International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Structural and Optical Properties of (PVA-PAA-FW) Composites

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Abstract: ***The aims of this paper are preparation of polyvinyl alcohol- poly-acrylic acid- fiber of wheat composites with different for fiber of wheat concentrations by using casting technique and study their optical properties. The results show that the optical properties are changed with increase the fiber of wheat concentrations. The absorbance of (PVA-PAA-FW) composites is increased with increase the fiber of wheat concentrations. The absorption coefficients, extinction coefficient, refractive index, real and imaginary dielectric constants of (PVA-PAA-FW) composites are increasing with increasing the fiber of wheat concentrations. The energy band gap of composites is decreased with increase the fiber of wheat concentrations.***

Keyword: composites, fiber, poly-acrylic acid, optical properties.

1. Introduction

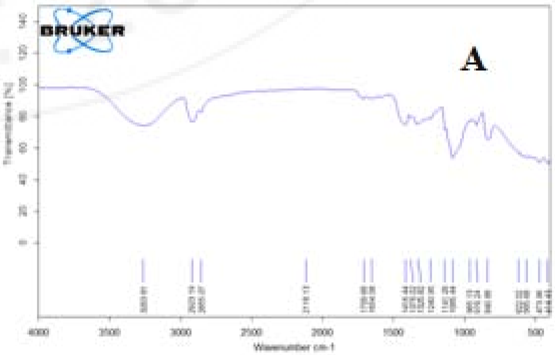
The composites have been widely used in the various fields such as military equipments, safety, protective garments, automotive, aerospace, electronics and optical devices. However, these application areas continuously demand additional properties and functions such as high mechanical properties, flame retardation, chemical resistance, UV resistance, electrical conductivity, environmental stability, water repellency, magnetic field resistance, radar absorption, etc [1]. Optical properties of polymers constitute 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 [2]. Poly(vinyl alcohol) (PVA) is included in the list of synthetic polymers which is used in medicine, it presents important features such as high hydrophilicity, recognized biodegradability, biocompatibility and good processability on film formation. Moreover, these synthetic polymers are water soluble which is a remarkable characteristic for film formation. Nevertheless, this characteristic could be a disadvantage because the material would dissolve in contact with fluids into the human body [3].Poly vinyl alcohol (PVA) is a cheap polymer having excellent film forming and adhesive properties, good chemical and mechanical stability and high potential for chemical cross-linking. However, PVA has highly swelling and low proton conductivity [4]. The insulator applications of polymers include printed circuit boards, wire encapsulants, corrosion protective electronic devices, and cable sheathing materials. Polymers have several advantages, such as easy processing, low cost, flexibility, high strength, and good mechanical properties. In the microelectronic fabrication industry, polymers are used in the photolithography process [5].

2. Materials and Methods

The composites are prepared by using 90 wt.% of polyvinyl alcohol and 10 wt.% poly-acrylic acid. The polymers are dissolved in distill water by using magnetic stirrer. The FW is added with different weight percentages are (0,2 ,4 and 6) wt.%. The samples of composites are prepared by using casting technique. The optical properties of (PVA-PAA-FW) composites are measured by using UV/1800/ Shimadzu spectrophotometer in range of wavelength (200-800) nm.

3. Results and Discussion

The FTIR spectra of (PVA- PAA- FW) composites are shown in figure 1. The spectra exhibited characteristic bands of stretching and bending vibrations of the functional groups formed in composites. From the spectra, the broad band at about 3260 cm^{-1} is assigned to the stretching vibration of hydroxyl group (OH) of polymers, which may be due to the intermolecular or intermolecular type of hydrogen bonding of the polymer and the additive. The peaks at about 1709 cm^{-1} attributed to the C= O, C= C stretching mode. Also, absorption peaks at 1664 cm^{-1} and 1325 cm^{-1} relating to amide I and III of C=O stretching, N-H/C-N stretching and CH_2 wagging coupled with OH groups of chitosan respectively. [6,7].



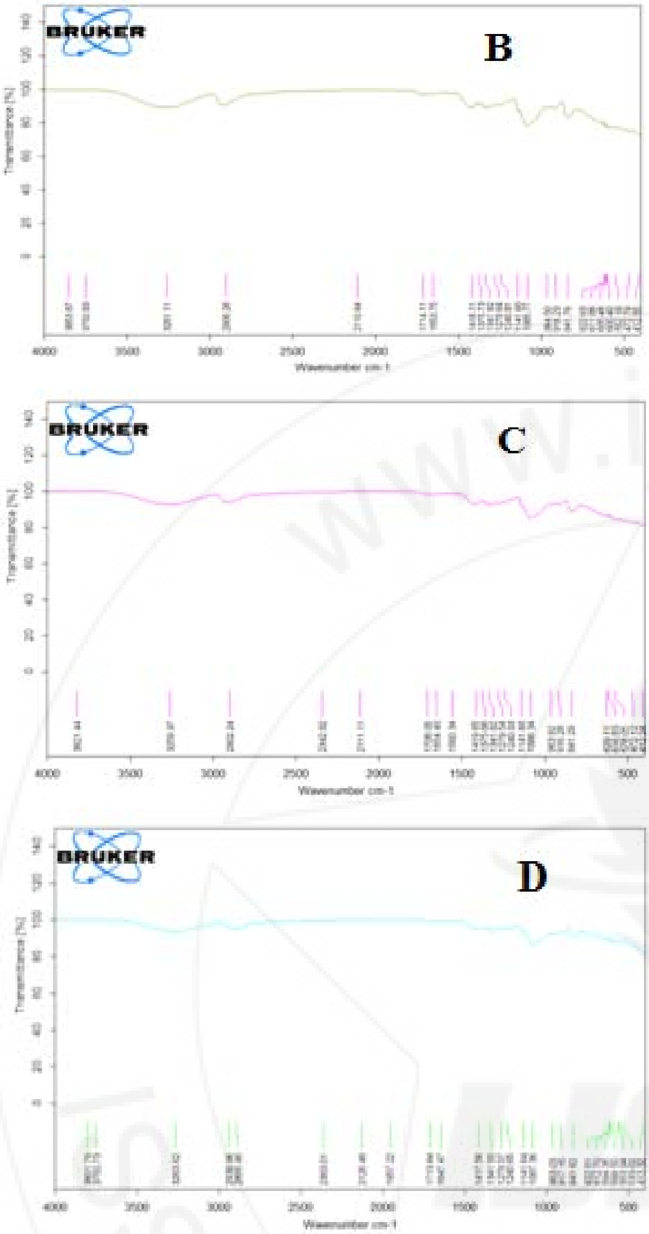


Figure 1: FTIR spectra for (PVA-PAA-FW) composites
A- pure (PVA-PAA)
B- 2 wt.% FW
C- 4 wt.% FW
D- 6 wt.% FW

The absorbance spectrum of composites is recorded by using UV/1800/ Shimadzu spectrophotometer with wavelength range (200-800) nm as shown in figure2. The absorbance of composites with different concentration of fiber of wheat is increased with the increase of fiber of wheat concentrations, this behavior attributed to form the network of molecules of fiber wheat which absorb the light [8].

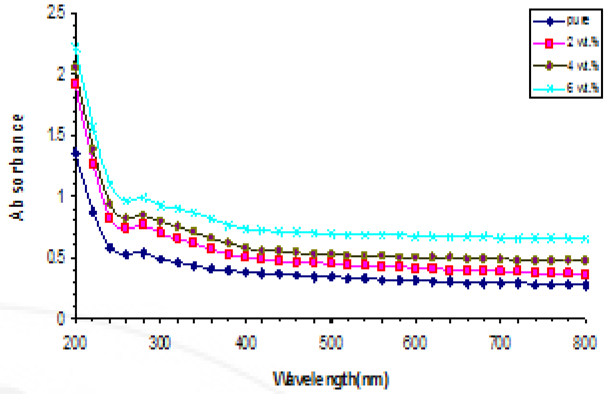


Figure-2
The variation of optical absorbance for (PVA-PAA-FW) composites with wavelength

The absorption coefficient (α) of composites calculated by [9]:

$$\alpha = 2.303A/t \qquad (1)$$

A: is the absorbance of sample and t: is the thickness of sample.

The absorption coefficient of (PVA-PAA-FW) composites is increased with the increase of FW concentrations as shown in figure 3, which attributed to increase the absorbance of composites [10].

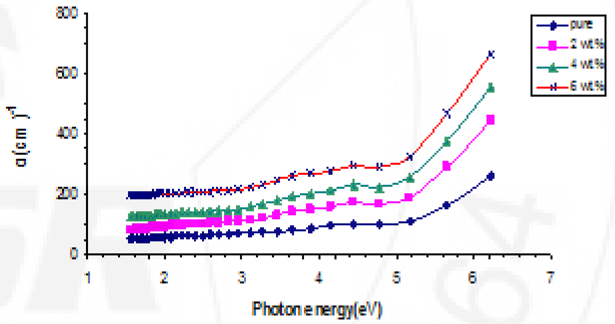


Figure 3
The absorption coefficient for (PVA-PAA-FW) composites with various photon energy

The value of absorption coefficient refers to the composites have indirect energy gap which calculated by following equation [11]:

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

B is a constant, hυ is the photon energy , E_g is the optical energy band gap and r = 2 : allowed indirect transition and r = 3 : forbidden indirect transition.. The figures (4 and 5) show that the allowed and forbidden indirect transition of composites respectively. The energy band gap of composites is decreased with the increase of the

FW concentrations, this is due to increase of the localized level in gap between the valence and conduction band [12].

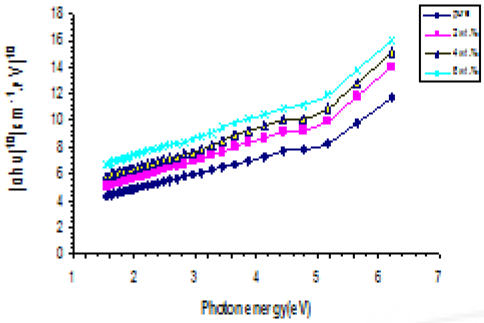


Figure5

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

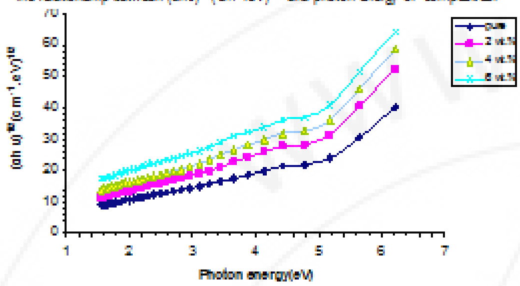


Figure. 4

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

The extinction coefficient (k) calculated by using the following equation [13]:

$$K=\alpha\lambda/4\pi \quad (4)$$

The increase of FW concentrations effects on extinction coefficient of composites as shown in figure 6. The extinction coefficient is increased with the increase of FW concentrations; this increase attributed to increase the number of carries charges in composites [13]

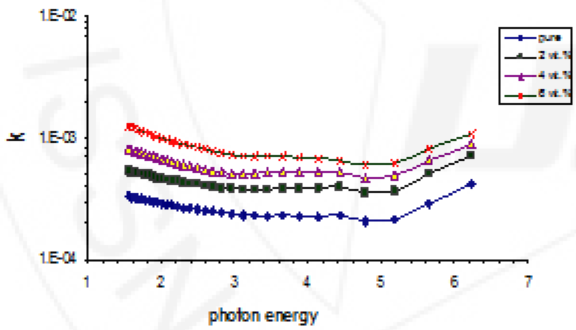


Figure. 6

The extinction coefficient for composites with various photon energy

The Refractive index (n) of composites is calculated by [14]:

$$n= (1+R^{1/2})/ (1-R^{1/2}) \quad (3)$$

R is the reflectance of composites.

The variation of refractive index for (PVA- -PAA-FW) composites with photon energy is shown in figure 6. The figure show that the refractive index of composites is increased with the increase of FW concentrations which attributed to increase of the density for composites [14].

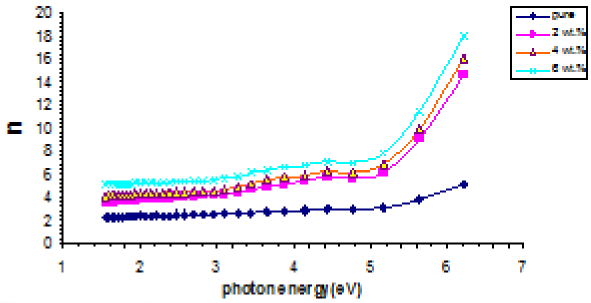


Figure-7

The relationship between refractive index for composites with photon energy

The real and imaginary parts of dielectric constant (ε_1 and ε_2) for composites are calculated by using equations [15]:

$$\varepsilon_1=n^2-k^2 \quad (5)$$

$$\varepsilon_2=2nk \quad (6)$$

The variation of real and imaginary parts of dielectric constants of (PVA- -PAA-FW) composites with photon energy for different concentrations of fiber of wheat. The real and imaginary parts of dielectric constant of (PVA- -PAA-FW) composites are increased with increasing the fiber of wheat concentrations, this behavior attributed to increase the polarization and scattering with increasing the fiber of wheat concentrations [15].

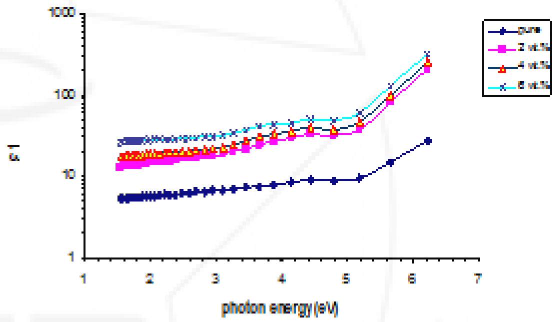


Figure-8

The variation of real part of dielectric constant of composites with photon energy

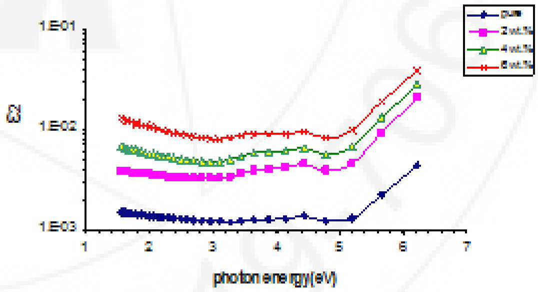


Figure-9

The variation of imaginary part of dielectric constant of composites with photon energy

4. Conclusions

1) The absorbance of (PVA- -PAA) composites is increased with the increase of wheat fiber concentrations.
2) The absorption coefficient, extinction coefficient, refractive index, real and imaginary dielectric constants are increasing with the increase of wheat fiber concentrations.
3) The energy band gap of (PVA- -PAA-FW) composites is decreased with the increase of FW concentrations.

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