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Study the Effect of Nano-Mgo On the Optical Properties of (PVA-PEG-Mgo) Nanocomposites

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***Abstract*— In this research, many samples have been prepared by adding magnesium oxide (MgO) nanoparticles to the poly vinyl alcohol and poly ethylene glycol with different weight percentages (o, 4, 8,12 and 16) wt%. The effect of addition MgO nanoparticles on optical properties of poly vinyl alcohol and poly ethylene glycol have been studied. The absorbance has been recorded in the wavelength (200-1100) nm, also the absorption coefficient, real and imaginary dielectric constant, energy gap of the indirect allowed and forbidden transition, extinction coefficient and refractive index have been determined.**

***Keywords*— optical properties, (PVA-PEG-MgO) nanocomposites, magnesium oxide**

I. Introduction

We live in polymer age. Plastics, fibers, elastomers, coatings, rubber, cellulose- these are all terms in our modern vocabulary [1]. Although many people probably do not realize it, everyone is familiar with polymers. They are all around us in everyday use, in rubber, plastics, resins and in adhesives and adhesive tapes, and their common structural feature is the presence of long covalently bonded chains of atoms They are an extraordinarily versatile class of materials, with properties of a given type often having enormously different values for different polymers and even sometimes for the same polymer in different physical states[2]. Later, the development of polymer science has started to increase by leaps and bounds. Nowadays, scientists seek to produce polymers that can be used for different industrial applications. Plastics are the most versatile materials used in different chemical industries. They are solid, cheap, flexible, and multi-purpose. They are used in housing, automobiles, aircraft, packaging, electrical equipment, and as electrical insulators. They have increasingly important role in the manufacture of satellites, space researches, and thermal barriers[3].Composite materials, which are usually, fabricated with an emphasis on properties such mechanical strength, have also been used in electronic applications. Integrated decoupling capacitors, angular acceleration accelerometers, acoustic emission sensors and electronic packing are some potential applications[4]. The new composites materials have become the foundation to change and develop engineering designs for many commodities and industrial products. The most important of these automotive industry are aircraft, ships, and construction materials[5]. PVA is a water-soluble synthetic polymer. Due to the characteristics of easy preparation, good biodegrade ability, excellent chemical resistance, and good mechanical properties, PVA has been used on many biomaterial applications[6]. PEG explain the high solubility in water on the basis that the polymer has the ability to fit in the water network more easily than other polymers [7]. The status of each of (Huethig) and (Wepf) in the (1986) abnormal behavior for PEG in water , as a result of the interaction by severe ties hydrogen to water molecules with Oxygen another polymer chains[8]. MgO is one of the most important metal oxides, which has great potential for use in a wide range of applications due to its predominant thermal, optical, electrical and chemical properties [9-12]. The nano-sized MgO particles can be used as the filling subjects in painting, paper, cosmetics, plastic, rubber, and as the co-assistant materials of some electric materials[13]. This present work deals with results of the effect of nano-MgO on optical properties of polyvinyl alcohol and poly ethylene glycol.

II. Experimental

The solution was prepared by melting (0.85)gm of PVA with (0.15)gm of PEG in (30)ml of distilled water, and by using magnetic stirrer for the mixing process to obtain more homogeneous solution with temperature of 100 oC, then adding the weight percentages of additives (4%, 8%, 12% and 16%) of magnesium oxide (MgO) ,and wait for 30 minutes to get mixture more homogenous, by using casting method we get the films from this mixture and casting each one of these ratios in the template (Petridish) (it has diameter 5cm) and then left to dry mixture. The absorbance Spectrum was recorded of the wavelength range (200 - 1100)nm by using the double-beam spectrophotometer (UV- 1800 shimedza).

III. Results and Discussion

A. The absorbance of nanocomposites

the relationship between the absorbance of nanocamposites and wavelength at room temperature shows in "Fig.1". The absorbance increases with increasing of weight percentages of MgO. This is due to absorb the incident light by free electrons [14].

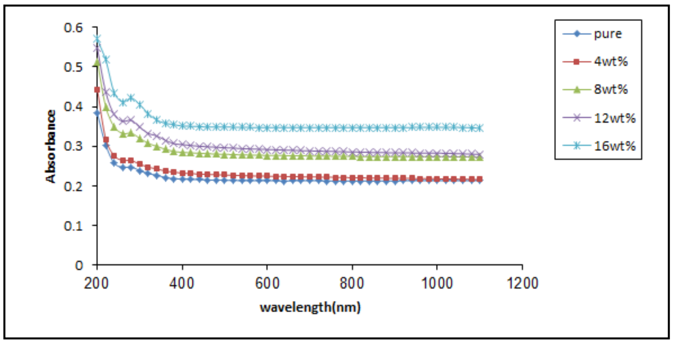

Fig.1 The absorbance as function of wavelength for (PVA-PEG-MgO) nanocomposites

B. The absoeption coefficient and energy gap of nanocompsites

Absorption coefficient can be defined as a decline in per iceberg incident radiation energy per unit distance direction of wave propagation inside the center, and absorption coefficient depends on the energy of the photon "hv"and on the properties of a semiconductor, in terms of the type of electronic transitions and energy gap him. [15]

Give permeability of the membrane following relationship [15]:

$$\alpha = 2.303\frac{A}{t} \qquad (1)$$

Where : A is absorbance t is the thickness of sample

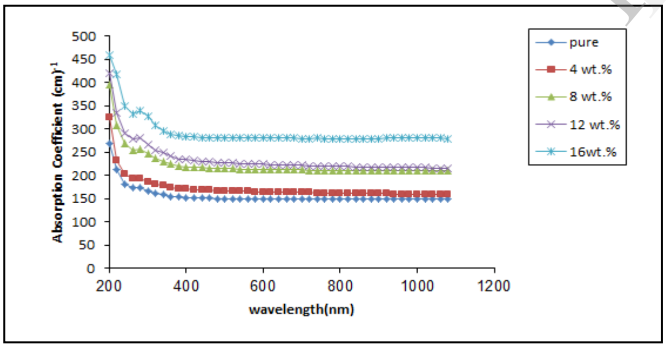

Fig. 2 The absorption coefficient $\alpha(cm)^{-1}$as a function of wavelength(nm) for(PVA-PEG-MgO) nanocomposites.

It can be seen that the absorption coefficientis the smallest at high wavelength and low energy ,this means that the possibility of electron transition is little because the energy of the incident photon is not sufficient to move the electron from the valence band to the conduction band"hv>Eg" . At high energies, absorption is bigger ,this means that a great possibility for electron transitions consequently, the energy of incident photon is enough to move the electron from the valence band to the conduction band , the energy of the incident photon is greater than the forbidden energy gap[16] . This shows that the absorption coefficient assists in figuring out the nature of electron transition ,when the values of the absorption coefficient are high "$\alpha > 10^4$ cm^{-1}" at high energies it is expected that direct transition of electron occur ,the energy and moment are maintained by the electrons and photons . But when the values of the absorption coefficient are low"$\alpha < 10^4 cm^{-1}$" at low energies ,it is expected that indirect transition of electron occurs ,and the electronic momentum is maintained with the assistance of the phonon [17]. among other results is that the coefficient of absorption for the (PVA-PEG-MgO) naoncomposites is less than 10^4 cm^{-1}at low concentrations .

$$\alpha h\nu = A(h\nu - Eg)^m \qquad (2)$$

Where: hv is the energy of photon; A is proportionality constant, Eg is forbidden energy gap of the indirect transition.

If the value of (m=2) indicates to allowed indirect transition. When the value (m=3) indicates to forbidden indirect transition."Fig.3"shows the relationship between "$(\alpha h\nu)^{1/2}$ $(cm^{-1}.eV)^{1/2}$ "and the photon energy .

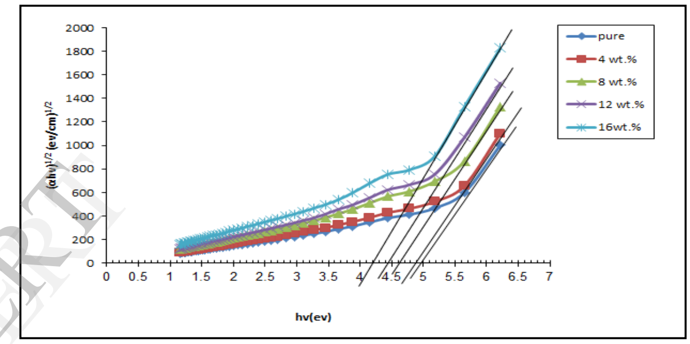

Fig. 3 The energy gap for the allowed indirect transition$(\alpha h\upsilon)^{1/2}$ as a function of photon energy of (PVA-PEG-MgO) nanocomposites.

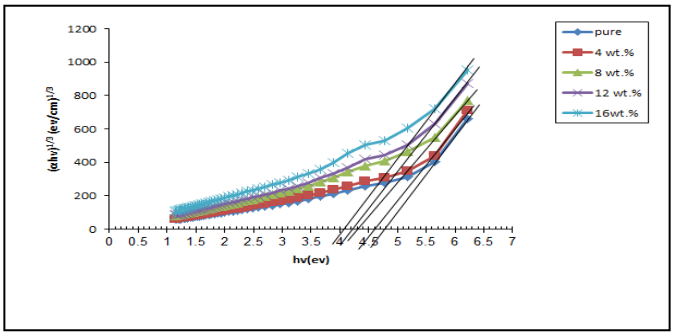

Fig. 4 The energy gap for the forbidden indirect transition$(\alpha h\upsilon)^{1/3}$ as a function of photon energy of (PVA-PEG-MgO) nanocomposites.

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TABLE I.

THE VALUES OF ENERGY GAP FOR THEALLOWED AND FORBIDDN INDIRECT TRANSIMITION FOR(PVA-PEG-MgO) NANOCOMPSITES

MgO nanoparticles wt.%	E_g(eV)	
	allowed	forbidden
0	4.9	4.8
4	4.8	4.7
8	4.6	4.4
12	4.4	4.3
16	4.2	4.1

IV. Optical Constant

Extinction Coefficient and Refractive Index

A. *Extinction coefficient (k_0):*

is calculated by using this equation

$$k_o = \alpha\lambda / 4\pi \qquad (3)$$

The change of the extinction coefficient as a function of the wavelength is shown in "fig. 5" for (PVA-PEG-MgO) nanocomposites.It can be noted that "k_0 "is low value at low concentration ,but it increases with the increasing of the concentration of nanoparticles "MgO" . This is attributed to increased absorption coefficient with the increase of weight percentages of "MgO" nanoparticles[17]

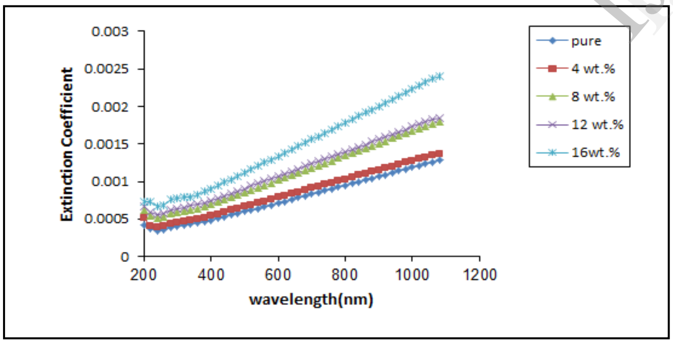

Fig.5 The Extinction coefficient as a function of wavelength for (PVA-PEG-MgO) nanocomposites

Refractive Index (n):

The refractive index is calculated from this equation[18]

$$n_o = \left[\frac{(1+R)^2}{(1-R)^2} - (k_o^2 - 1)\right]^{1/2} + \frac{(1+R)}{(1-R)} \qquad (4)$$

"Fig. 6" show the change of refraction index for (PVA-EG-MgO) nanocomposites as a function of wavelength .From the figure we can see that the refractive index increases with increasing the weight percentages of the concentration of nanoparticles "MgO" to the poly vinyl alcohol and poly ethylene glycol. The reason of this result is, the increase of the "MgO" concentration leads to increase the density of the nanocomposites .

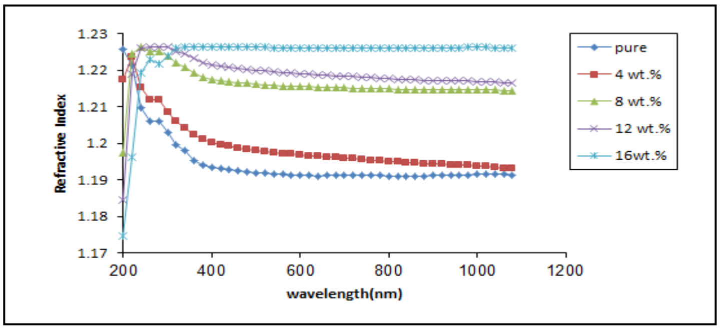

Fig.6 The refractive index(n)as a function of wavelength for (PVA-PEG-MgO) nanocomposites.

B. *Real and Imaginary part of Dielectric constant*

The real and imaginary dielectric constant "ε_1,ε_2" for (PVA-PEG-MgO) nanocomposites have been calculated from these equations

$$\varepsilon_1 = n^2 - k_o^2 \qquad (5)$$

$$\varepsilon_2 = 2nk_o \qquad (6)$$

The" fig. 7" show the change of (ε_1,) as a function of the wavelength. It can be seen that ε1 considerably depends on "n^2" due to low value of "k_0^2" so, the real dielectric constant is increased with the increase of the concentrations of (MgO) nanoparticles. "Fig.8" show the change of "ε_2" as a function of the wavelength .It can be seen that "ε_2 " is dependent on"k_0" values that change with the change of the absorption coefficient due to the relation between "α" and "k_0"[18].

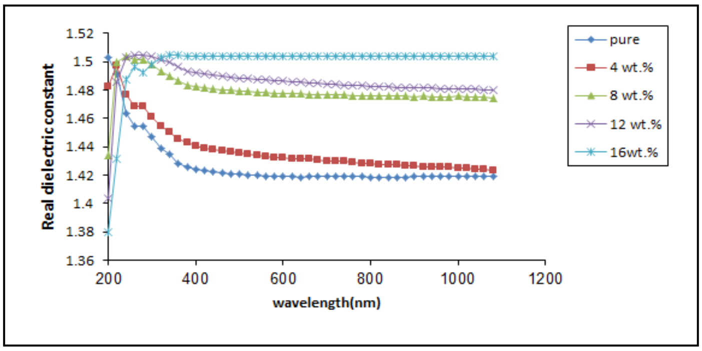

Fig. 7 The real dielectric constant "ε_1" as a function of incident wavelength(PVA-PEG-MgO) nanocomposites.

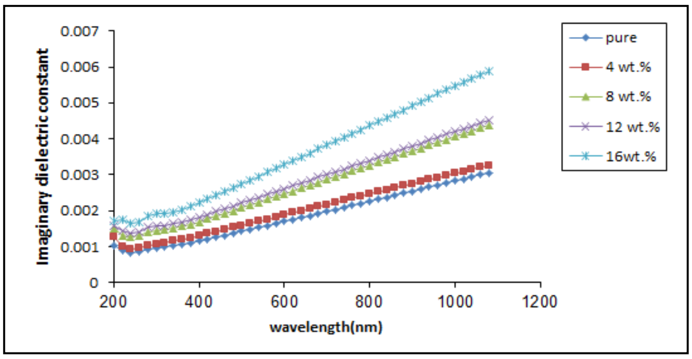

Fig. 8 The imaginary dielectric constant "ε_2" as a function of wavelength(PVA-PEG-MgO) nanocomposites**.**

V. CONCLUSIONS

A. The absorbance and the absorption coefficient for (PVA-PEG-MgO) nanocomposite increases with the increasing of the concentrations of the (MgO) nanoparticles.

B. The absorption coefficient for (PVA-PEG-MgO) nanocomposites is less than (104)(cm)-1 at all concentrations for (PVA-PEG-MgO) nanocompsites.

C. The energy gap for indirect transition (allowed, forbidden) decreases with increasing of (MgO) nanoparticles concentration.

D. Extinction coefficient has low values. Generally it increases with increasing of concentration for all nanocomposites.

E. Refractive index and dielectric constant (real, imaginary) increase with increasing of concentration for all composites

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