

Optical Properties of (PVA-CaO) Composites

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Abstract

Polyvinyl alcohol and calcium oxide composites appeared by casting technique. The calcium oxide added to polyvinyl alcohol with different weight percentages are (0,1,2 and 3) wt.%. Results showed that the absorbance increases with increase the weight percentage of calcium oxide. The absorption coefficient, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increase calcium oxide concentration.

Keywords: Optical absorbance, calcium oxide, polyvinyl alcohol.

Introduction

The study of composite materials, i.e., mixtures consisting of at least two phases of different chemical compositions, has been of great interest from both fundamental and practical standpoints. The macroscopic physical properties of such materials can be combined so as to produce materials with a desired average response. Composites have good potential for various industrial fields because of their excellent properties such as high hardness, high melting point, low density, low coefficient of thermal expansion, high thermal conductivity, good chemical stability and improved mechanical properties such as higher specific strength, better wear resistance and specific modulus. Composites are used in making solar cells, optoelectronic device elements, laser diodes and light emitting diodes (LED), industrial applications in aircraft, military and car industry[1]. Polyvinyl alcohol (PVA) is a polymer with several interesting physical properties, which are very useful in technical applications. PVA, as semi crystalline material, exhibits certain physical properties resulting from the crystal-amorphous interfacial effect[2].

Experimental

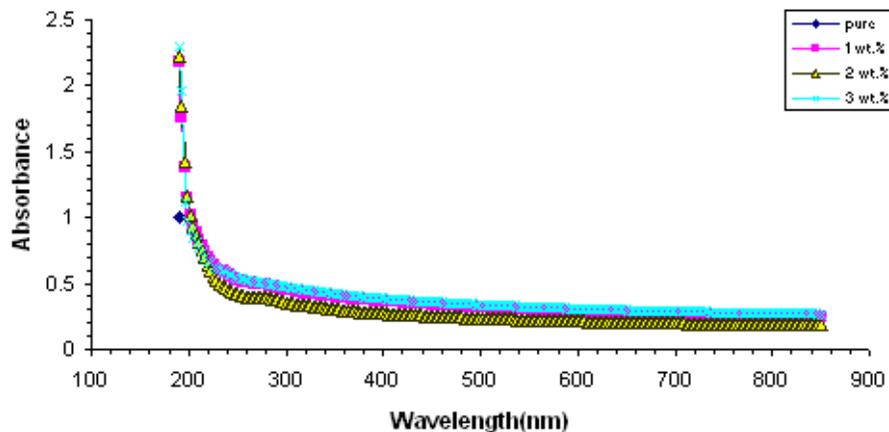
The materials used in this paper are polyvinyl alcohol and calcium oxide. The weight percentages of calcium oxide are (0,1,2 and 3)wt.%. The samples were prepared using casting technique thickness ranged between (190-422) μm .

The transmission and absorption spectra of PVA-CaO composites have been recording in the length range (190-850) nm using double-beam spectrophotometer (UV-210^oA shimedza).

Results and Discussion

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

Figure 1: Variation of Optical absorbance for (PVA-CaO) composite with wavelength



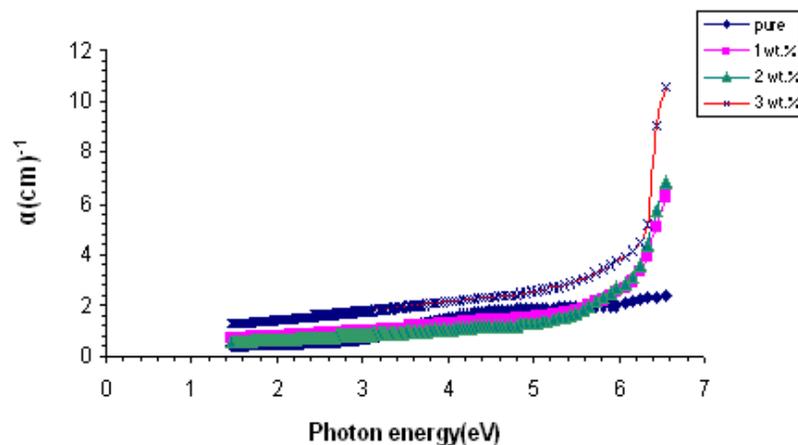
The figure indicate that the absorbance increases with increase of calcium oxide concentration, this attributed to the high absorbance of calcium oxide .

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

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

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

Figure 2: Absorption coefficient for (PVA-CaO) composite with various photon energy

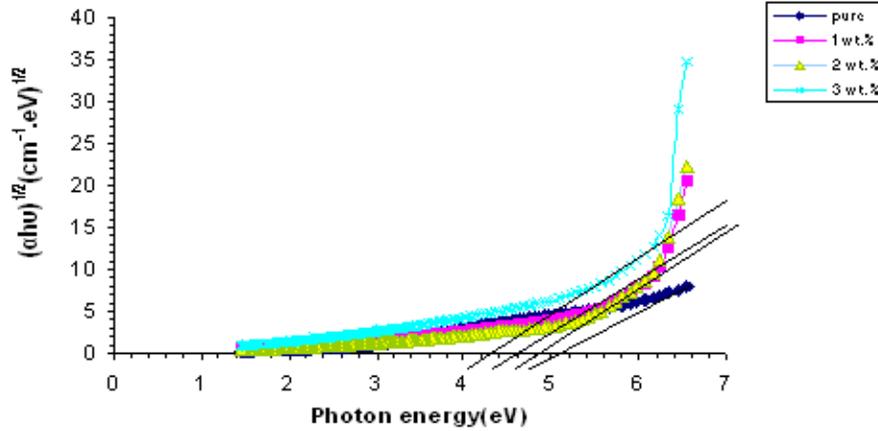


The values of the absorption coefficient are less than 10^4cm^{-1} in the investigation spectral range. The fundamental absorption, which corresponds to electron excitation from the valence band to conduction band, can be used to determine the nature and value of the optical band gap, E_g . The relation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

$$(\alpha hv)^n = A(hv - E_g) \quad (2)$$

where A 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 $(\alpha hv)^n$ and photon energy, hv , 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 hv -axis as shown in figure (3).

Figure 3: The relationship between $(\alpha hu)^{1/2}$ ($\text{cm}^{-1} \cdot \text{eV}$)^{1/2} and photon energy of (PVA-CaO) composites.

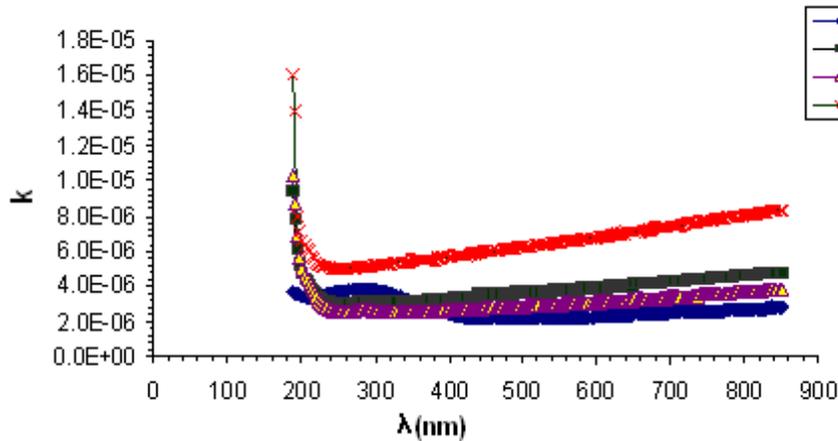


The attenuation coefficient (k) is directly proportional to the absorption coefficient (α) [4]:

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

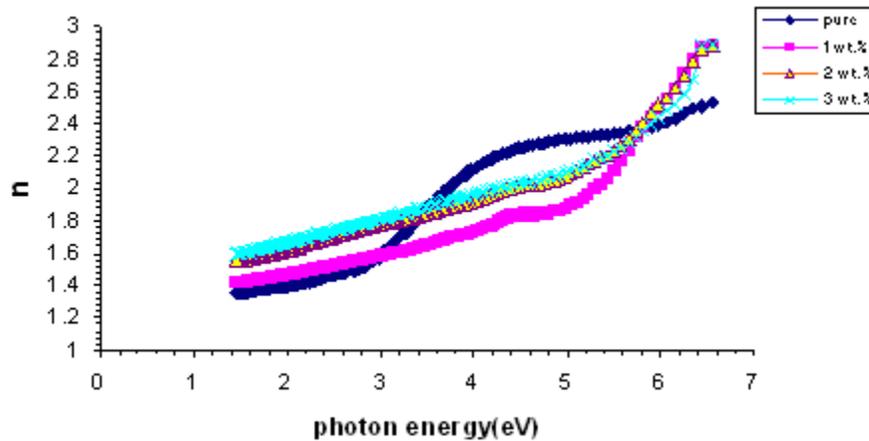
Where λ is the free space wavelength of light.

Figure 4: Extinction coefficient for (PVA-CaO) composite with various photon energy

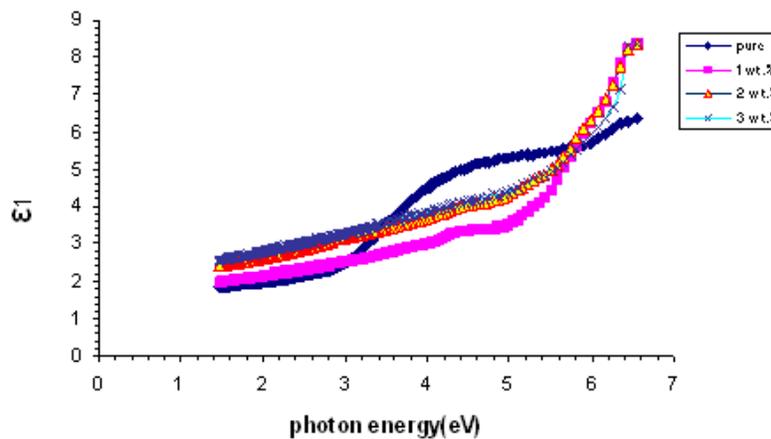
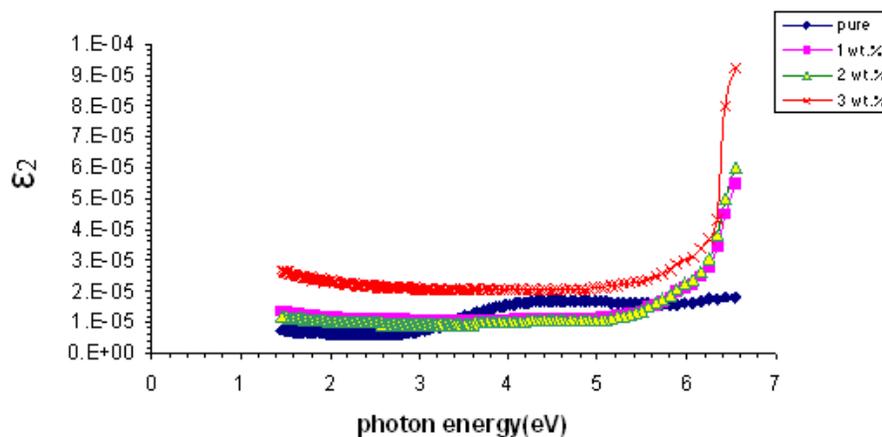


$$n = \frac{1 + \sqrt{R}}{1 - \sqrt{R}}$$

Figure (4) shows the variation of the refractive index (n) of composites as a function of photon energy. It has been found that the value of refractive index increases with increasing the concentration of calcium oxide 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].

Figure 5: The relationship between refractive index (PVA-CaO) composite with photon energy

Figures (5,6) show the variation of real and imaginary parts of dielectric constants ($\epsilon_1 = n^2 - k^2$ and $\epsilon_2 = 2nk$) of (polyvinyl alcohol- calcium oxide) 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].

Figure 6: Variation of real part of dielectric constant (PVA-CaO) composite with photon energy**Figure 7:** Variation of imaginary part of dielectric constant (PVA-CaO) composite with photon energy

Conclusions

1. The absorbance increases with increase the weight percentages of calcium oxide.
2. The absorption coefficient, extinction coefficient, refractive index and real and imaginary parts of dielectric constants are increasing with increase the weight percentages of calcium oxide.

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