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The Effect of Gama Ray on Optical Properties for Zincoxide (Zno) Thin Film

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ABSTRACT

In this work we investigated the effect of Gama Ray (0, 0.1 and 0.3) mG. on the efficiency on optical properties of Zinc Oxide (ZnO)nonmaterial's thin film . Samples prepared by spin coating method .The optical characteristics of the prepared samples have been investigated by UV/Vis spectrophotometer(min 1240) in the wavelength range (370 – 390) nm . The maximum value of the refractive index (n) for all thin films are given about (2.17). Also the extinction coefficient (K)the value of (K) at (346) nm for untreated film(0.0 mGy) is ($8.14x10^{-6}$) while for (0.1 mGy) film equal to ($6.1x10^{-6}$) and for (0.3 mGy) equal ($4.37x10^{-6}$) at the same wave length. And the real and imaginary dielectric constants the maximum value ofreal (ε1) equal to (4.6) , while imaginary (ε2) = $2x10^{-5}$ for all samples. The results indicate the films have good characteristics for optoelectronic applications.

KEYWORDS: Optical Properties, Thin film, Extinction Coefficient, Refractive Index, Real and Imaginary Dielectric Constants.

I. Introduction

The emphasize here will be on the fundamental properties of ZnO, like growth, electrical and optical properties, since the potential for optoelectronic devices based on ZnO is also one of the main motivations for the present work. ZnO is a direct wide band-gap (3.37 eV at room temperature) II-VI binary compound semiconductor and crystallizes inthree forms: hexagonal wurtzite, cubic zincblende, and the rarely observed cubic rocksalt [11]. The hexagonal wurtzite structure of ZnO is the most common phase having a crystal structure C6v or P63mc, which occurs almost exclusively at ambient conditions [12, 13]. The wurtzite ZnO structure consists of alternating zinc (Zn) and oxygen (O) atoms is shownin Figure 1.2. The ZnO structure has polar surface (0001) which is eitherZn or O terminated and non-polar surfaces (1120) and (1010) possessing an equal number of both atoms. The polar surface of ZnO is highly met stablein nature and is responsible for several unique and astonishing properties including piezoelectric properties, it also play a key role in column growth, favorable for etching due to higher energy. The polar surface is also known to possess different physical and chemical properties[14].Direct band gap materials have intrinsically high luminescence yield compared to indirect band gap materials and increase in the band-gap reduces the leakage current of the devices and their temperature dependence significantly [12, 15]. Among the II-VI semiconductors, ZnO has relatively higher and stable exciton binding energy of 60 meV at 300 K, almost three times larger than its competitor GaN which has an exciton binding energy of25 meV. It is also one of the reasons that ZnO is so attractive for optoelectronic devices. Higher exciton binding energy materials give brighter emissions, because exciton is already a bound system, which radiatively recombine with high efficiency without requiring traps to localize the carriers[12, 15]. Other favorable aspects of ZnO are that it is non-toxic, cheap, relatively abundant source materials, and chemically stable. It can be synthesized as a large single crystal by various methods and it can be grown in various morphologies and dimensions. ZnO nanostructures are promising candidates in miniaturized optoelectronics and sensing devices. By alloying, the band-gap can be tuned further into the UV or down into the green spectral ranges i.e. from 2.8 to 4 eV [16]. A tendency of different fast growth directions of ZnO could result in growth of a diverse group of hierarchical and complex nanostructures. This is partly reflected by the various structural morphologies of ZnO nanomaterials such as nanorods, nanotubes, nanocorals, nanoflowers, and

nanowalls. These unique nanostructures show that ZnO probably has the richest family of nanostructures among all known materials which demonstrate potential for its diverse practical applications in the near future. In particular,1-D ZnO nanorods are potentially useful for various nanodevices such as light emitting diodes (LEDs), chemical sensors, solar cells, and piezoelectric devices, because of their high aspect ratio and large surface area to volume ratio ensure high efficiency and sensitivity in these applications. Furthermore, ZnO is bio-safe and biocompatible and may be used for biomedical applications without coating.

II . Experimental

Different solvents and precursors are being used for the preparation of the seed solution. We have chosen two different seed solutions in our work for making the seed layers. We prepared first the solution by dissolving 5 mM of zinc acetate dehydrate ($Zn(CH_3COO)_2\ 2H_2O$) in pureethanol solution as previously reported by Green et al.

[9]. We preferred the use of hard substrate because these substrates with spin coated at a speed of 1500 rpm for 60seconds seed layer need annealing at $250^{O}C$ for 30 min with (180±5) nm thickness (three sample as the same thickness) to decompose Zn(CH3COO)2 2H2O into ZnO nanoparticles. And study the effect of gamma ray in tow does (0.1 and 0.3) mGy and compeer this sample with control (0 mGy)on optical properties of this three samples by investigated used UV/Vis spectrophotometer(min 1240) .

III . Results

From figure 1to figure 5. It clear that the relation between absorbance, transmission, reflection, absorption coefficient and extinction coefficient with wavelength

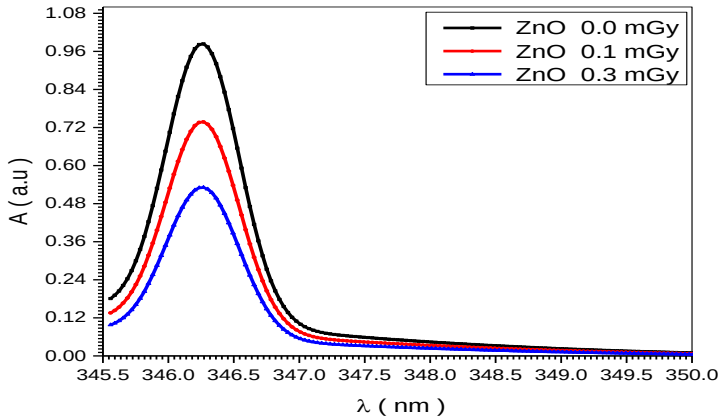

Fig. (1). The variation of absorption with (λ) for thin films in different gamma does (0,0.1 and 0.3) mGy

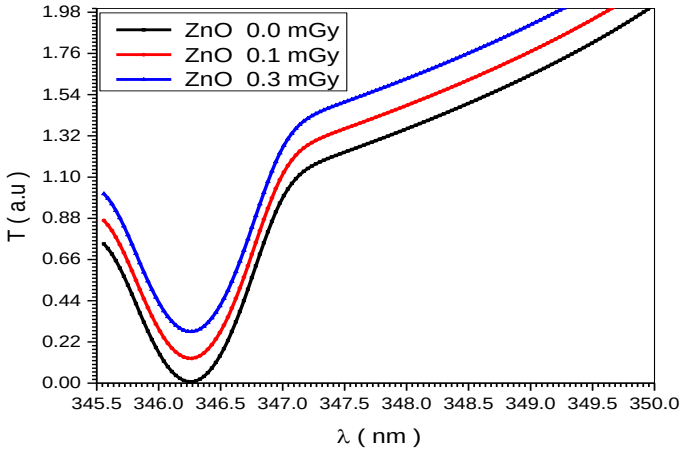

Fig. (2). The variation of transmission with (λ) for thin films in different gamma does (0,0.1 and 0.3) mGy

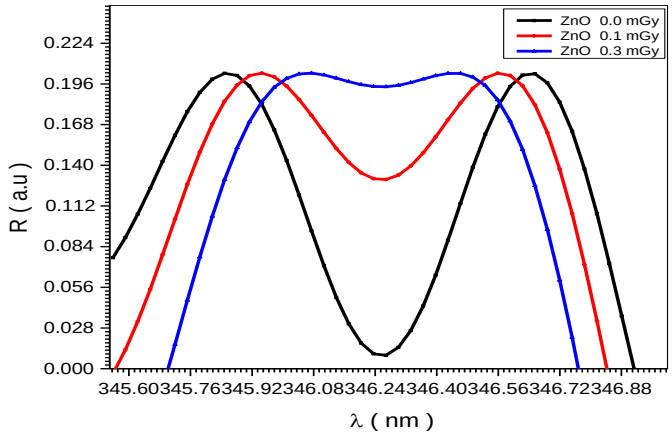

Fig. (3). The variation of reflection with (λ) for thin films in different gamma does (0,0.1 and 0.3) mGy

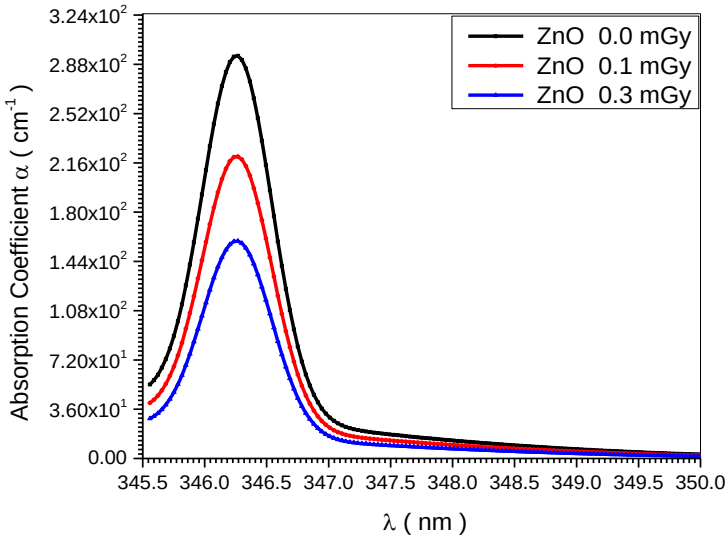

Fig. (4). The variation of absorption coefficient (α) with (λ) for thin films in different gamma does (0,0.1 and 0.3) mGy

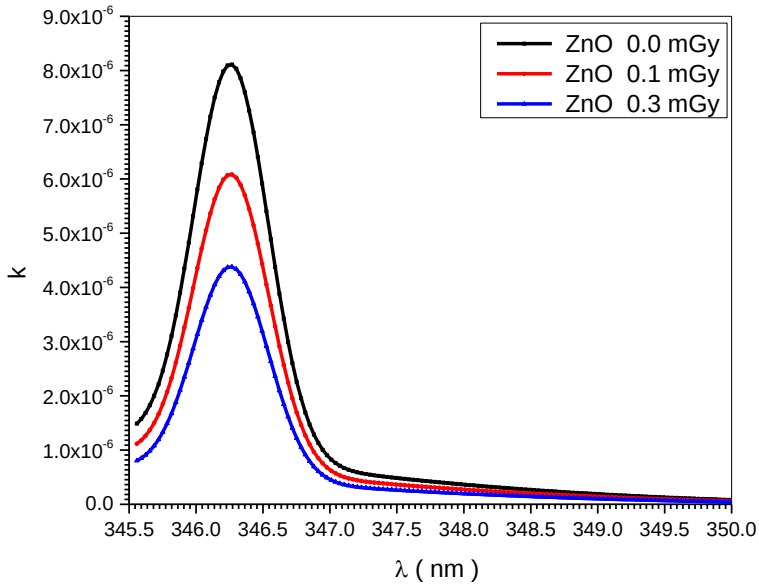

Fig. (5). The variation of extinction coefficient (k) with (λ) for thin films in different gamma does (0,0.1 and 0.3) mGy

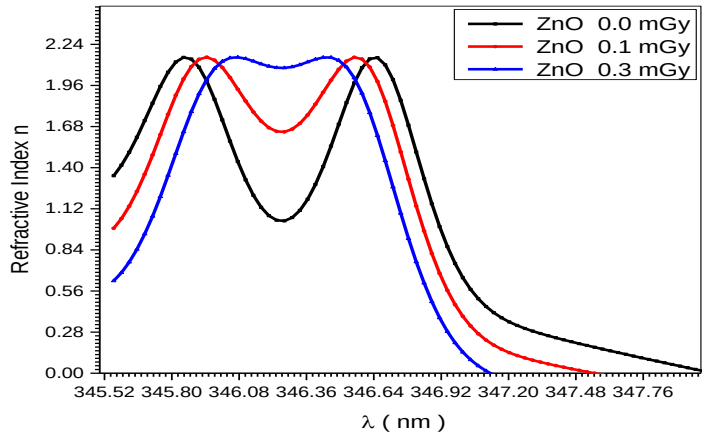

Fig. (6). The variation of refractive index (n) with (λ) forthin films in different gamma does (0,0.1 and 0.3) mGy

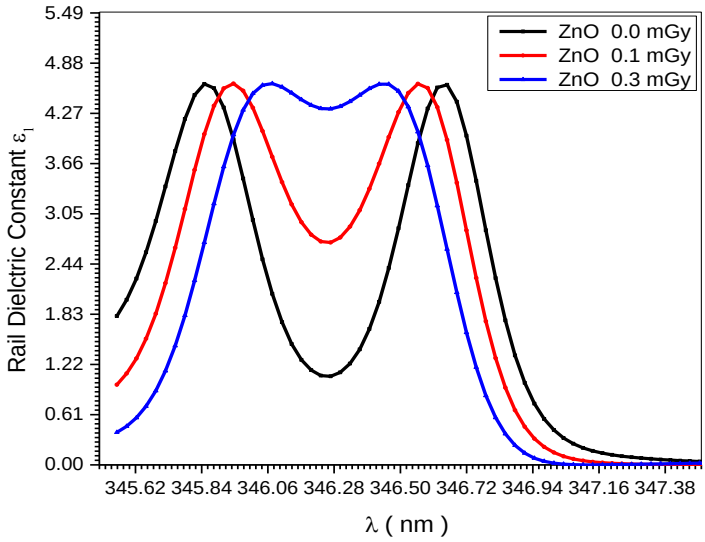

Fig. (7). The variation of real dielectric constant with (λ) for thin films in different gamma does (0,0.1 and 0.3) mGy

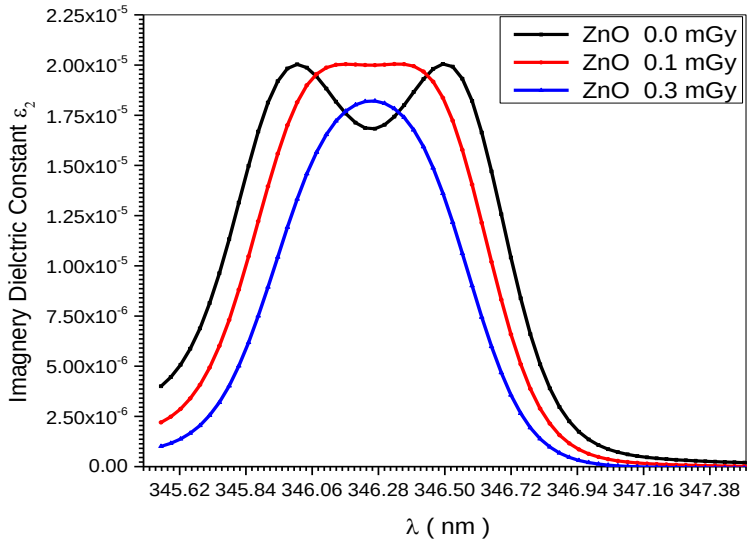

Fig. (8). The variation of imagnery dielectric constant with (λ) for thin films in different gamma does (0,0.1 and 0.3) mGy

IV . Discussion

The optical absorption (A), transmittance (T) and reflectance(R) spectra in the (370–390) nm wavelength range for three ZnO nanoparticles thin film samples effect by gamma ray does (0.0 , 0.1 and 0.3) mGy are depicted in Fig. (1), fig(2) and fig(3) . The maximum absorption (0,983 a.u) at wavelength (346 nm) for 0.0 mGy dose sample then it decreases to (0.74 a.u) for the 0.1 mGy doses and become (0.53 a.u) for the 0.3 mGy at the same wavelength. The absorption edge of the film occurs at wavelength (346 nm) corresponding to photon energy (3.58 eV).

The absorption coefficient (α) of the prepared ZnO thin films were found from the following relation [10] .α = 2.303 A/t where (A) is the absorbance and (t) is the film thickness. Fig. (4) shows the plot of (α) with wavelength (λ), which obtained that the value of $\alpha = 2.88 \times 10^2$ cm^{-1} for all films in the UV region , this means that the transition must corresponding to indirect electronic transition [7] , and the properties of this state are important since they are responsible for electrical conduction. Also, fig.(4) shows that the value of (α) for the untreated films are greater than (0.1 and 0.2) mGy dose . The increase in absorbance may be due to the increase in grain size and decrease in the number of defects [12]. Extinction coefficient (K) was calculated using the related [10]. $K = \lambda \alpha / 4\pi$ The variation at the (K) values as a function of (λ) are shown in fig. (5).It is observed that the spectrum shape of (K) as the same shape of (α).Fig.(5) obtained the value of (K) at the UV region was depend on the film treatment method , where the value of (K) at (346) nm for untreated film(0.0 mGy) is (8.14×10^{-6}) while for (0.1 mGy) film equal to (6.1×10^{-6}) and for (0.3 mGy) equal (4.37×10^{-6}) at the same wavelength ,this difference in (K) value become smaller at (350 nm) region .The refractive index (n) is the relative between speed of light in vacuum to its speed in material which does not absorb this light. The value of n was calculated from the equation [13] $n = \left[(\frac{1+R}{1-R})^2 - (1 + k^2)\right]^{\frac{1}{2}} + \frac{(1+R)}{(1-R)}$Where (R) is the reflectivity. Thevariation of (n) vs (λ) is shown in fig.(6)which shows that the maximum value of (n) is (2.17) for all films at the different wavelength . Also we can show that the value of (n) begin red shifted to increase dose in (345 -346) nm region of spectrum while (K)become blue shifted(346-347) nm region .Also (n) value decrease with gamma ray dose decrease at 346.25 nm , this means that the film become more transparent in the 346.25 nm region. Fig.(7) shows the variation of the real dielectric constant (ε1) with wavelength of ZnO thin films, which calculated from the relation [10]$\varepsilon 1 = n^2 - k^2$Where the real the dielectric (ε1) is the normal dielectric constant .From fig (7)the variation of (ε1) is follow there fractive index, where begin red shifted to increase dose in (345 -346) nm region of spectrum while (K)become blue shifted(346-347) nm region , where the absorption of the film for these wavelength is small, but the polarization was increase. The maximum value of (ε1)equal to (4.6) for all films. The imaginary dielectric constant (ε2) vs (λ) was shown in fig.(8) this value calculated from the relation [10] ε2 = 2nk (ε2) represent the absorption associated with free carriers [14] .As shown in fig(8) the shape of (ε2) is the same as (ε1), this means that the refractive index was dominated in these are different according to the treatment operation , so the maximum value of(ε1) equal to (4.6), while $\varepsilon 2 = 2 \times 10^{-5}$ for all samples , these behavior may by related to the different absorption mechanism for free carriers.

V . Conclusions

ZnO thin nanoparticles effect by gamma ray in tow does (0.1 and 0.3) mGy and study the optical properties of tow this samples and compeer with control sample (0 mGy).The absorption edge of the film occurs at wavelength (346 nm) corresponding to photon energy (3.58 eV).The value of absorption coefficient (α) for the untreated films(0.0 mGy) are greater than (0.1 and 0.2) mGy dose. The extinction coefficient value was (0.0 mGy) is (8.14×10^{-6}) while for annealed film at the same wavelength equal (0.88) and for (0.1 mGy) film equal to (6.1×10^{-6}) and for (0.3 mGy) equal (4.37×10^{-6}) at the same wavelength . Thefilms give refractive index value equal to(2.17) in the UV region .Hence, these treatment for thin film effect on the optical properties to be used for optoelectronic applications.

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