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

Ibrahim R.Agool¹, Ahmed Hashim²

¹Al- Mustansiriah University, College of Science, Department of Physics, Iraq
²Babylon University, College of Education of Pure Science, Department of Physics, Iraq

Abstract: Nanocomposites have many applications such as optical integrated circuits, sensors, coatings, medical devices, etc. So, this paper aims to prepare a new type (PVA-PEG-PVP-MgO, CoO) nanocomposites to synthesize new nanocomposites in many applications. The nanocomposites were prepared by the casting technique. The polymers were mixed with different weight percentages are (PVA₀.₉₀-PEG₀.₀₅-PVP₀.₀₅). The nanomaterials (MgO and CoO) were added to the polymers 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 (ε₁ and ε₂)) of nanocomposites are increasing with 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. 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 (ε₁ and ε₂)) of nanocomposites are increasing with 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; metal nanoparticles have different physical and chemical properties from bulk metals (lower melting points, higher specific surface area, specific optical properties, mechanical strength, and specific magnetoization) 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 nanocomposites with size- and shape dependent properties that can be exploited [3]. Metal oxides such as TiO₂, 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 materials for human. Other metal oxides such as TiO₂ 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 casting technique was used to prepare 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]:

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

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

The indirect transition model for amorphous semiconductors is[6]:

$$\alpha \nu = B(h\nu - E_g)^r \quad ... (2)$$

Where B is a constant, hν 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]:

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

Where R is the reflectance.

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

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

The dielectric constant is divided into two parts real(ε₁), and imaginary (ε₂). The real and imaginary parts of dielectric constant (ε₁ and ε₂) are calculated by using equations[8]:

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

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

![Absorbance Spectra](image1)

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) nanocomposites respectively and figures (7 and 8) for forbidden indirect transition of (PVA-PEG-PVP-MgO) and (PVA-PEG-PVP-CoO) nanocomposites 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].

![Absorption Coefficient](image2)

![Absorption Coefficient](image3)
The variation of refractive index of the (PVA-PEG-PVP-MgO) and (PVA-PEG-PVP-CoO) nanocomposites 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 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) nanocomposites 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].

The variation of real and imaginary parts of dielectric constants of the (PVA-PEG-PVP-MgO) and (PVA-PEG-PVP-CoO) nanocomposites 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].
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 and cobalt oxide nanoparticles concentrations.

3) The absorption coefficient (\(\alpha\)), 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.

References


