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Study of Optical Properties of (PVA-PVAC-Rice Shell) Composites

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Abstract*: In this paper, samples of composites consisting of polyvinyl alcohol- polyvinyl acetate and rice shell were prepared by using the casting method. The polymers composites which the prepared have many applications. The concentrations of rice shell are (5, 10,15,20,25,30 and 35) wt.%. The results show that the optical properties of polymer matrix are changed with the increase of the rice shell concentrations.*

Keywords: Optical Properties, Polyvinyl alcohol, Rice shell

1. Introduction

Composite consisting of two or more materials that have different characteristics, where one serves as a binder material and the other as a fiber. The properties of the composites are strong, lightweight, corrosion resistant, wear resistant, and attractive in appearance. Many composites have been developed with various types of synthetic fibers in order to improve the physical properties [1]. Composites with natural fibers have many significant advantages over composites with synthetic fibers such as low cost, lighter weight, available in the form of plants or waste, non-toxicity, and does not cause skin irritation [2]. Rice Shell is a cellulosic-based fiber, which has been widely utilized in the manufacture of composite panels. The main advantages of using Rice shell as biodegradable filler are their low cost, low density, high specific strength and modulus, and recyclability[3]. Recently, the manufacture of composite materials from agricultural residues such as rice shell has been able to make a commercial product. Rice Shell developed into a raw material to produce ash known as rice shell ash [4]. Using natural fibers as reinforcing fillers facing several underlying factors related to characteristics of lignocellulosic materials, and should be concerned in order to meet the requirement of mechanical properties. Properties of composites with natural fibers are strongly influenced by the bond strength between the matrix and fibers [5]

2. Experimental Part

The materials used in this work are polyvinyl alcohol and polyvinyl acetate as a matrix and rice shell as filler. The polyvinyl alcohol and polyvinyl acetate were dissolved in ethanol with percentage (70 wt.% polyvinyl alcohol, 30 wt.% polyvinyl acetate, concentrations are (0,5,10,15,20,25,30 and 35) wt.% . The casting technique is used to preparation the samples. The optical properties were measured by using UV/1800/Shimadzu spectrophotometer.

3. Results and Discussion

The absorbance of composites was measured in the wavelength range (200-800)nm. Fig.1: shows that the absorbance of composites is increased with the increase of the rice shell concentration, this behavior attributed to particles which absorbance the incident light [6].

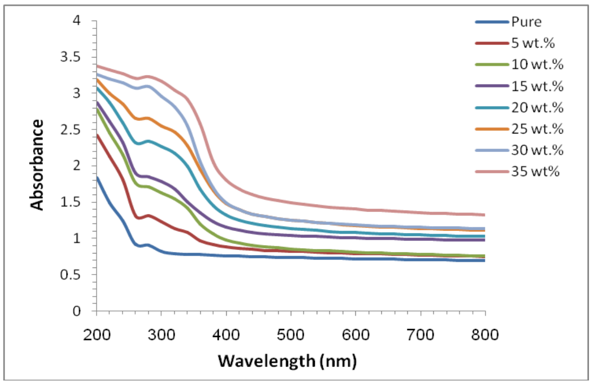

Figure 1: The variation of optical absorbance of composite with wavelength.

The absorption coefficient (α) is defined by [6,7]:

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

Where A: is the absorbance of sample and d: is the sample thickness. Figure (2) represents the variation of absorption coefficient of composites of different concentration of filler with the photon energy..

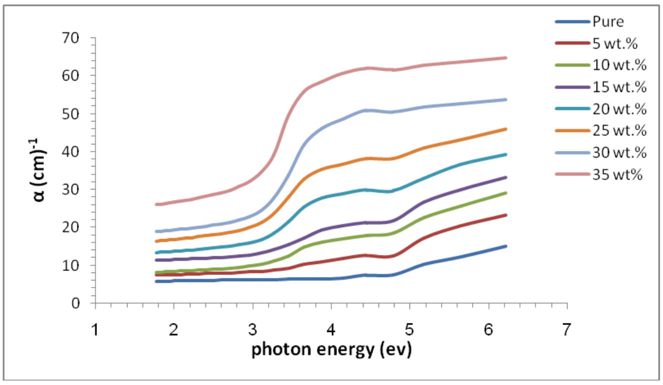

Figure 2: The absorption coefficient of composite with various photon energy

From the figure, the absorption coefficient of composites less than 104 cm^{-1} which refer to the composites have indirect energy band gap which calculated by[8]:

$$\alpha h\upsilon = B(h\upsilon - Eg)^r \quad \text{..........................} (2)$$

Where: $h\upsilon$ is the photon energy, B is a constant, Eg is the energy band gap, r=2 and 3 for allowed and forbidden indirect transition.

The increase of the concentration of filler is produced increase of the localized states in the forbidden gap which decreases the optical energy gap [8] as shown in figures (3 and 4).

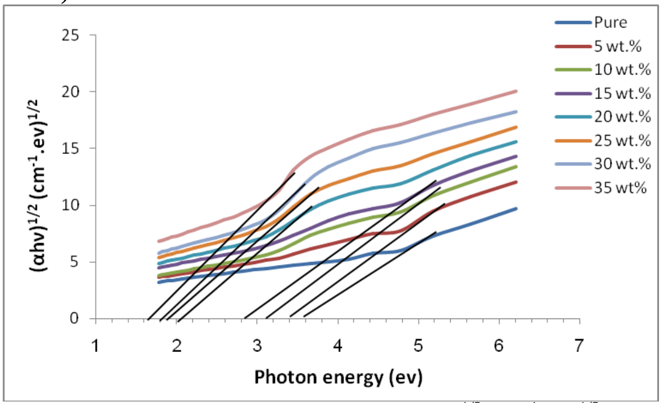

Figure 3: The relationship between $(\alpha hu)^{1/2}(cm^{-1}eV)^{1/2}$ and photon energy of composites.

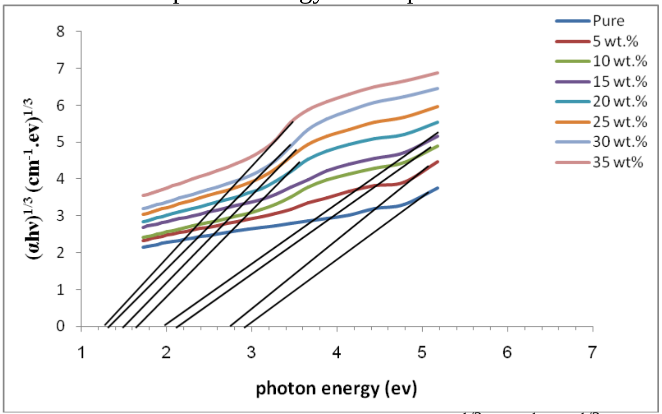

Figure 4: The relationship between $(\alpha hu)^{1/3}(cm^{-1}eV)^{1/3}$ and photon energy of composites.

The refractive index (n) of the composites is defined :

$$n= (1+R1/2)/ (1-R1/2) \qquad \ldots\ldots \ldots (3)$$

Where R is reflectance index

The extinction coefficient (k) of composites is calculated by:

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

The variation of the refractive index for composites for various different concentration a function of wavelength at room temperature is shown in figure (5). The figure shows that the refractive index increase as a result of filler addition, this behaviour can be attributed to the increasing of the packing density as a result of filler content[9].

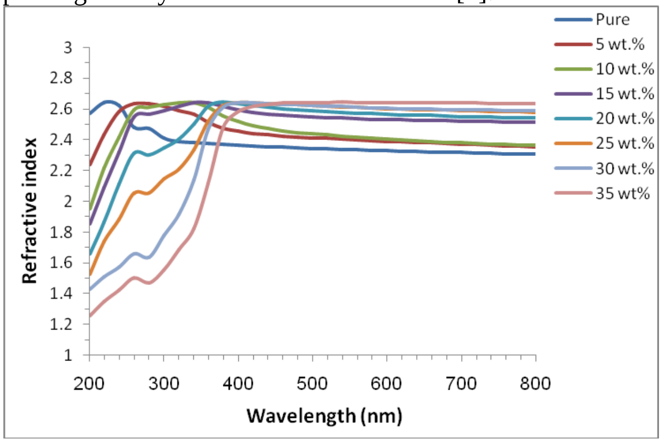

Figure 5: The variation of refractive index of composite with wavelength.

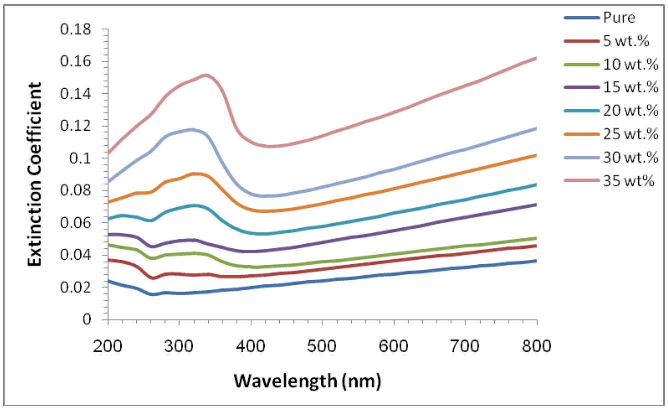

Figure 6: The relationship between the extinction coefficient (k) and wave length of composites.

The variation of extinction coefficient (k) with wavelength for composites is as shown in figure (6). The extinction coefficient increases with increasing of (PVA-PVAC-Rice Shell) concentration. This behaviour of extinction coefficient can be ascribed to high absorption coefficient. The extinction coefficient is high at the longest wavelengths and high concentration[9].

The dielectric constants (real (ε1) and imaginary (ε2) parts) are defined by[10]:

$$\varepsilon 1=n2-k2 \qquad \ldots\ldots \ldots\ldots (5)$$

$$\varepsilon 2=2nk \qquad \ldots\ldots \ldots\ldots\ldots (6)$$

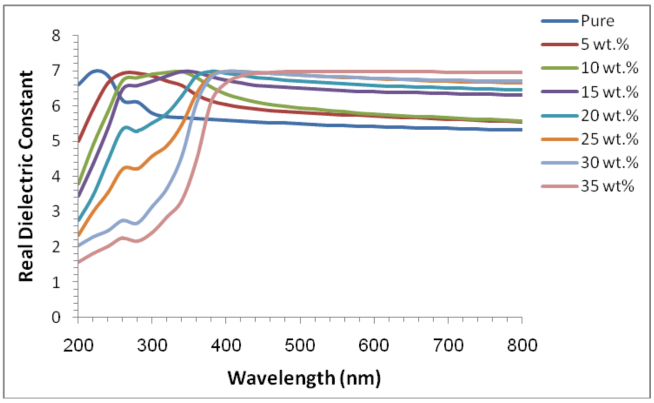

Figure 7: The relationship between the real dielectric constant and wave length of composites.

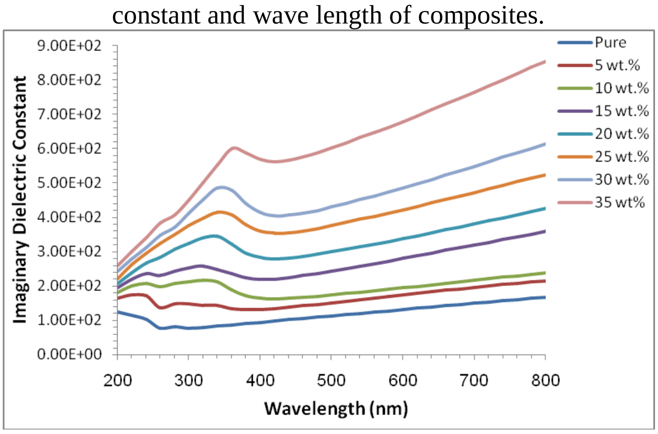

Figure 8: The relationship between the imaginary dielectric constant and wave length of composites.

Figures (7) and (8) show the relationship between the real and imaginary parts of dielectric constants of composites with different concentration of filler. From these figures, the real and imaginary parts of dielectric constants are increased with the increase of the concentration of the rice shell.

It is concluded that the variation of ε1 mainly depends on (n2) because of small values of (k^2), while ε2 mainly depends on the (k) values which are related to the variation of absorption coefficients. The values of the real dielectric constant are high with respect to the imaginary dielectric constant[10].

4. Conclusions

1) The absorbance of the polyvinyl alcohol-polyvinyl acetate is increased with the increase of the rice shell concentration.
2) The absorption coefficient, extinction coefficient, refractive index and real and imaginary dielectric constants
3) the polyvinyl alcohol-polyvinyl acetate are increasing with the increasing of the weight percentages of rice shell.
4) The indirect energy band gap of the decreased with the increasing of the polyvinyl alcohol-polyvinyl acetate rice shell concentration.

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