Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2017, 9(5):310-314

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The Optical Properties of Copper Oxide Nanoparticles with (Polyvinyl Alcohol-Polyethylene Glycol) Blend

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ABSTRACT

The optical constants and optical energy gap of (PVA-PEG-CuO) nano-composite films have been studied in the present paper. The nano-composite films was prepared by casting technicality, where, (PVA-PEG) blends used as matrix while the Copper oxide nanoparticles were (0, 2, 4, 6, 8) wt% as a filler. The present study is aimed to modification of the optical properties of blends with different concentrations of (CuO) nanoparticles and for achieves a new class of material. The absorption and transmission spectra have been recorded at the wavelength range 220-800 nm. The experimental results illustrate that the absorbance of pure blend was increased with increase of Copper oxide concentrations and vice versa with transmission. On the other hand, the optical constants and optical energy gap were changed with the addition of Copper oxide nanoparticles concentrations.

Keywords: Nanocomposites; Copper oxide nanoparticles; UV visible spectroscopy

INTRODUCTION

Polymers are macromolecules set up by the bonding together, under creation of chemical ties, of large numbers for much smaller molecules. The tiny molecules that accumulate with one another to compose polymer molecules are called monomers. There prospects will be thousands, or more monomer molecules bonded with one another in a polymer [1]. For achieve special material properties different polymers can be used as polymer compounds like polymer blends. Thermal and mechanical or chemical properties of polymer blends are defined by the kind of different polymers used within the polymer blend [2].

Polymer nanocomposites are an interacting blend of two states, a solid state which is in the nanometer size range in at least one dimension and also a polymer matrix. Very momentous appearance for polymer nanocomposites is that the small size of the fillers guides to a dramatic increase in interfacial area creates significant volume fraction of interfacial polymer reaction with nano-fillers forming properties unlike from the block polymer as far as at low concentration of nanofillers [3]. There are two mechanisms of a network are probable in a polymer matrix of nanoparticles this is either by chain to be interlaced or agglomeration, may be the more powerful effects foretell when chains of macromolecules are tethered at the nanoparticles surfaces (hydrogen, physical, Vander walls, dipole) interaction. The mobility of the chains inside a few nanometers of the surface is decrease in this state, while discontinue the bulk comparatively unaffected. The surface may act to constrains chains as of adsorption, thus happen due to the dipole attraction of the nanoparticles for example metal oxide [4,5]. The copper oxide nanoparticles compared with ordinary copper oxide powder can possess a wide range of applications and show superior catalytic activity and selectivity. The nanoparticles of copper oxide have excellent antimicrobial activity against various bacterial strains [6]. Polyvinyl alcohol is one of the most-studied and general polymeric materials with have it carbon chain backbone and hydroxyl groups, on the other hand it is very low conductivity at room temperature, while mixing it with polyethylene glycol (PEG) enhances it conductivity [7].

EXPERIMENT SECTION

For one hour at room temperature, (0.5) gm of (86% PVA and 14% PEG) was dissolved completely in distilled water in a glass beaker under constant stirring while the mixture was heated up till (75°C), then wait for the solution to be cooled to room temperature while the stirring of the mixture was hold to ensure a homogenous composition. Miscellaneous concentrations of nanoparticles of copper oxide are added by (0, 2, 4, 6, 8) weight percentages were dissolved as stated above and in this way various samples were obtained. The samples were placed in a petri dish it has diameter (5 cm) and let it arid at room temperature for 14 days.
At the expiry of this time, the films were prepared which were disjoined off the casting glass and cut into pieces for testing. During that the absorption spectra of (PVA-PEG-CuO) nanocomposites have been recorded at room temperature by using double-beams spectrophotometer between the length wave range (220-800) nm to different samples with different thickens. The surface morphology of (PVA-PEG-CuO) nanocomposites was observed using (Bruker Nano GmbH, company, German origin, type vertex 5600 LV SEM).

RESULTS AND DISCUSSIONS

SEM images of the surface morphology of the nanocomposites films show many granule groups or spherical particles aggregates randomly distributed and spread densely on the top surface (Figure 1). The fillers form uninterrupted network inside the polymers, this contain paths inside the nanocomposites. When copper oxide concentrations increase this occasion to the increase of the charge carriers, consequently the result shows that the absorbance increases as a result of filler addition [8]. On the other hand, the Figure 2 shows the optical absorbance as a function of the wavelength of the incident light for (PVA-PEG-CuO) nanocomposites of various concentrations. The hump at nearly 280 nm may be due to the absorption band which are due to electronic transition from the ground states to excited states and also assigned to existence of carbonyl groups [9]. In addition, it can be seen that no change in the chemical structure of the material as no change in this band position.

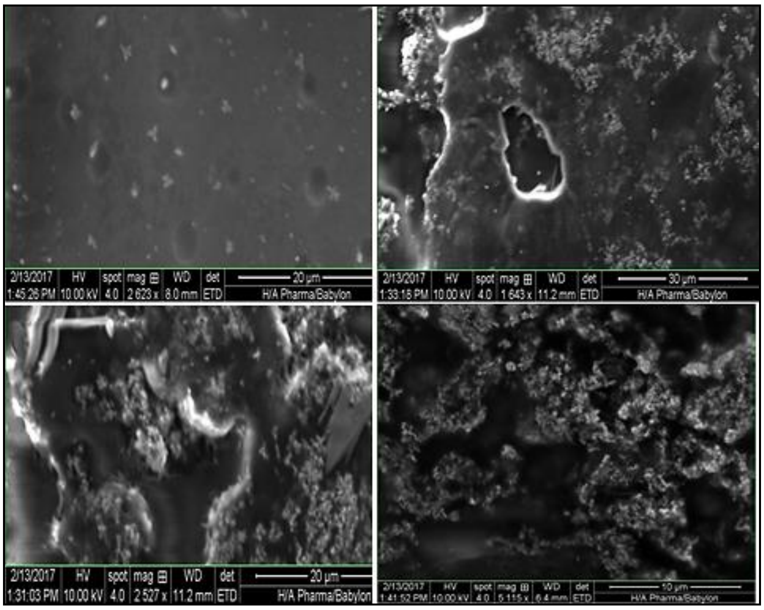

Figure 1: SEM images for (PVA-PEG-CuO) nanocomposites: (A) 2 wt.% CuO (B) 4 wt.% CuO, (C) 6 wt.% CuO, (D) 8 wt.% CuO

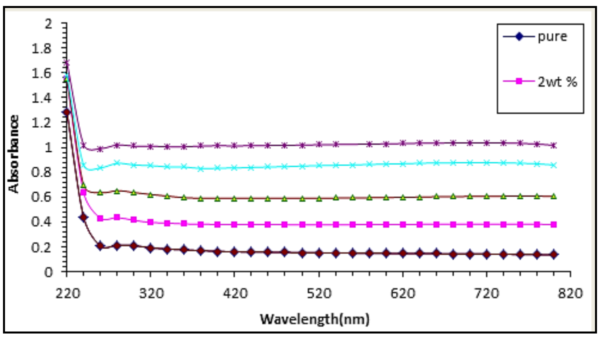

Figure 2: Variation optical absorbance for PVA-PEG-CuO nanocomposite with wavelength

The absorption coefficient (α) contribute to revelation the nature electronic transitions,it was calculated by the following equation [10].

$$I = I_o \exp(-\alpha d) \;\ldots\ldots (1)$$

$$\text{Hence; } \alpha = (2.303/d)\log(I_o/I) = (2.303A)/d \;\ldots.(2)$$

Where, (A) is absorbance and (d) is the thickness of sample, I_0 and I are the intensities of incident and transmitted radiation respectively. From the relationship between the photon energy and absorption coefficient for the (PVA-PEG-CuO) nanocomposites in Figure 3 we note that, at low energies the change in the absorption coefficient is small this indicates that the possibility of electronic transitions is a few, but at high energies is conversely.

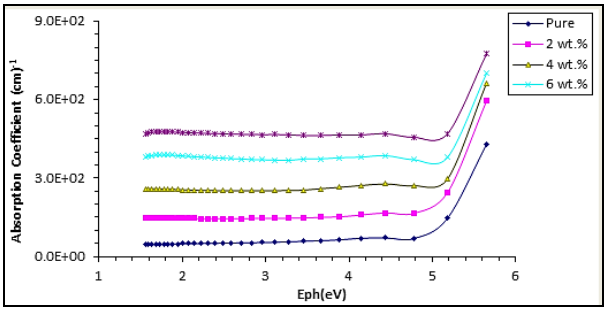

Figure 3: Relationship between the absorption coefficient and photon energy of the PVA-PEG- CuO nanocomposite

The results in Figure 3 refer to that the values of absorption coefficient of the (PVA-PEG-CuO) nanocomposites less than 10^4 cm^{-1}, which indicates the indirect electronic transition, where, in this case the momentum of the electron and photon conserves by phonon helps [11].

On the other hand, the forbidden energy gap of indirect transition was calculated by the following relationship: [12]

$$(\alpha h\upsilon = B\,[h\upsilon - E_g^{opt.}\,]^r) \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where (E_g) is optical energy gap of the indirect transition, (hυ) is the energy of photon and (B) is proportionality constant, when r=2 this refer to an allowed indirect transition but when r=3 this refers to forbidden indirect transition. From Figure 4 noted that the value of the optical energy gap decreases with increasing Copper oxide nanoparticles concentration. Where, the value of optical energy gap of the allowed and forbidden indirect transition will get it by the straight line cut oriented axis at the point $(\alpha h\nu)^{1/r} = 0$. In short, by appearance of new levels in the band gap, this lead to make easy the traversing of electrons from the valence band to these local levels to the conduction band this lead to decreased the energy band gap for indirect allowed and indirect forbidden transition with the increase of the Copper oxide nanoparticles concentrations of which to be in pure blend [13] (Figure 5).

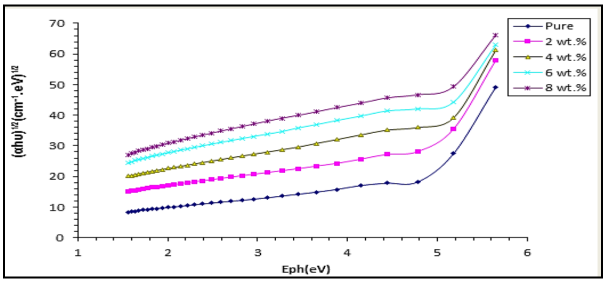

Figure 4: Relationship between $(\alpha h\nu)^{1/2}$ and photon energy of (PVA-PEG-CuO) nanocomposite

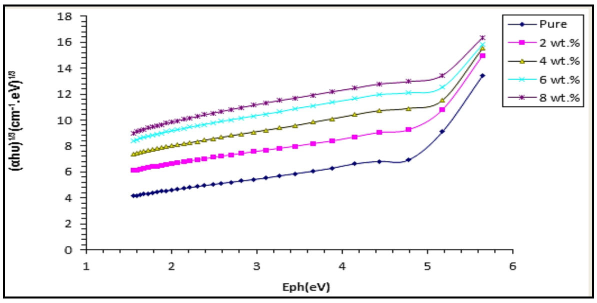

Figure 5: The energy gap for the forbidden indirect transition $(\alpha h\upsilon)^{1/3}$ as a function of photon energy of (PVA-PEG-CuO) nanocomposites

Figure 6 shows the variations of extinction coefficient with wavelength of (PVA-PEG-CuO) nanocomposite, the extinction coefficient can calculate by the following equation.

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

This figure shows an increase extinction coefficient with increasing Copper oxide nanoparticles concentration. This behavior of extinction coefficient can be imputed to high absorption coefficient (α) [6].

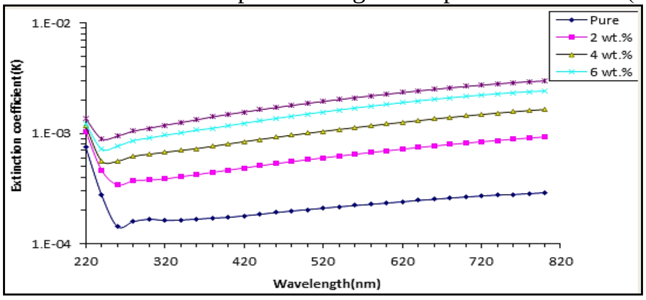

Figure 6: Variation of extinction coefficient (k) for (PVA-PEG-CuO) nanocomposite with wavelength

From relation below we can be determined the refractive index (n):

$$n = ((4R/(R-1)^2 - k^2) - (R+1)/(R-1))^{1/2} \quad ....(5)$$

Where Figure 7 shows the refractive index as a function of wavelength, the higher concentration of Copper oxide nanoparticles causes the increase of extinction coefficient which ascribed to the increase of package density hence increase the refractive index (n).

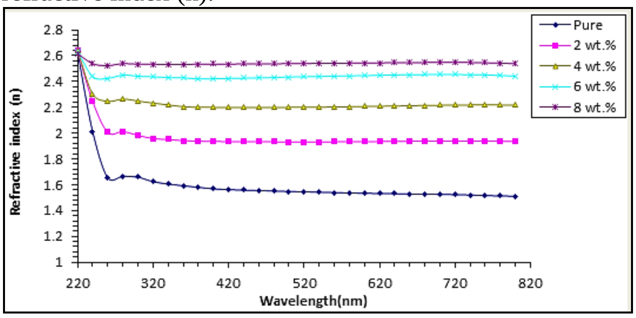

Figure 7: Variation refractive index for (PVA-PEG-CuO) nanocomposite with wavelength

The information about the loss factor given by the real and imaginary part of the dielectric constant, the first show that a quantity of light speed lost in the material due to scattering, we can be calculated it by the following equation [14]:

$$\varepsilon_r = n^2 - k^2 \quad .... (6)$$

On the other hand, the real dielectric constant for (PVA-PEG-CuO) nanocomposite increase with increases the concentration of Copper oxide nanoparticles as shown in Figure 8.

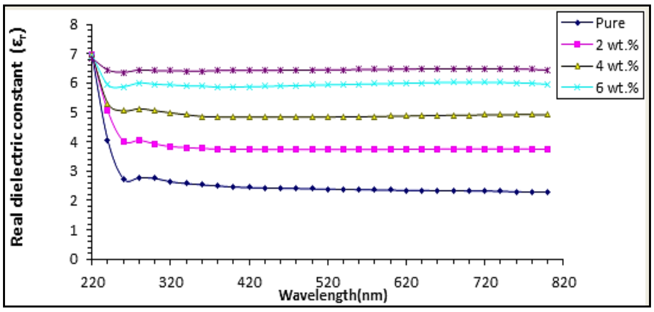

Figure 8: Variation real dielectric constant for (PVA-PEG-CuO) nanocomposite with wavelength

The imaginary dielectric constant for (PVA-PEG-CuO) nanocomposite increased with increasing the concentration of Copper oxide nanoparticles as shown in Figure 9, and determined by the relation

$$(\varepsilon_i = 2nk) \quad .... (7)$$

Where, the dielectric loss (ε_i) demonstrates the absorption quantity of dielectric of the energy from an electric field due to dipole motion [11]. According to the relationship(5) and (6) we note that both real and imaginary part of the dielectric constant depend on the refractive index and extinction coefficient this make the value of the real part more than the imaginary part of the dielectric constant.

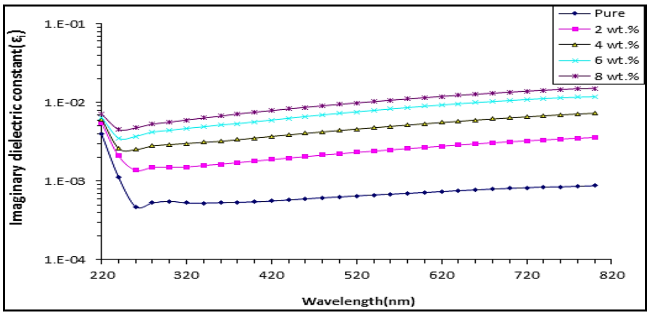

Figure 9: Variation imaginary dielectric constant for PVA-PEG-CuO nanocomposites with wavelength

CONCLUSION

1. The absorption increases with increasing of the copper oxide nanoparticles concentrations.
2. The addition of Copper oxide nanoparticles concentrations to the (PVA-PEG) blend causes decreases the optical energy gab.
3. The experimental results showed that the absorption coefficient less than10^4 cm^{-1} this indicates to indirect electronic transitions.
4. The extinction coefficient, refractive index, real and imaginary part of the dielectric constant increases with increasing the CuO nanoparticles concentrations.

REFERENCES

[1] O George. Principles of polymerization. John Wiley & Sons, **2004**.
[2] Klein Rolf. Laser welding of plastics. John Wiley & Sons, **2012**.
[3] H Zulkefle; LN Ismail; RA Bakar; MH Mamat; M Rusop. *Int J Appl Phy Mat.* **2012**, 38.
[4] A Boudenne, L Ibos, Y Candau, S Thomas. Handbook of multiphase polymer systems. John Wiley and Sons, **2011**.
[5] R Kotsilkova. Thermoset Nanocomposites for Engineering Applications, Shawbury: Smithers Rapra Technology Limited. **2007**, 207-276.
[6] M Ahamed; HA Alhadlaq; MA Khan; P Karuppiah; NA Al-Dhabi. *J Nanomaterials.* **2014**, 17.
[7] AF Mansour; SF Mansour; MA Abdo. *IOSR J Appl Phy.* **2015**, 7, 97-106
[8] Hamdalla; A Taymour; A Taha; Hanafy; EB Ashraf. *J Spectroscopy*. **2015**.
[9] EM Abdelrazek; IS Elashmawi; A El-Khodary; A Yassin. *Current Appl Phy*. **2010**, 607-613.
[10] B Thangaraju; P Kalianna. *Cryst Res Technol*. **2000**, 35, 71.
[11] A Kathalingam. *Mat Chem Phy*. **2007**, 6.
[12] LI Soliman; WM Sayed. *Eyptian J Solids.* **2002**, 25, 103-113.
[13] RM Ahmed. *Int J Photoenergy*. **2009.**
[14] R Tintu; K Saurav; K Sulakshna; VPN Nampoori; P Radhakrishnan; S Thomas. *J Non-Oxide Glasses.* **2010**, 167-174.