Preparation of (PVA-PEG-PVP-MgO, CoO) Nanocomposites and Study their Optical Properties

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Abstract: ***Nanocomposites have many applications such: optical integrated circuits, sensors, coatings, medical devices.. etc. So, this paper aims to preparation of new type (PVA-PEG-PVP- MgO, CoO) nanocomposites to production new nanocomposites use in many applications. The nanocomposites were prepared by using casting technique. The polymers was mixed with different weight percentages are ($PVA_{0.90}$-$PEG_{0.05}$-$PVP_{0.05}$). The nanomaterials (MgO and CoO) were added to polymers composites with concentrations are (0, 2, 4 and 6) wt.%. The results show that the absorbance (A) of nanocomposites is increased with increase of concentrations of magnesium oxide and cobalt oxide nanoparticles. The optical constants (absorption coefficient (α), extinction coefficient (k), refractive index (n), real and imaginary dielectric constants (ε_1 and ε_2)) of nanocomposites are increasing with the increase of the weight percentages of magnesium oxide and cobalt oxide nanoparticles. The energy gap (E_g) of (PVA-PEG-PVP) decreases with the increase of the weight percentages of magnesium oxide and cobalt oxide nanoparticles.***

Keywords: nanocomposites, optical properties, magnesium oxide, cobalt oxide

1. Introduction

When you submit your paper print it in two-column format, A nanoparticle is the most fundamental component in the fabrication of a nanostructure; metallic nanoparticles have different physical and chemical properties from bulk metals (lower melting points, higher specific surface area, specific optical properties, mechanical strength, and specific magnetization) properties that might prove to be attractive in various industrial applications. The optical property is one of the fundamental attraction and characteristic of nanoparticle [1]. The applications of nanocomposites are quite promising in the fields of microelectronic packaging, optical integrated circuits, automobiles, drug delivery, sensors, injection molded products, membranes, packaging materials, aerospace, coatings, adhesives, fire-retardants, medical devices, consumer goods, etc[2] . The development of polymer based nanocomposites with antimicrobial activity offers interesting possibilities because the polymer matrix can be varied in order to fulfill not only specific technological requirements but also nanostructures with size- and shape dependent properties that can be exploited [3]. Metal oxides such as TiO_2, ZnO, MgO and CaO are of particular interest as they are not only stable under harsh process conditions but also generally regarded as safe materials to human beings and animals. Some of the metal oxides e.g. MgO and CaO are essential minerals for human. Other metal oxides such as TiO_2 and ZnO have been used extensively in the formulation of personal care products. Synthetic fibers can be treated with these metal oxides during production in order to make them anti-microbial [4].

2. Materials and Methods

The materials are used in this paper are polymers (polyvinyl alcohol (90 wt.%), Polyethylene glycol (5 wt.%) and polyvinyl pyrrolidinone (5 wt.%) as a matrix and the nanomaterials (.magnesium oxide and cobalt oxide) as additive. The polymers (polyvinyl alcohol (90 wt.%), Polyethylene glycol (5 wt.%) and polyvinyl pyrrolidinone (5 wt.%) are dissolved in distill water by using magnetic stirrer in mixing process to get homogeneous solution. The magnesium oxide and cobalt oxide nanoparticles were added to solution with concentrations are (0,2 ,4 and 6) wt.% . The casting technique was used to preparation the (PVA-PEG-PVP-MgO, CoO) nanocomposites. The optical properties of (PVA-PEG-PVP-MgO, CoO) are measured by using UV/1800/ Shimadzu spectrophotometer in range of wavelength (200-800) nm.

Absorption coefficient (α) is defined by following equation[5]:

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

Where A: is the absorbance and t: is the sample thickness.
The indirect transition model for amorphous semiconductors is[6]:

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

Where B is a constant, hυ is the photon energy , E_g is the optical energy band gap, r = 2 for allowed indirect transition and r = 3 for forbidden indirect transition.
The Refractive index (n) is given by following equation[7]:

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

Where R is the reflectance.
The extinction coefficient (k) is calculated by using the following equation[7]:

$$K=\alpha\lambda/4\pi \quad \text{...........} (4)$$

The dielectric constant is divided into two parts real(ε_1), and imaginary (ε_2).The real and imaginary parts of dielectric constant (ε_1 and ε_2) are calculated by using equations[8]:

$$\varepsilon_1=n^2-k^2 \text{ (real part)} \quad \text{........} (5)$$

$$\varepsilon_2=2nk \text{ (imaginary part)} \quad \text{......} (6)$$

3. Results and Discussion

The variation of absorbance spectra of (PVA-PEG-PVP-MgO, CoO) nano composites with wavelength (200-800) nm of different concentrations of magnesium oxide and cobalt oxide nanoparticles are shown in figures (1 and 2) respectively. From the figures the absorbance of (PVA-PEG-PVP) polymers composites is increased with increase the concentrations of magnesium oxide and cobalt oxide nanoparticles which attributed to nanoparticles which absorb the incident light [9].

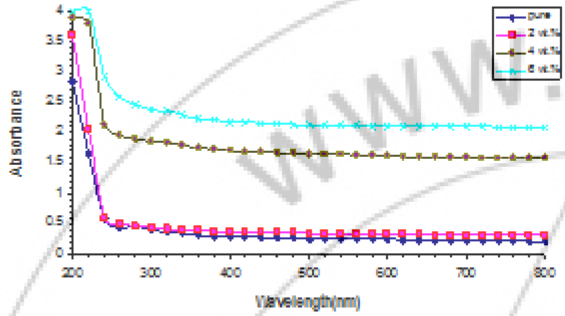

Figure. 1
The variation of optical absorbance for (PVA-PEG-PVP-MgO) nanocomposite with wavelength

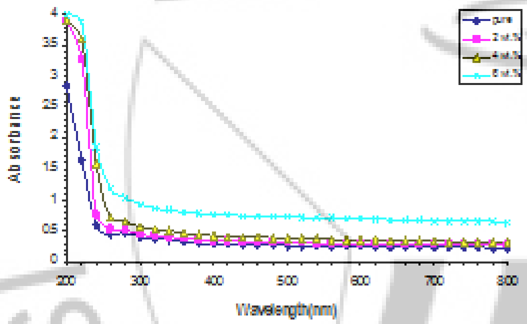

Figure 2
The variation of optical absorbance for (PVA-PEG-PVP-CoO) nanocomposite with wavelength

The effect of magnesium oxide and cobalt oxide nanoparticles concentrations on the absorption coefficient of nanocomposites are shown in figures (3 and 4) respectively. These figures show that the absorption coefficient of (PVA-PEG-PVP) polymers composites increases with increase of the magnesium oxide and cobalt oxide nanoparticles concentrations, this increase attributed to increase the number of carries charges which causes to increase the absorbance. The absorption coefficient have values are less than 10^4 cm^{-1} which mean the nanocomposites have indirect energy band gap as shown in figures (5 and 6) for allowed indirect transition of (PVA-PEG-PVP- MgO) and (PVA-PEG-PVP-CoO) nanocompsites respectively and figures (7 and 8) for forbidden indirect transition of (PVA-PEG-PVP-MgO) and

(PVA-PEG-PVP-CoO) nanocompsites respectively. The energy band gap for allowed and forbidden indirect transition decreases with increase of the magnesium oxide and cobalt oxide nanoparticles concentrations which attributed to the increase the localized level in forbidden energy band gap[10].

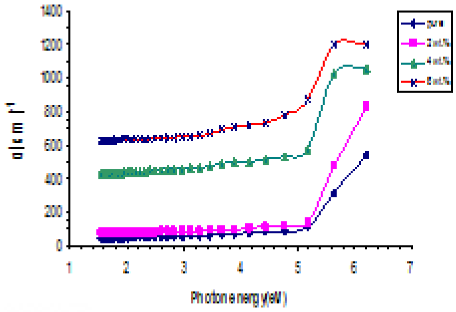

Figure 3
The absorption coefficient for (PVA-PEG-PVP-MgO) nanocomposite with various photon energy

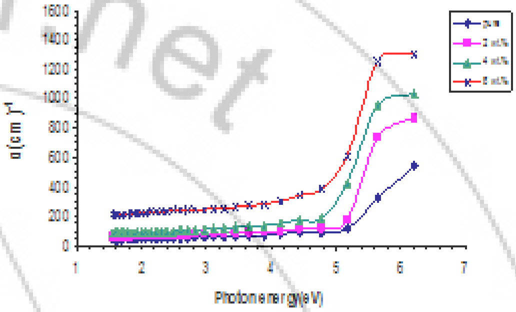

Figure 4
The absorption coefficient for (PVA-PEG-PVP-CoO) nanocomposite with various photon energy

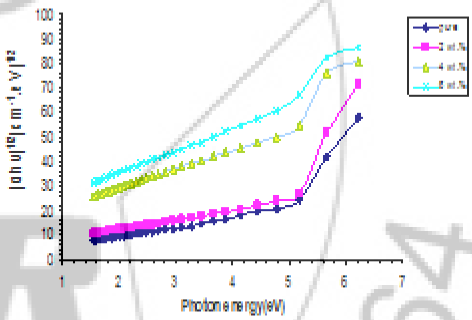

Figure 5
The relationship between $(\alpha h\upsilon)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of nanocomposites.

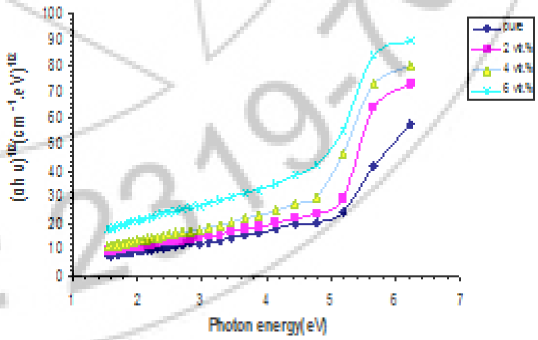

Figure 6
The relationship between $(\alpha h\upsilon)^{1/2}(cm^{-1}.eV)^{1/2}$ and photon energy of nanocomposites.

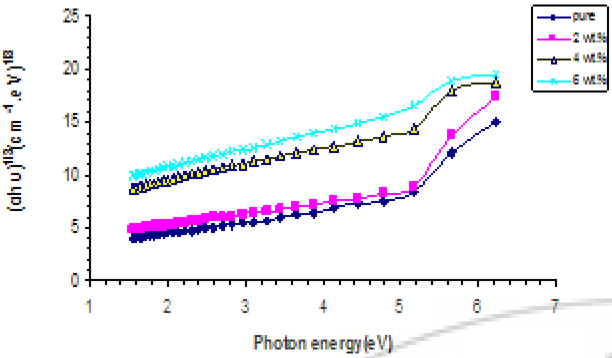

Figure.7
the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of nanocomposites.

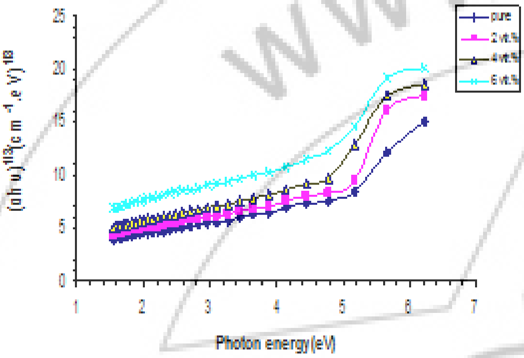

Figure.8
the relationship between $(\alpha h\upsilon)^{1/3}(cm^{-1}.eV)^{1/3}$ and photon energy of nanocomposites.

The variation of refractive index of the (PVA-PEG-PVP-MgO) and (PVA-PEG-PVP-CoO) nanocompsites with photon energy for different concentrations of magnesium oxide and cobalt oxide nanoparticles are shown in figures (9 and 10) respectively. The figures show that the refractive

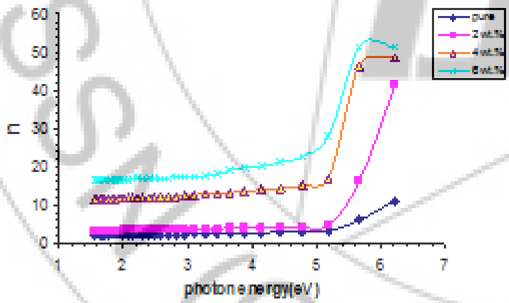

Figure.9
The relationship between refractive index for (PVA-PEG-PVP-MgO) nanocomposite with photon energy

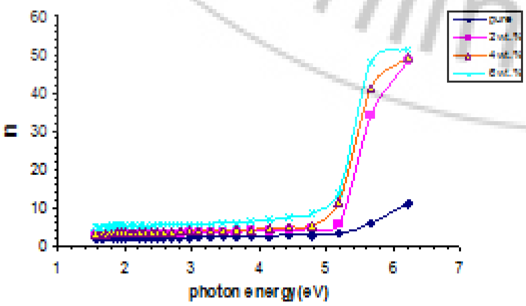

Figure.10
The relationship between refractive index for (PVA-PEG-PVP-CoO) nanocomposite with photon energy

index of (PVA-PEG-PVP) polymers composites increases with increase of the magnesium oxide and cobalt oxide nanoparticles which attributed to increase the scattering of incident photon which causes to increase the reflectance[11]. Figures (11 and 12) show that the variation of the extinction coefficient of the (PVA-PEG-PVP- MgO) and (PVA-PEG-PVP-CoO) nanocompsites with photon energy for different weight percentages of the magnesium oxide and cobalt oxide nanoparticles respectively. From the figures, the extinction coefficient is increased with increase of the concentrations of magnesium oxide and cobalt oxide nanoparticles, this behavior attributed to increase of absorption of the incident light[12].

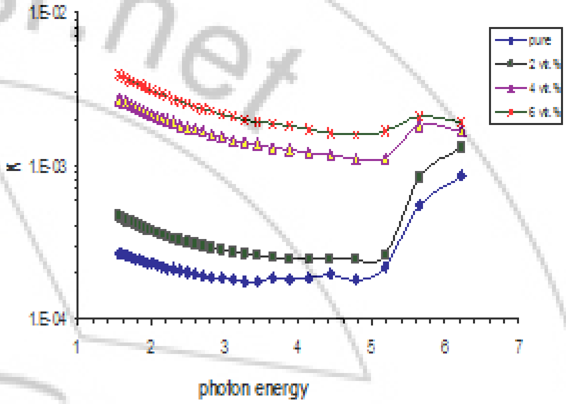

Figure.11
The extinction coefficient for nanocomposite with various photon energy

The variation of real and imaginary parts of dielectric constants of the (PVA-PEG-PVP- MgO) and (PVA-PEG-PVP-CoO) nanocompsites with photon energy for different concentrations of magnesium oxide and cobalt oxide nanoparticles are shown in figures (13, 14, 15 and 16). The figures show that the real and imaginary parts of dielectric constants are increased with increase of the magnesium oxide and cobalt oxide nanoparticles concentrations which attributed to increase the absorption and scattering of incident light with increase of the concentrations of magnesium oxide and cobalt oxide nanoparticles[13]

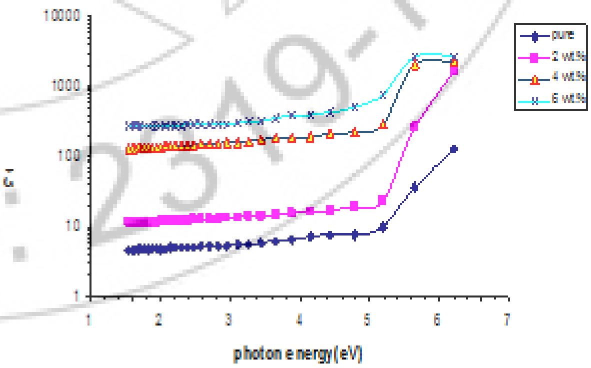

Figure.13
The variation of real part of dielectric constant of nanocomposite with photon energy

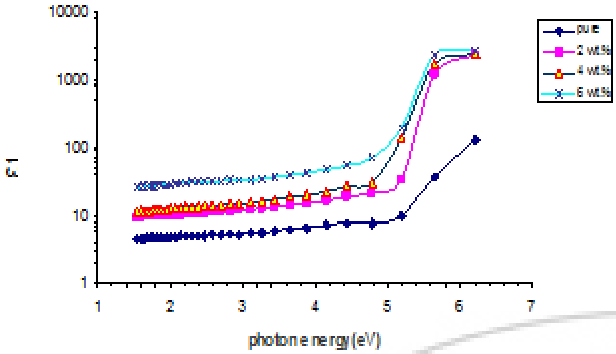

Figure. 14
The variation of real part of dielectric constant of nanocomposite with photon energy

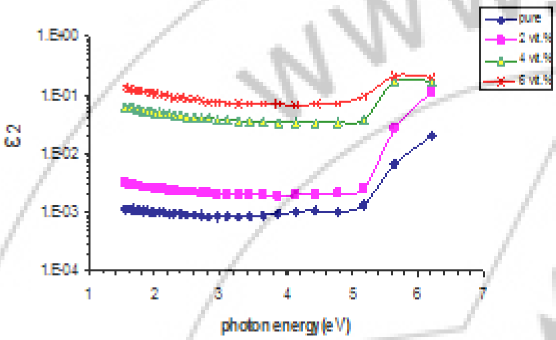

Figure. 15
The variation of imaginary part of dielectric constant of nanocomposite with photon energy

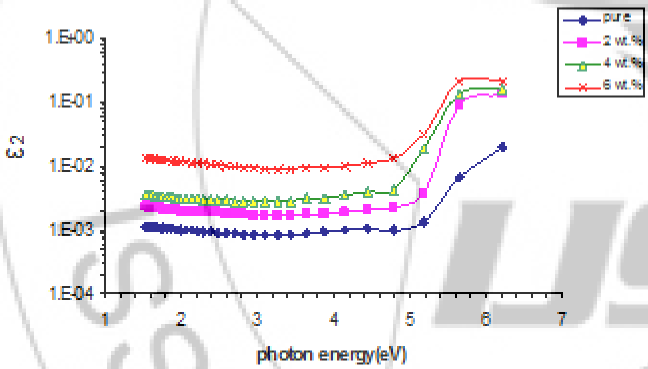

Figure.16
The variation of imaginary part of dielectric constant of nanocomposite with photon energy

4. Conclusions

1) The absorbance of (PVA-PEG-PVP) nanocomposites increases with increase of the magnesium oxide and cobalt oxide nanoparticles concentrations.
2) The energy band gap of (PVA-PEG-PVP) nanocomposites decreases with increase of the magnesium oxide an cobalt oxide nanoparticles concentrations
3) The absorption coefficient (α), extinction coefficient (k), refractive index (n) and real and imaginary dielectric constants are increasing with increase of the weight percentages of the magnesium oxide and cobalt oxide nanoparticles concentrations.

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