

Optical Properties of PVA-$BaSO_4.5H_2O$ Composites

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Abstract

Composites consisting of a polyvinyl alcohol matrix and $BaSO_4.5H_2O$ as filler are designed. The optical properties were measured in the wavelength range from (190-850) nm. The experimental results showed that the absorption coefficient, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increase the addition of $BaSO_4.5H_2O$ content.

Keywords: Polyvinyl alcohol, Optical constants, Composites.

1. Introduction

Composites are a class of materials consisting of a mixture of two or more components to produce a multiphase system with different physical properties obtained from the constituents [1] The typical advantages of organic polymers are flexibility, toughness, formability, and low density, whereas ceramics have excellent mechanical, thermal, and optical properties, such as surface hardness, modulus, strength, heat resistance, and high refractive index. The combination of organic polymers and ceramics promises new hybrid materials with high performance. Numerous technological applications have been identified for these composite materials, such as electromagnetic and radio frequency interference shielding for electronic devices (for example, computer and cellular housings), over-current protection devices, photothermal optical recording, and direction-finding antennas [2]. Polyvinyl alcohol (PVA) is a polymer with several interesting physical properties, which are very useful in technical applications. PVA, as semicrystalline material, exhibits certain physical properties resulting from the crystal-amorphous interfacial effect [3]. Al-Ramadhan et al, 2011 studied the optical properties of the PVC- Zn(etx)2 composites. Results show that the absorption coefficient, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increase $Zn(etx)_2$ concentrations [4]. This paper deals with results of the effect of $BaSO_4.5H_2O$ on the optical properties of poly vinyl alcohol.

2. Experimental work

The materials used in this work are polyvinyl alcohol and $BaSO_4.5H_2O$. The weight percentages of $BaSO_4.5H_2O$ are (0.5, 10 and 20) wt. %. The casting technique is used to prepare the samples with thickness (d) ranged between (70-83) μm.

The transmission and absorption spectra of PVA- $BaSO_4.5H_2O$ composites have been recording in the length range (190-850) nm using double-beam spectrophotometer (UV-210oA Shimedza).

3. Results and Discussion

Figure 1 shows the variation of the optical absorbance (A) with the wavelength (λ) of the incident light for (PVA-$BaSO_4.5H_2O$) composites.

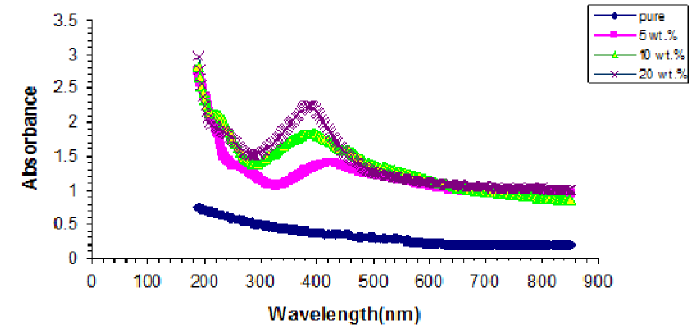

FIG.1

Variation of Optical Absorbance for (PVA-$BaSO_4.5H_2O$) composite with wavelength

The figure indicates that the absorbance increases with increase of $BaSO_4.5H_2O$ concentration, this attributed to the high absorbance of $BaSO_4.5H_2O$.

The variation of the absorption coefficient, α, as a function photon energy are presented in figure 2. It was calculated from equation [5]:

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

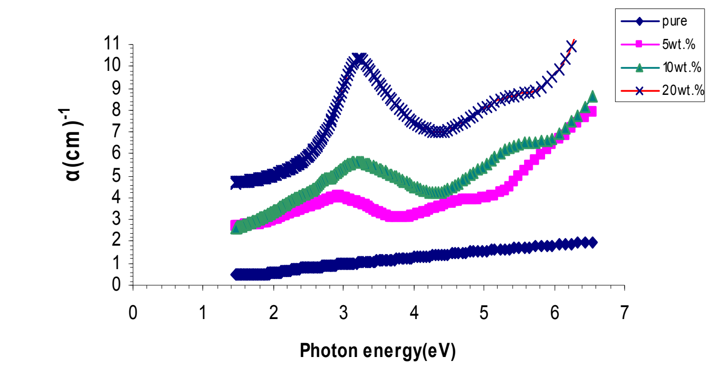

FIG.2

the relationship between the absorption coefficient and photon energy for (PVA-$BaSO_4.5H_2O$) composite

The values of the absorption coefficient are less than $10^4 cm^{-1}$ in the investigation spectral range. The fundamental absorption, which corresponds to electron excitation from the valence band to conduction band, can be used to determine the nature and value of the optical band gap, E_g. The relation between the absorption coefficient, α, and the incident photon energy, hν, can be written as [6]:

$$(\alpha h\nu)^n = B(h\nu - E_g) \qquad (2)$$

where B is an constant depending on the transition probability and n is an index that characterizes the optical absorption process and is theoretically equal to 1/2,2, 1/3 or 2/3 for indirect allowed, direct allowed, indirect forbidden and direct forbidden transition, respectively. The usual method to calculate the band gap energy is to plot a graph between $(\alpha h\nu)^n$ and photon energy, hν, and find the value of the n which gives the best linear graph. This value of n decides the nature of the energy gap or transition involved. If an appropriate value of n is used to obtain linear plot, the value of E_g will be given by intercept on the hν-axis as shown in figures 3 and 4.

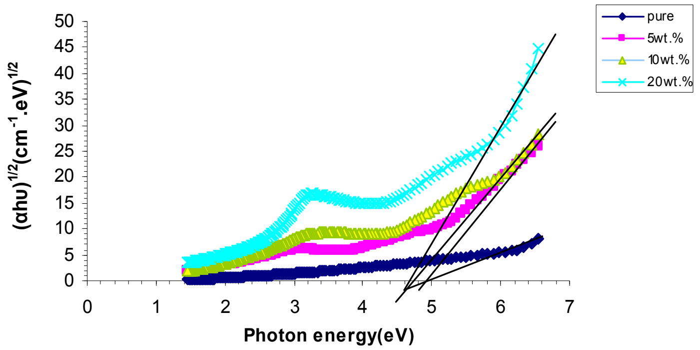

FIG.3
the relationship between $(\alpha hu)^{1/2}(cm-1.eV)^{1/2}$ and photon energy of PVA-$BaSO_4.5H_2O$ composites.

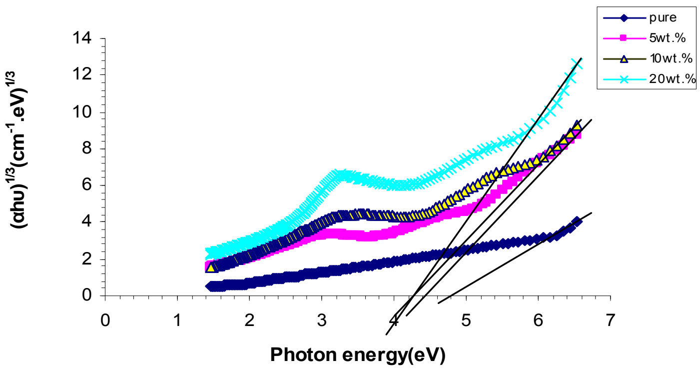

FIG.4
the relationship between $(\alpha hu)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of PVA-$BaSO_4.5H_2O$ composites.

The attenuation coefficient (k) is directly proportional to the absorption coefficient (α):

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

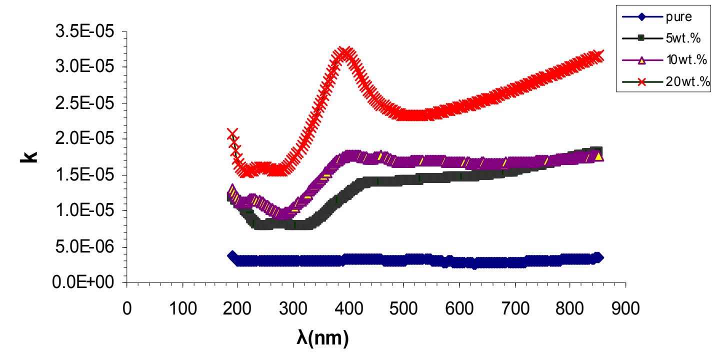

FIG.5
Variation of attenuation coefficient with wavelength for (PVA-$BaSO_4.5H_2O$) composites.

Figure 6 shows the variation of the refractive index ($n = \frac{1+\sqrt{R}}{1-\sqrt{R}}$) of composites a function of photon energy. It has been found that the value of refractive index increases with increasing the concentration of $BaSO_4.5H_2O$ which is a result of increasing the number of atomic refractions due to the increase of the linear polarizability in agreement with Lorentz - Lorentz formula.

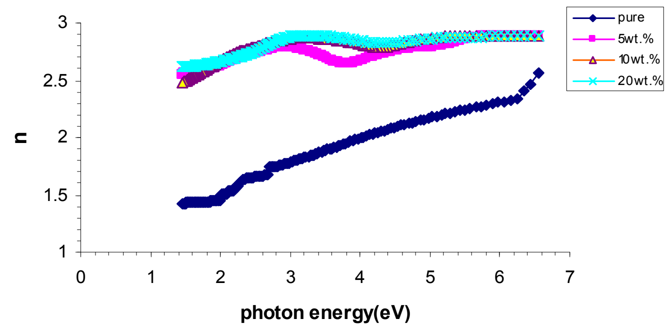

FIG.6
Variation of refractive index for (PVA-$BaSO_4.5H_2O$) composite with photon energy

Figures 7 and 8 show the variation of real and imaginary parts of dielectric constants ($\varepsilon_1 = n^2 - k^2$ and $\varepsilon_2 = 2nk$) of (PVA-$BaSO_4.5H_2O$) composites .It is concluded that the variation of ε1 mainly depends on n^2 because of small values of k^2, while ε_2 mainly depends on the k values which are related to the variation of absorption coefficients [7].

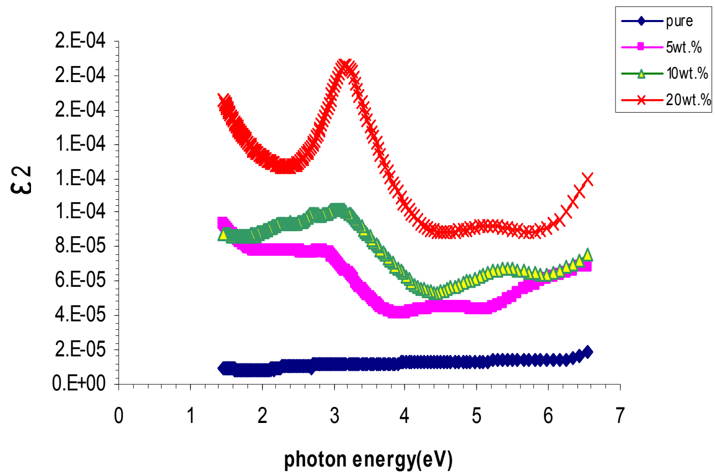

FIG.8

Variation of imaginary part of dielectric constant(PVA -$BaSO_4.5H_2O$) composite with photon energy

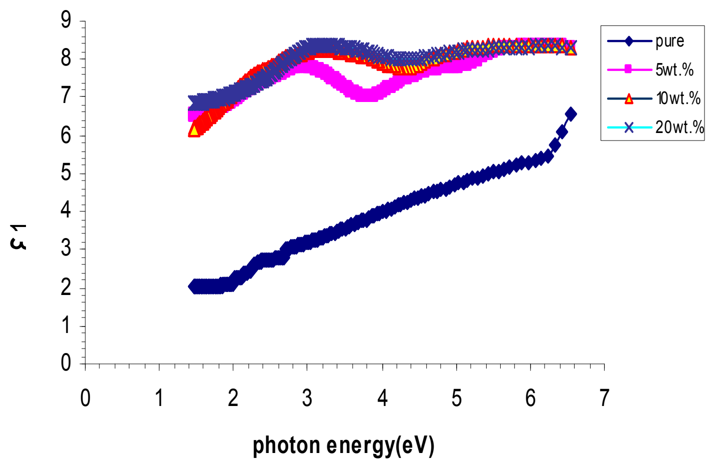

FIG.7

Variation of real part of dielectric constant (PVA-$BaSO_4.5H_2O$) composite with photon energy

4. Conclusions

The absorbance increases with increase the weight percentages of $BaSO_4.5H_2O$. The absorption coefficient, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increase the weight percentages of $BaSO_4.5H_2O$. The forbidden energy gap decreases with increase of the filler wt.% content.

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