical and optical properties of polymers have attracted much attention in view of their application in electronic and optical devices. Polymer blends (PB) is a mixture of at least two polymers or copolymers (polymeric material synthesized from more than single monomer) [1]. Polyvinyl Alcohol offers a combination of excellent film forming and binder characteristics, along with insolubility in cold water and organic solvents. This combination of characteristics is useful in a variety of applications. Moreover, it contains a carbon backbone with hydroxyl groups attached to methane carbons. These hydroxyl groups can be a source of hydrogen bonding, hence the assistance in the formation of polymer blends [2]. The stability of polymer thin films on solid substrates is of great technological importance in applications ranging from protective coatings to paintings, semiconductors, and micro- and optoelectronic devices [3, 4]. We focused our research on studying the optical properties of (PVA -PEG- KBr) composites.

2. Experimental Part

The materials ware used in this paper are (PVA-PEG) composite as matrix and potassium bromide as additive. The polymers were dissolved in water by using magnetic stirrer with ratio (7:3) (PVA: PEG). The weight percentages of KBr are (0, 5, 10, 15) wt% were added to mixture and mixed for 10 minutes to get more homogenous solution. The casting technique was used to preparation the composites. The spectra photo metrically by using UV/1800/Shimadzu spectrophotometer.

3. Results and Discussion

3.1 The absorbance of (PVA-PEG-KBr) composites

Figure 1 shows the relationship between absorbance of PVA-PEG-KBr composite with wave length, from the figure shows that the absorption increases as a result of filler addition, the composites have high absorbance in the UV-region.

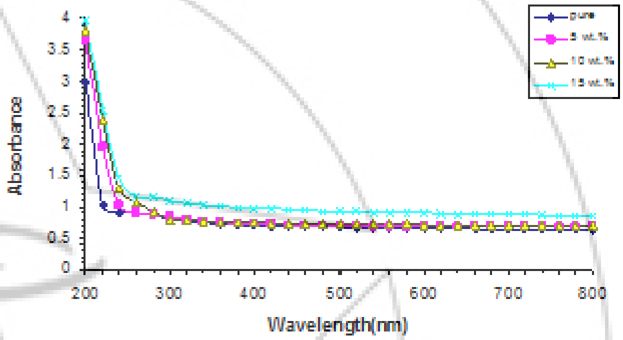

FIG.1
The variation of optical absorbance for (PVA-PEG-KBr) composite with wavelength

Figure 1

3. 2 The Absorption coefficient and energy gap of composites

Figure 2 shows the optical absorption spectrum of composite for different impurities quantities, it was found that the composite have a low absorption coefficient at a small photon energy then increase at different rates dependence on the composite structure.

Analysis of optical absorption spectra could reveal the energy gap Eg between the Conduction Band (CB) and the Valence Band (VB) due to direct and indirect transitions of both crystalline and amorphous materials.

The absorption coefficient (α) was calculated in the fundamental absorption region from the following equation [5]:

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

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

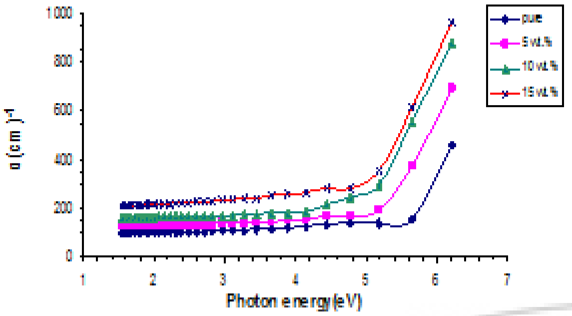

FIG.2
The absorption coefficient for (PVA-PEG-KBr) composite with various photon energy

Figure 2

Figure 3 represented the indirect transition. The optical energy gap (Eg) of the thin films has been determined from absorption coefficient data as a function of photon energy. According to the generally accepted "non-direct transition model" for amorphous semiconductors proposed by Tauc [6].

$$\alpha h\upsilon = B(h\upsilon - E_g)^n \ldots\ldots\ldots\ldots.(2)$$

Where B is a constant related to the properties of the valance band and conduction band, hυ is the photon energy, E_g is the optical energy band gap, n=2, or 3 for indirect allowed and indirect forbidden transition.

From the linear plots of $(\alpha\ h\ \nu)^{1/n}$ against (h ν) for these samples as shown in Figure 3, the optical energy gap has been determined from the intercepts of extrapolations to zero with the photon energy axis $(\alpha h\nu)^{1/n} \rightarrow 0$ From the results obtained it is seen that an increase of concentration of KBr in the system leads to an decrease in the optical band gap. A decrease in the energy band gap with increasing KBr concentration may be attributed to an increase in structural disorder of the polymer films with increasing KBr content.

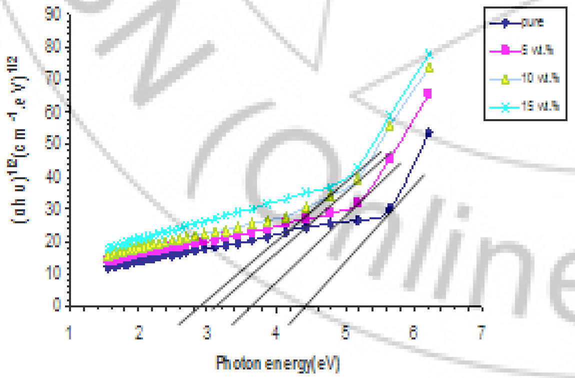

FIG.3
The relationship between $(\alpha h\upsilon)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of (PVA-PEG-KBr) composites.

Figure 3

3.3 Refractive Index and Extinction Coefficient

The extinction coefficient can be calculated by the relation [7]:

$$k = \alpha\, \lambda / 4\pi \qquad (3)$$

Where λ is the wavelength, α is the absorption coefficient.

The refractive index of the films was calculated by the following equation [5]:

$$N = [4R/(R-1)^2 - K^2] - (R-1)/(R-1) \qquad (4)$$

where R the reflectance and K the extinction coefficient. Figure 4 shows the variation of extinction coefficient (k) with the photon energy of the composite, the values increase with increasing photon energy. This increase indicates that the electromagnetic radiation passing through the material is faster in the low photon energy.

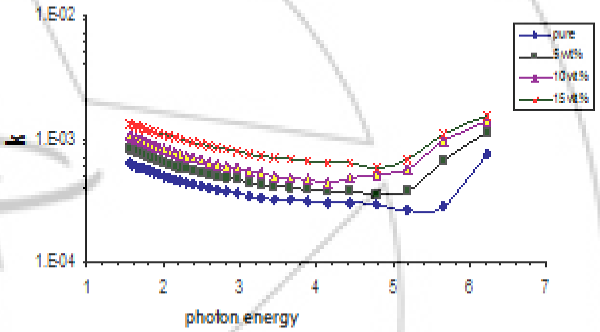

FIG.4
The extinction coefficient for (PVA-PEG-KBr) composite with various photon energy

Figure 4

Figure 5 represent the variation of the refractive index (N) with the incident photon energy, the variation is simple in the low energy region while it increased in the high photon energy region, and this behavior may be as a result to the variation of the absorption coefficient which leads to spectral deviation in the location of the charge polarization.

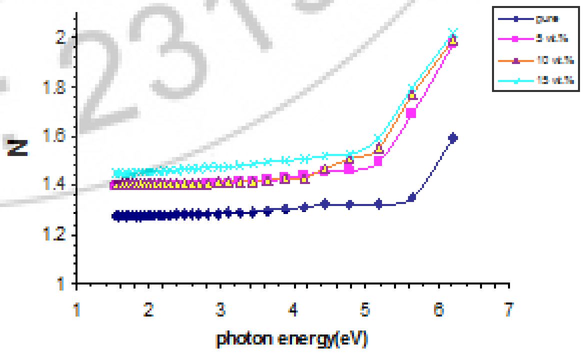

FIG.5
The relationship between refractive index for (PVA-PEG-KBr) composite with photon energy

Figure 5

3.4 Dielectric Constants

The real and imaginary of dielectric ($\varepsilon_1$and ε_2) can be calculated by using equations [8]:

$$\varepsilon = \varepsilon_1 - i\,\varepsilon_2 \qquad (5)$$

$$\varepsilon_1 = n^2 - k^2 \qquad (6)$$

$$\varepsilon_2 = 2nk \qquad (7)$$

Figure 6 represented the real part of the dielectric constant, in the real part the variation it was very clear spatially in the high impurities concentration this may be due to the absence the resonance between the frequencies of the incident photon energy (electromagnetic and the induced dipoles in the composite.

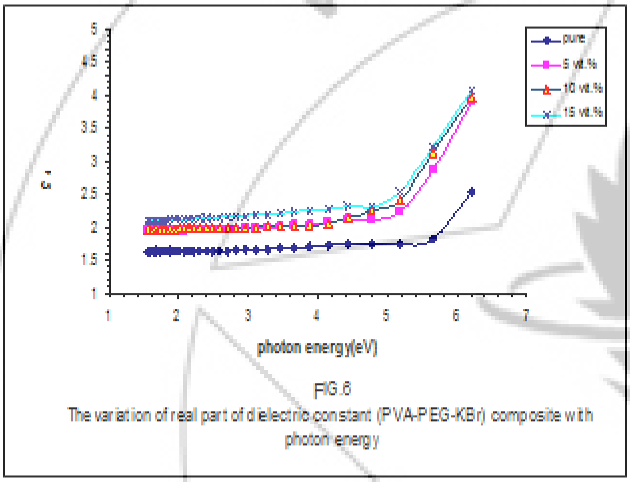

Figure 7

Figure 7 shows the variation the imaginary part of dielectric constant with photon energy. the imaginary part shows how a dielectric absorbs energy from an electric field due to dipole motion, so the variation nearly constant until it reaches to the high photon energy.

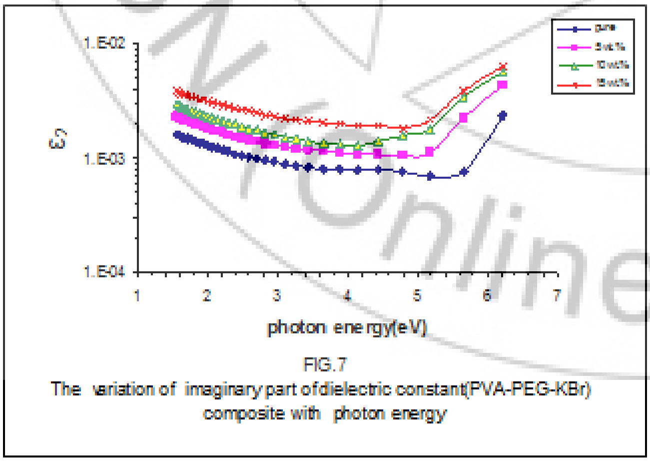

Figure 8

4. Conclusion

The optical properties of films of (PVA-PEG-KBr) composites were studied in the spectral region 200-800 nm. The composites have high absorbance in the Ultraviolet region and poor absorbance in the Vis-region making it suitable for using in solar thermal devices. The inter band transitions were found to be indirect type. The optical energy gap has been found to decrease with the increasing the concentration of KBr. The extinction coefficient, refractive index and real and imaginary dielectric constant are increasing with the increasing of the concentration of KBr.

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