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Effect of Gamma irradiation on The Optical properties of (PVA: $CuCl_2$) films

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Abstract

The study effect irradiation on optical properties of film (PVA: $CuCL_2$) prepared by casting method, with thickness of (30±1) µm. And used Cs^{137} to obtained Gamma ray with energy (662)keV and time irradiation(5,6 and 7) weeks and affectivity (4.3) ci. The spectra absorbance and transmittance register in range (300-1100) nm . Results show that the optical band gap for (PVA: $CuCl_2$) decreasing after irradiation with gamma ray from (3.2,3.1,3 and 2.7)eV, urbach energy values increase with the increasing time radiation. And the absorption constants (α,k,n,) and the optical conductivity are changing after irradiated with gamma ray .

Keywords: PVA: $CuCl_2$, irradiation, band gap, urbach energy.

تاثير التشعيع باشعة كاما على الخواص البصرية لآغشية بوليمر فينال الكحول المشوبة بوكلوريد النحاس

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الخلاصة:

دراسة تاثير التشعيع على الخواص البصرية لغشاء (PVA: $CuCl_2$) والمحضرة بطريقة الصب وبسمك (30±1) µm, وقد استخدم المصدر المشع Cs^{137} ذو طاقة 663keV للحصول على اشعة كاما وكان زمن التشعيع (5،6،7) اسابيع وبفعالية ci(4.3).

سجل طيف الامتصاصية والنفاذية ضمن المدى nm (300−1100). اظهرت النتائج ان فجوة الطاقة لـ(PVA: $CuCl_2$) تقل بعد التشعيع باشعة كاما من (3.2,3.1,3 and 2.7)eV ، وطاقة اورباخ تزداد بزيادة زمن التشعيع والثوابت البصرية(معامل الامتصاص ،معامل الخمود ،معامل الانكسار)، والتوصيلية البصرية تتغير بعد التشعيع باشعة كاما.

Introduction

Polymers usually have low thermal conductivity, ~(0.1–0.3)Wm^{-1} K^{-1}[1–3]. Usually to modify and improve properties of polymer added different additives such as transition metal salts are changing the physical properties of PVA polymer [4,5].

Depending on the method in which they interact with the matrix and" chemical nature of the doping, the dopant change the physical properties" [6,7]. Generally have modern characteristices, unlike from matrix and filler ones, could be Inexpensive[3].

Also to modify and improve properties of polymer used Irradiation with X-rays, alpha, beta and gamma radiation also have important effect on polymer properties [8,9].

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Khaled et al [8] show change the refractive indices and optical absorption with gamma irradiation to Poly(Vinyl Alcohol) doped with $NiCl_2$ and $CrCl_3$.

Eid et al [10] bring to light impress of gamma irradiation on the optical Energy gap of PVA based ferrotitanium alloy film.The energy band gap was decreases after irradiation.

Basfar et al [11] investigated effectiveness of gamma irradiation on the optical properties of $PS(C_8H_8)_n$ doped by methylene blue dye . The Eg was determined it decrease after irradiation.

A purpose of the search is study the optical characteristices of the polyvinyle alcohol(PVA): $CuCl_2$ (7%)films and irradiation effect, were exposed to Cs^{137} γ-radiation source.

Experimental

Were used as requisite polymeric material, polyvinyle alcohol (PVA), distilled water and magnetic stirred used to solubility PVA at 50 ℃ for two hours, and used it to solubility $CuCl_2.H_2O$ at 30 ℃ for one hour. Congenial mixtures of PVA and **(**7%) from$CuCl_2.H_2O$ solution were appears Homogenous.The solution was but into level glass plate, After run dry in the kiln for (one houre) at 50 ℃ were obtained on films .The thickness gauge (indicating micrometer) used to found sample thickness .

(Ultraviolet -visible 1800 spectra photometer) in the wavelength range (300 – 1100) $*10^{-9}$m. Used to Absorptance measurement .

Cs^{137} was used to obtained Gamma ray with energy(662)keV and time irradiation(4,5,6 and 7) weeks and effective(4.3)ci.

Results and Debate

The most ways in expansion and comprehension the energy gap and structure materials by optical absorption spectra. Figure-1 The absorption spectrum of before and after radiation Poly(Vinyl Alcohol) doped with $CuCL_2$. It is shows that the absorption decreases with time radiation increases at low wavelength (350)nm and increased the absorption with time radiation increases wavelength, the absorbance change after irradiation that it is related to changes in film structure.

Figure-2 shows the transmittance spectrum in the rang (300 – 1100)nm, It is figure the transmittance increase after irradiation , may be due to the some physical effects such as, surface nature.

Figure-3 shows the optical absorption coefficient (α) with photon energy .It is very important to determined kind of electronic transition if ($\alpha>10^4$) the transition is direct and if ($\alpha\leq10^4$) the transition is indirect [12].

We used the following equation to determine the absorption coefficient [12]:

$$\alpha = \frac{2.303\,A}{d} \quad (1)$$

A = the absorbance, d is the sample thickness.

The following equation [13]:

$$\alpha = \alpha o \exp(h\nu / Ee) \quad (2)$$

(αo) is a constant and Ee is the urbach energy. Used to determine the urbach energy .Urbach tail is the the distance between the localized states ready in the optical band gap . Figure-4 shows the change of Lnα with photo energy for (PVA: $CuCL_2$) films before and after radiation with different time radiation, the Ee were studied from the slope and the obtained Ee in Table-1,which indicates that Ee increase after radiation [14].

The following equation to found E_g [10,15]:

$$\propto h\nu = B(h\nu - E_g)^m \quad (3)$$

B is a constant ,m=2, 3, 1/2 and 3/2 (experimental index), depending on kind of transition accountable m = 2 which specific indirect, allowed transitions [16] [17].Figure-5 shows that and the obtained value of energy gap in Table-1." the energy gab dependence in general on the crystal structure of the composites" [16], also the decrease of energy band gap due to decease the distance between the valance band and conduction band with the increase the time radiation

Figure-6 shows the dependence of the extinction coefficient on the photon energy the extinction coefficient can be related by the equation [18].

$$K = \frac{\propto\lambda}{4\pi} \quad (4)$$

The extinction coefficient (k) behaves just like the absorption coefficient (α) because they are joined by previous relation (4). This is due to increase in absorption coefficient the extinction coefficient values increased.
The refractive index n value provides the optical properties of the film and it is related by the fallowing equation [19].

$$n=\frac{(1+\sqrt{R})}{(1-\sqrt{R})} \quad (5)$$

Where R is the reflectance was calculated depended energy save law using the relation: [19,20]

$$R + T + A = 1 \quad (6)$$

The real part (ε_r) and imaginary part($\varepsilon_{i)}$ of dielectric constants were determined from the following equations [21]

$$\varepsilon_r = n^2-k^2 \quad (7)$$

$$\varepsilon_i = 2nk \quad (8)$$

It can be observed from Figure-7 and Figure-8, the values of n, ε_r and ε_i dependence on the photo energy. The refractive index , real part (ε_r) and imaginary part($\varepsilon_{i)}$ of dielectric constant values of irradiated is less than that un-irradiated film, this may be due to the change in stoichiometry and internal strain of films. The behavior of ε_r similar to the behavior of n, because of k^2 very small comparison with n^2, but the behavior of ε_i mainly depends on the variation of k. Therefor concluded that ε_r is larger than ε_i
The optical conductivity was calculated using the relation [21]

$$\sigma = \frac{\alpha n\, c}{4\, \pi} \quad (8)$$

$$c=3*10^8 m/s$$

Figure-9 shows the relation between optical conductivity and photon energy. The optical conductivity increased after irradiation in low photon energy and decreased in the visible range. The optical conductance and band gap indicated that the films are transmittance within the visible range"[21].

Conclusions:

1. The band gap decreases after irradiation**.**
2. Urbach energy values increase with the increasing time radiation.
3. The (α,n,k, ε_r and $\varepsilon_{i\,)}$of (PVA: $CuCL_2$) are changing after irradiation.

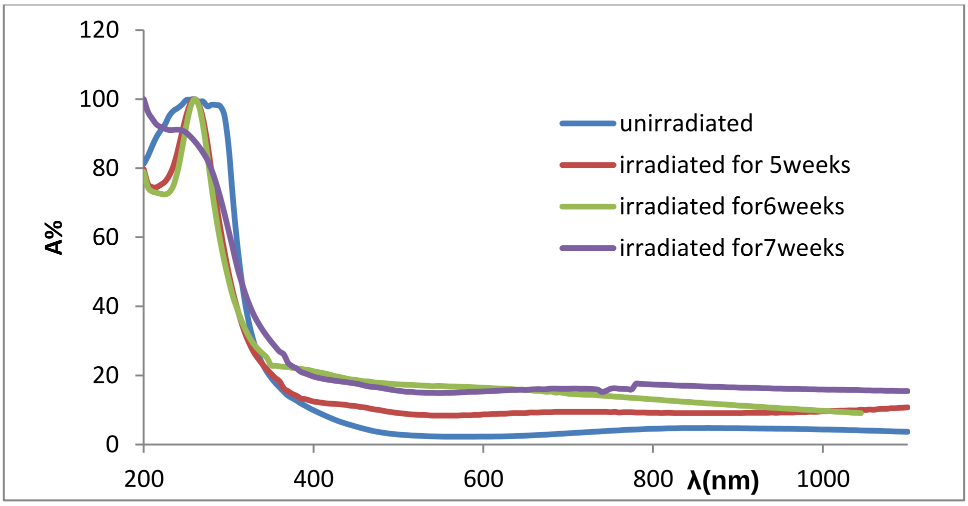

Figure 1-The variation of the absorbance(A) with wavelength(λ)

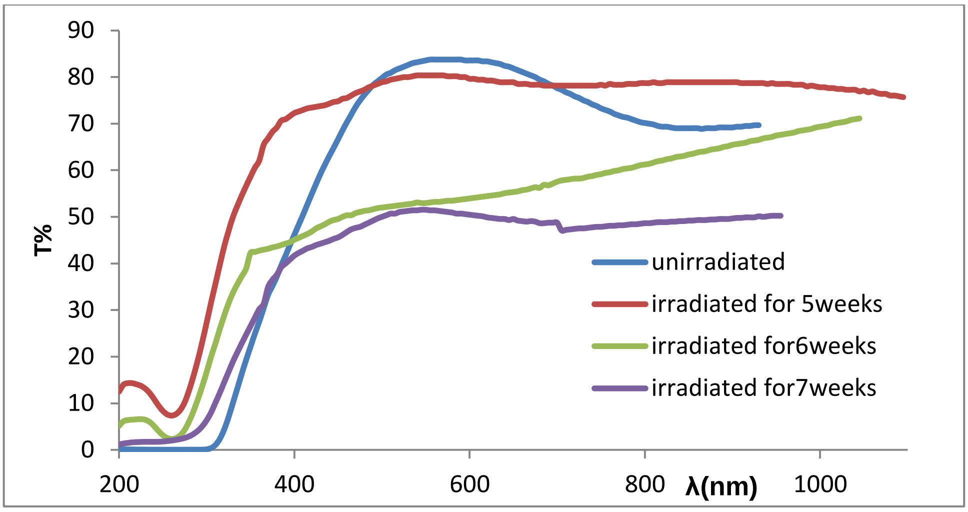

Figure 2- The variation of the transmittanc(T)with wavelength(λ)

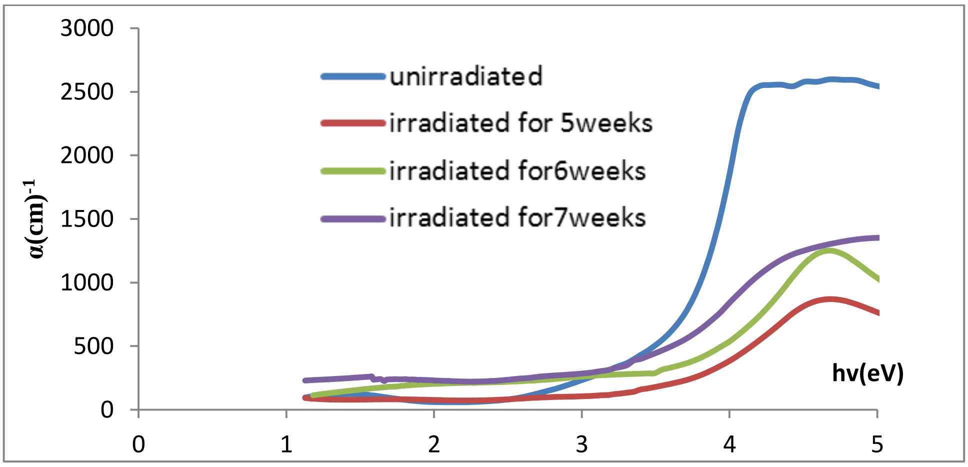

Figure 3- The variation of the absorption coefficient(α) on the photon energy.

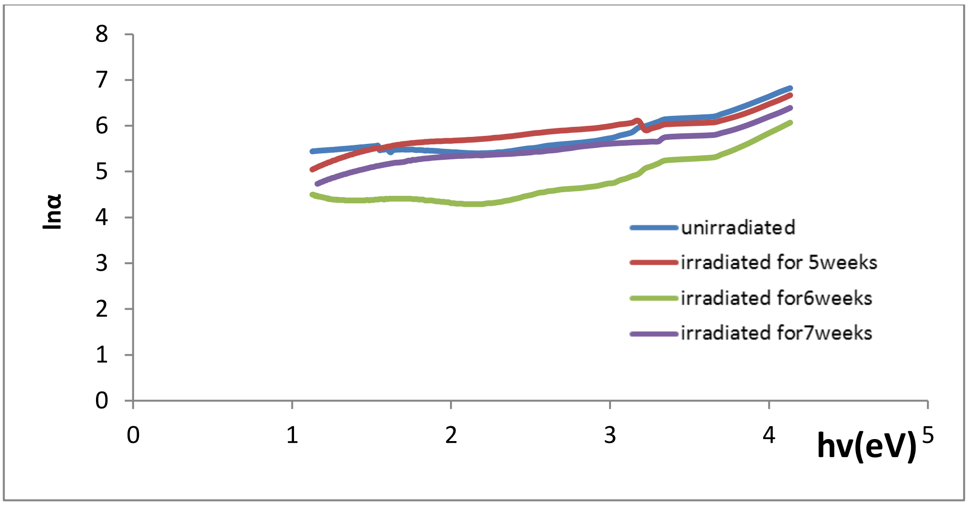

Figure 4- Variation of Ln(α) with photon energy

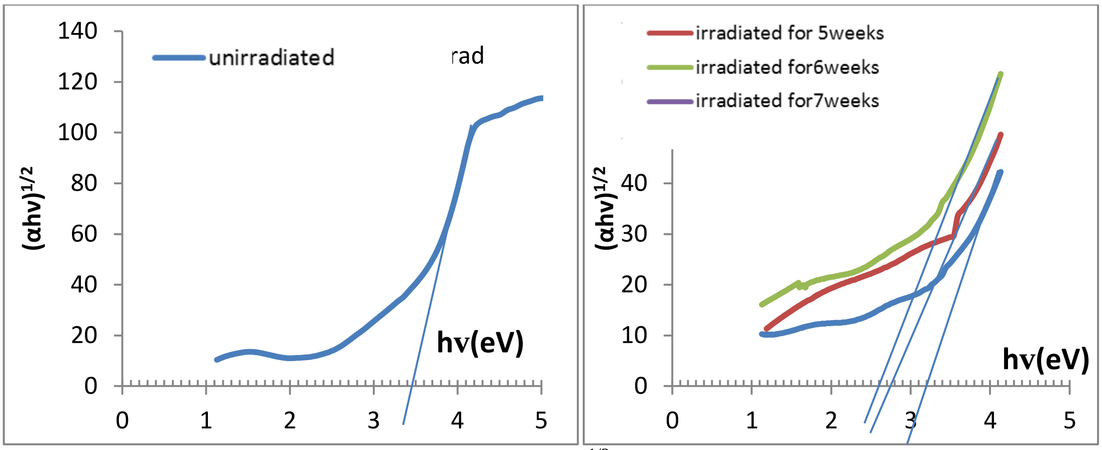

Figure 5- Variation of $(\alpha h\nu)^{1/2}$ with photon energy

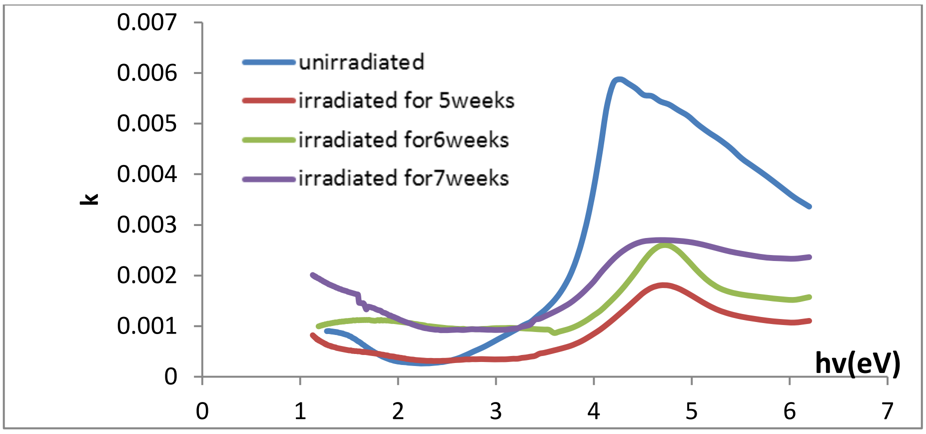

Figure 6- Variation of extinction coefficient(k) with photon energy.

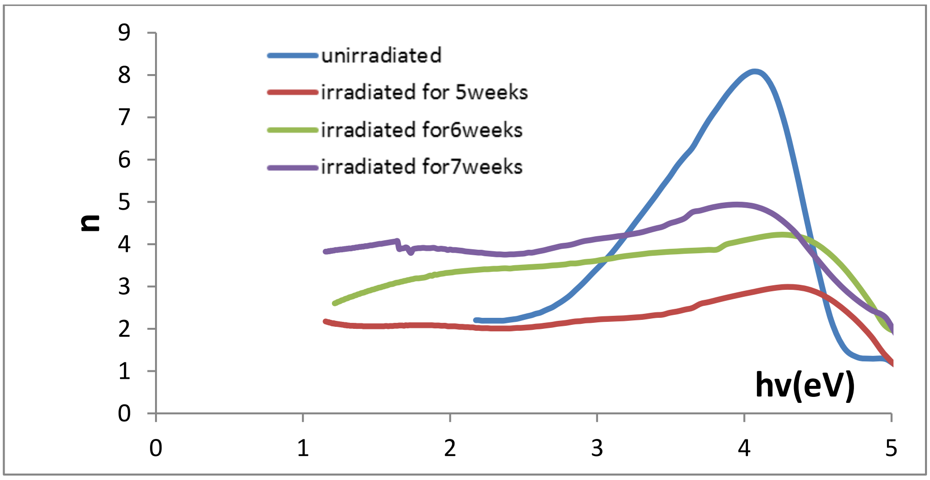

Figure 7- Variation of refractive index(n) with photon energy

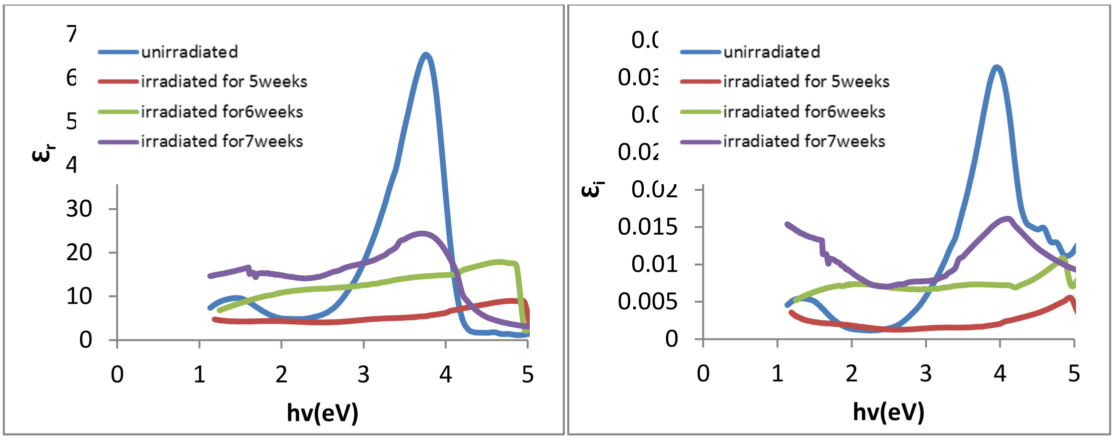

Figure 8- Variation of imaginary ($\mathcal{E}_i$)and real part ($\mathcal{E}_r$) of dielectric constant with photon energy

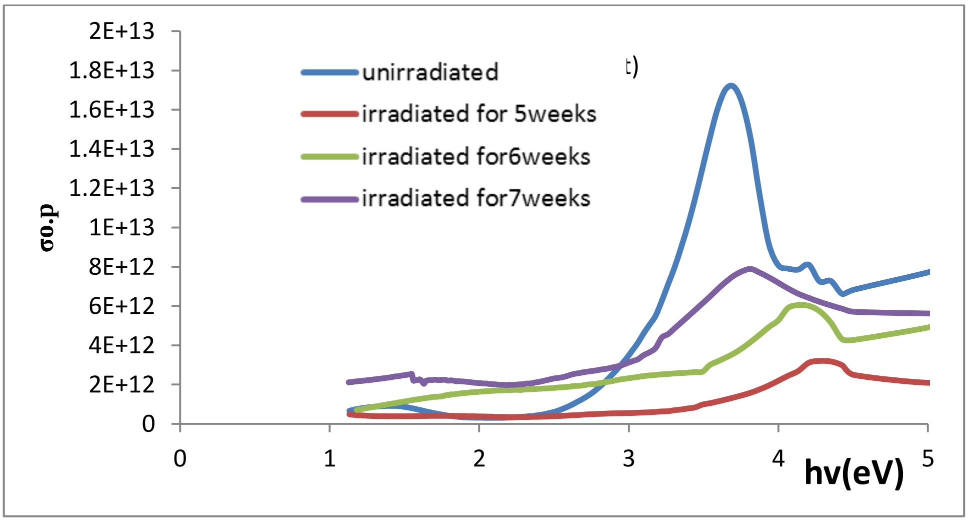

Figure 9- Variation of optical conductivity with photon energy

Table 1- properties of PVA:$CuCl_2$ films at different time radiation

Time of irradiation.	Eg(eV)	Ee(eV)
un irradiated.	3.5	0.276
5week	3.1	0.318
6week	2.8	0.376
7week	2.6	0.387

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