

Optical Properties of (PVA-CrCl₂) Composites

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Abstract

The purpose of this paper, study the effect of addition Chromium chloride on optical properties of polyvinyl-alcohol . The composites prepared by casting technique with different weight percentages of CrCl₂ are (0,1,2,3). Results showed that the absorbance increases with increase the concentration of CrCl₂, absorption coefficient, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increase CrCl₂ concentration.

keywords: Polyvinyl alcohol, Optical Properties, Composites.

Introduction

Optical properties of polymers constitute an important aspects in study of electronic transition and the possibility of their application as optical filters, a cover in solar collection, selection surfaces and green house. The information about the electronic structure of crystalline and amorphous semiconductors has been mostly accumulated from the studies of optical properties in wide frequency range. The significance of amorphous semiconductors is in its energy gap[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].

Experimental work

The materials used in this work are polyvinyl alcohol and CrCl₂. The weight percentages of CrCl₂ are (0,1,2 and 3) wt.%. The casting technique is used to prepare the samples with thickness ranged between (350-475)μm.

The transmission and absorption spectra of PVA-CrCl₂ composites have been recording in the length range (200-800) nm using double-beam spectrophotometer (UV-210°A Shimadzu).

Results and Discussion

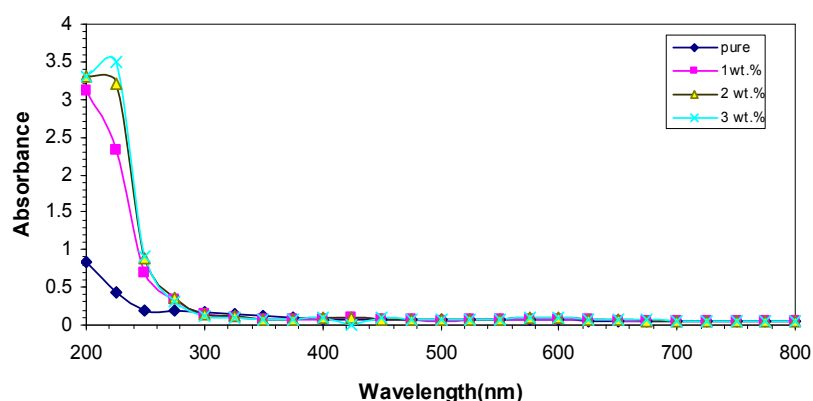


FIG.1

Variation of Optical absorbance for (PVA-CrCl₂) composite with wavelength

Figure(1) shows the variation of the optical absorbance with the wavelength of the incident light for (PVA-CrCl₂) composites.

The figure indicate that the absorbance increases with increase of CrCl₂ concentration, this attributed to the high absorbance of CrCl₂.

The variation of the absorption coefficient, α , as a function photon energy are presented in figure(2) . It was calculated from equation[3]:

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

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

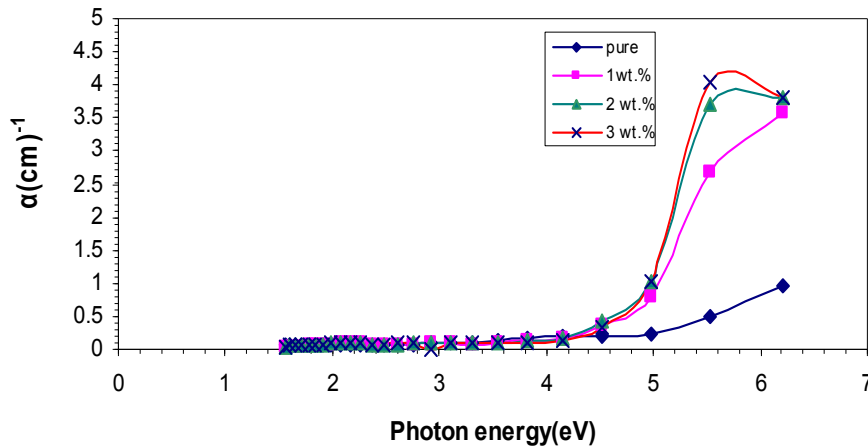


FIG.2
 absorption coefficient for (PVA-CrCl₂) composite with various photon energy

The values of the absorption coefficient are less than 10⁴cm⁻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, $h\nu$, can be written as[4] :

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

where B is a 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, $h\nu$, 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 $h\nu$ -axis as shown in figures(3,4).

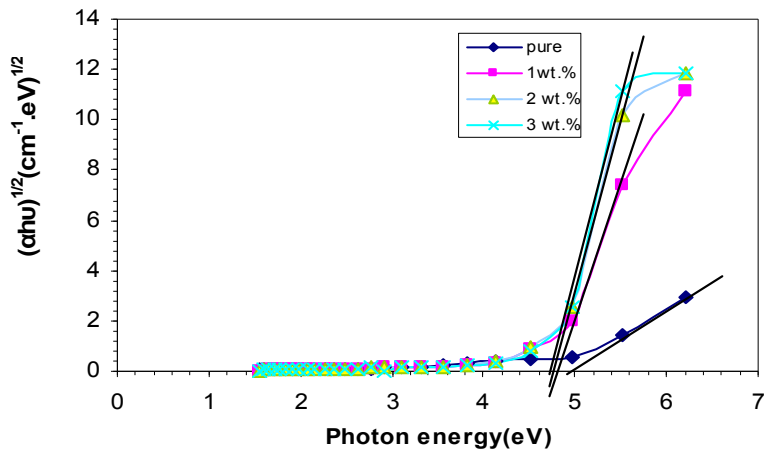


FIG.3
 the relationship between $(\alpha hu)^{1/2}(\text{cm}^{-1}.\text{eV})^{1/2}$ and photon energy of (PVA-CrCl₂) composites.

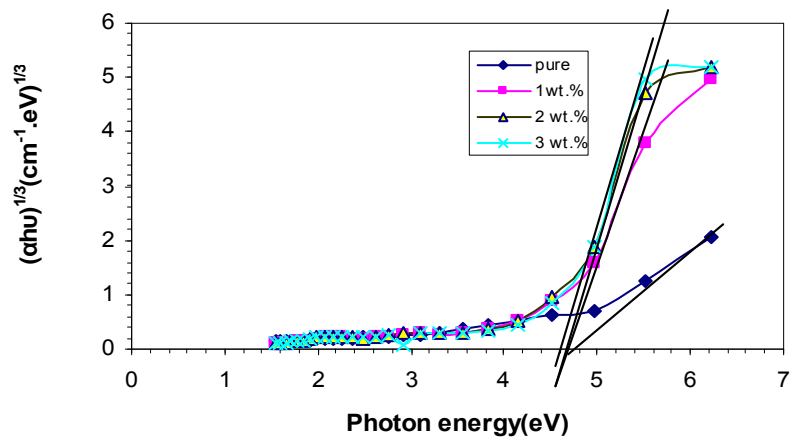


FIG.4
 the relationship between $(\alpha hu)^{1/3}(\text{cm}^{-1}.\text{eV})^{1/3}$ and photon energy of (PVA-CrCl₂) composites.

The attenuation coefficient (k) is directly proportional to the absorption coefficient(α):[4]

$$k = \alpha \lambda / 4\pi \dots\dots\dots(3)$$
 Where λ is the free space wavelength of light.

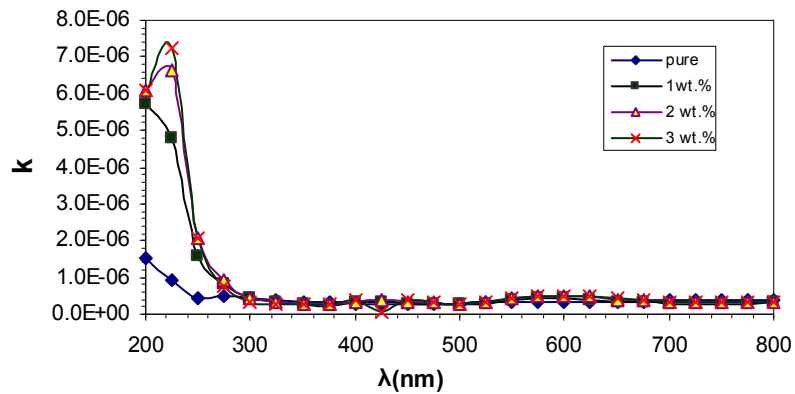


FIG.5
 extinction coefficient for (PVA-CrCl₂) composite with various photon energy

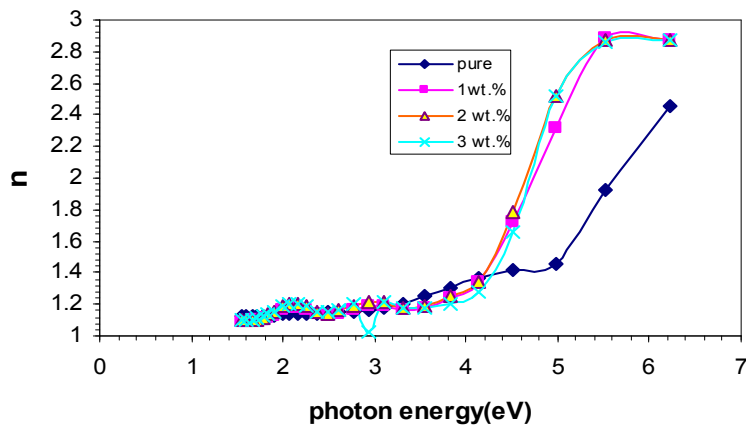


FIG.6
 the relationship between refractive index for (PVA-CrCl₂) composite with photon energy

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 CrCl₂ 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[4].

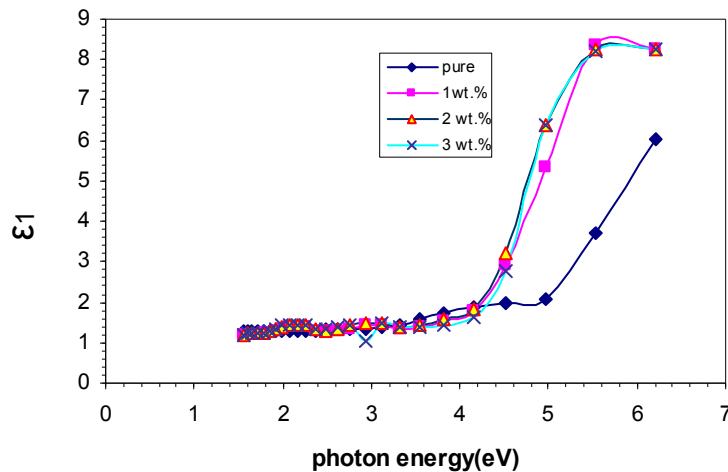


FIG.7
 variation of real part of dielectric constant (PVA-CrCl₂) composite with photon energy

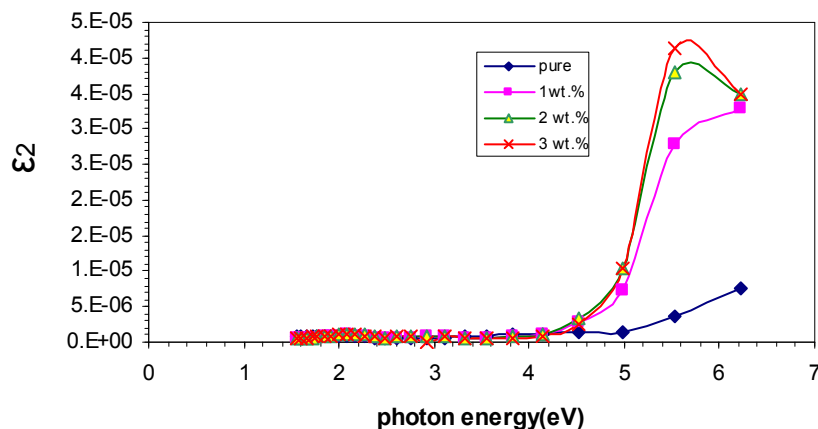


FIG.8
 variation of imaginary part of dielectric constant(PVA-CrCl₂) composite with photon energy

Figures(7,8) show the variation of real and imaginary parts of dielectric constants ($\epsilon_1 = n^2 - k^2$ and $\epsilon_2 = 2nk$) of (PVA- CrCl₂) composites .It is concluded that the variation of ϵ_1 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[5].

Conclusions

1. The absorbance increases with increase the weight percentages of CrCl₂.
2. The absorption coefficient, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increase of CrCl₂ concentration.
3. The forbidden energy gap decreases with increase of CrCl₂ concentration.

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