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Research Article

The Effect of Gamma Rays on the Structural and Optical Properties of ZrO_2Thin Films with Different Thicknesses

Hiyam Chasib Majed*, Ameera Jawad Kadhm and Israa Akram Abbas

Department of Physics, College of Education, Univ.Al-Mustansiriyah, Iraq

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Abstract

In this work thin films ZrO_2 have been irradiated by Gama rays .The film characteristics are Fromcs-1370.9uciat thin films were successfully deposited on suitably cleaned glass substrate at constant room temperature and different concentrations thicknesses different (330,450 and550)nm. Absorbed dose samples from the source is 2.67sv/h. XRD analysis detect that all the films were polycrystalline tetragonal with a choose orientation bearing (111) plane. At half-maximum full-width (FWHM) of the preferred orientation (111) for the material ZrO_2.that the absorbance of all the films have high rate at a wavelength in the neighbourhood of the border of the essential absorption (280 nm), then the absorbance reduction with rising of wavelength. The reflectance in wavelength range about (275-385) nm increases with the decreasing of the film thickness, also increases with the increasing of the wavelength. In contrast, λ>385 nm the reflectance increases with the increasing of film thickness and decreases with increasing of the wavelength. The value of energy gap has been observed to depend on thickness, showing a slightly decreases as a thickness increase and the variations of refractive index with the wavelength of the accident photon. The conduct of this figure is similar to the behaviour of reflectance spectrum.

Keywords: *Optical properties, transparent conducting, Zirconium dioxide, ray gamma element Cs^{137}.*

Introduction

Faultless zirconia exists (ZrO_2)in three valuable stone stages at various temperatures. Temperatures at high (>2370°C) the substance has a cubic construction. Temperatures at moderate (1170 to 2370°C) it has a tetragonal structure. Temperatures at depressed (underneath 1170°C) the material changes to the monoclinic structure [S.H.Jeong *et al*, 2003]. The change from tetragonal to monoclinic is quick and is joined by a 3 to 5 percent volume assemble that causes expansive softening up the material. A couple of oxides which separate in the zirconia valuable stone structure can back off or wipe out these pearl structure changes. Used normally feasible included substances are MgO, CaO, and Y_2O_3[Al-Salehi at,1998]. With satisfactory aggregates incorporated, the structure cubic at high temperature can be kept up to room temperature. Settled cubic zirconia is a significant adamant and specific mud material since it doesn't encounter harming stage moves in the midst of warming and cooling [A. S. Ablitsova *et al*,1998].

Moreover, some composes of zirconium oxide pottery generation can lead oxygen particles. Fragments created utilizing this material are in a general sense more exorbitant than parts made of alumina ceramic generation[H.Bensouyad *et al*,2010]. Oxide zirconium ceramics are used, among various applications, as instruments for wire encircling, as aides in welding frames, as materials for crowns and expansions in the dental business, as rings securing in warm systems, and as estimation oxygen cells in lambda tests. Zirconia is an amazingly obstinate material [P.Southon *et al*, 2000].

Experimental details

Thin films of nana structured Zirconium dioxide (SrO_2) have been prepared by chemical spray pyrolys is technique. Aqueous dismissal, of ($ZrOCl_2.8H_2O$)with different thicknesses(330,450,550)nm was utilized as a exporter of Sr, glass substrates were applied to deposit SrO_2. After many lawsuit, the following event were chosen in order to secure homogenous films, pinhole free, well adherent to substrates. These event arrived at the following: substrate self same temperature was (300±10)°C, and was kept fixed through, the sedimentation process, distance between substrate and nozzle was 29 cm ,spraying time was 10 Slasted by 90 to avert exaggerated cooling, deposition rate was 4 ml/min., nitrogen was used as a gas carrier .The irradiation samples exposed to ray gamma fromCs^{137},Radiological Card 661.61KeV,Absorbed dose to the sample from the source 2.67.Structural

*Corresponding author: **Hiyam Chasib Majed**

possession were carried out using X-Ray Diffraction Technique (shimadzu - XRD6000, shimadzu company /Japan).Transmittance and absorbance were measured by using a double beam spectrophotometer (Schimadzu 1650 UV probe Japan) in the wavelength domain (350-1100)nm . All the measurements were achieved at room temperature [Y.Shen,S.Shao *et al*,2007].

Results and discussion

The XRD Patterns registered for with thickness of ZrO_2 thin films. Exercise the JCPDS data card, these films were establish to be of cassis trite kind with a tetragonal structure [E. Martı´nez *et al*,2001]. The prime diffraction peaks attributed to (111) and (220) of ZnO_2 these peaks signalize the polycrystallanity of these films, have a preferred orientation along (111) which vestige predominant irrespective of the molar concentration [M.Cassir *et al*,2001].

The XRD patterns of all thin films with different thicknesses (330,450 and 550)nm. The X –ray Diffraction (XRD) analysis has been carried out for these films, which display polycrystalline structure of tetragonal phase regardless of thickness as shown in figures (1a), (1b) and (1c). Polycrystalline films exhibit two main peaks which correspond to (111) and (220) planes. In all condition the concentration of (220) peak is extremely low in comparison with (111) one, this signalize that a dominant peak correspondent was(111) plane. It shows there is a shifting due to radiation suffered by the specimens. Also one can observe that when thickness raise, the position of peaks do not change position. These results are in good agreement with (JCPDS) card and Martı´nez [Y.Shen *et al*,2007].

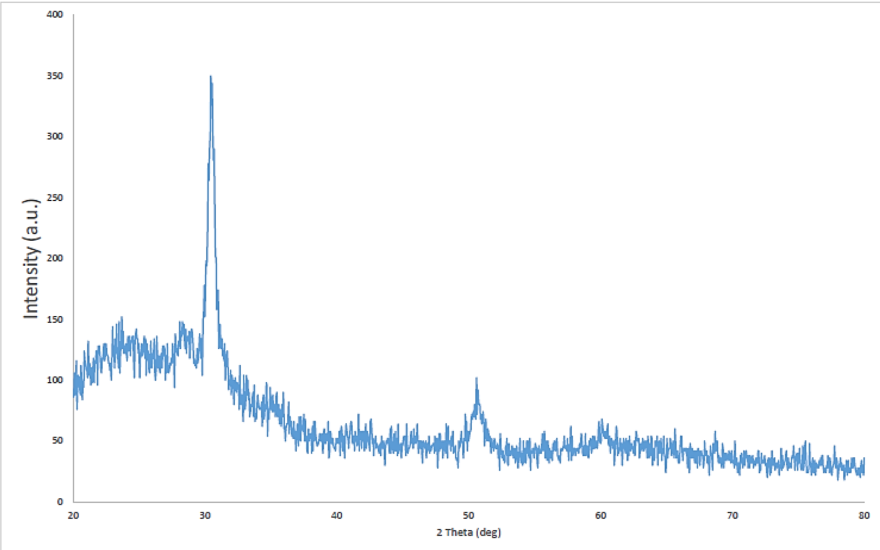

Figure 1a: XRD spectrum for ZrO_2 thin film with thickness (330) nm and the irradiation of samples ray gamma element Cs^{137}

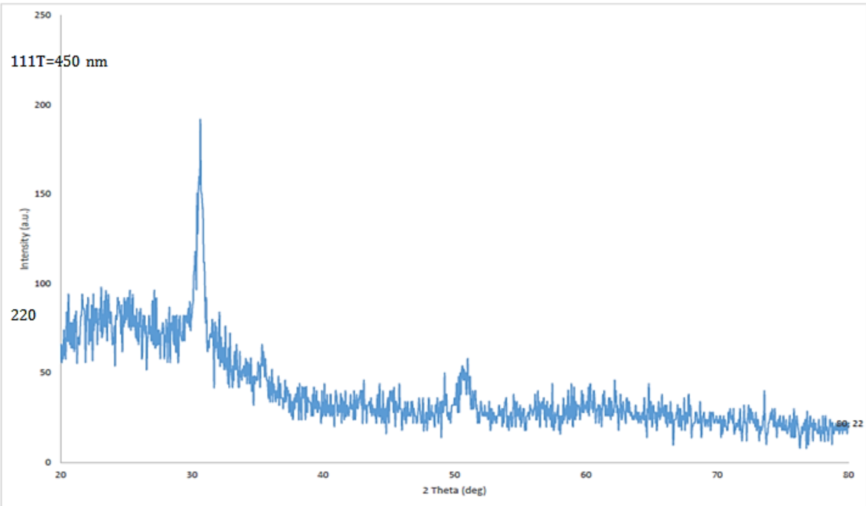

Figure 1b: XRD spectrum for ZrO_2 thin film with thickness (450) nm and the irradiation of samples ray gamma element Cs^{137}

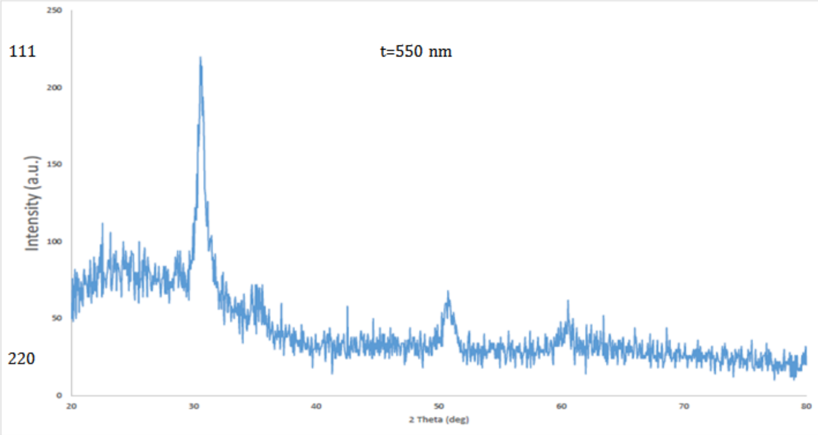

Figure 1c: XRD spectrum for ZrO_2 thin film with thickness (550) nm and the irradiation of samples ray gamma element Cs^{137}

Table 1 shows The lattice constants a and c for the ZrO_2 thin film are calculated by using the equation:

$$\frac{1}{d^2}+\frac{h^2+k^2}{a^2}+\frac{l^2}{c^2} \quad (1)$$

for different thicknesses, It is observed that the lattice constants change slightly with thickness, also the value of lattice constants is nearly in agreement with(JCPDS) card and Garcia.[E. Martı´nez *et al*,2001]

Table 1 The variation of Lattice constants with thickness

Thickness (nm)	c (Å)	a(Å)
330	5.058	5.107
450	5.090	5.116
550	5.080	5.114
J C P D S	5.25	5.12

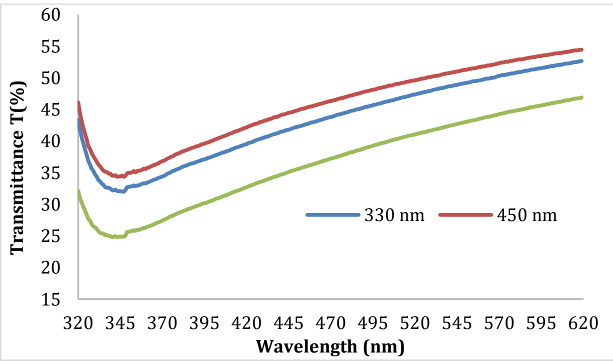

Fig. 2 Transmittance versus wavelength for ZrO_2 thin film is exposed to gamma rays (Cs^{137}) different thicknesses

Fig. 2 illustrate the transmittance via wavelength, it can be clearly seen that the transmittance of 330 nm was higher than the all deposited thin films showing a shift in peak location. All the films exhibit peaks maxima and minima this could be attributed to the high homogeneity of the deposited thin films. Transmittance was given by the ratio of the intensity of the transmitting radiation (I_T) through the film to the intensity of the episode rays (Io) on it as [Zhu LQ *et al*,2006]

$$T=I_T/I_O \quad (2)$$

It is also observed from the Fig. 1 that increasing thicknesses tends to reduce transmittance in all the spectrum of solar light energy. These results could be attributed to the formation of denser films because of water evaporation. This behaviours in good agreement with result published by Ezema et al [Li, W *et al*, 2007]. Fig. 3 shows that was observed that absorbance was higher for the thickness untreated one and then begin to decrease. When the Lower thickness, this can be explained by the inverse relation between transmittance and absorbance. A can be defined as the ratio between absorbed light intensity (I_A) by material and the accident intensity of light (Io).[Shen Y *et al*,2007].

$$A=I_A/I_O \quad (3)$$

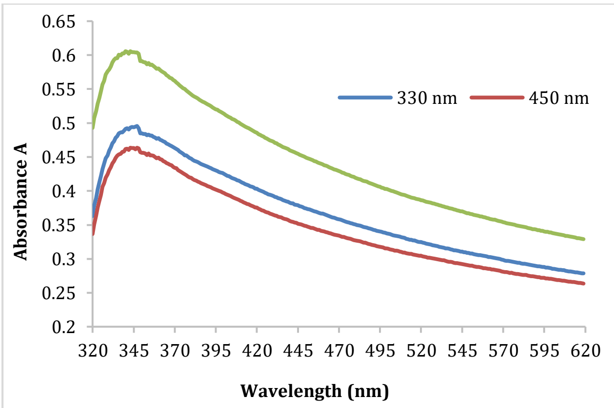

Fig. 3 Absorbance versus wavelength for ZrO_2 thin film is exposed to gamma rays (Cs^{137}) different thicknesses

Fig. 4 illustrates the Reflectance via wavelength. Ranges Reflectivity of the material $ZrO_2$from (0.185 to

0.203) cm^{-1} the, and be less reflect when the thickness of the material 550 nm, and more reflective when the thickness of the material 330 nm. Equally reflective material when thickness (330,450 and 550) nm when the wavelength 495 nm.

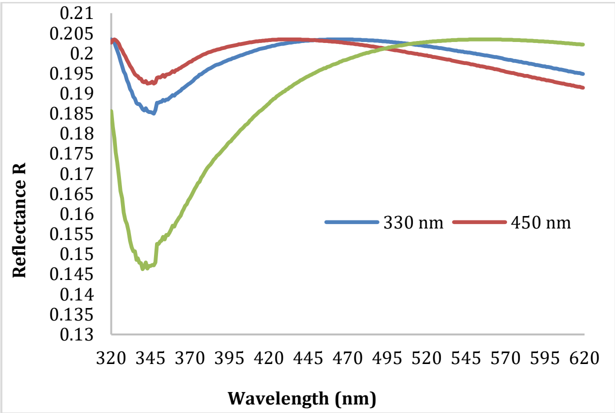

Fig. 4 Reflectance versus Wavelength for ZrO_2 thin film is exposed to gamma rays (Cs^{137}) different thicknesses

Fig. 5 depicts the relation between the absorption coefficient and photon energy, increasing photon energy leads to increased reflectance, it can be seen that the highest value of the absorption coefficients at Increasing photon energy was at thickness 330 nm. The absorption coefficient datum were applied to locate the optical band gap, eg, using the relation: [Ma, C.Y., Laspostolle *et al*,2007]

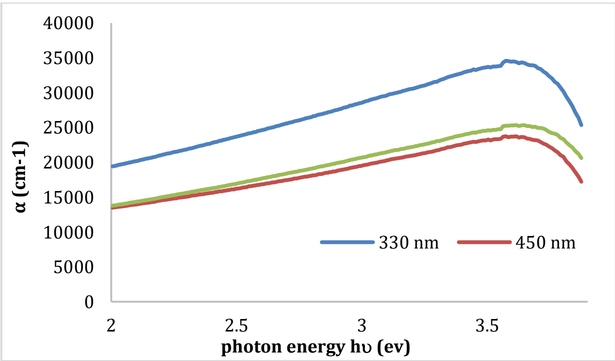

Fig. 5 Absorption coefficient is exposed to gamma rays (Cs^{137}) different thicknesses

$$\alpha h\upsilon \approx (h\upsilon - E_g)^{n/2} \qquad (4)$$

where hυ is the photon energy n=1 for direct transition, n=4for indirect transition. In this case the transitions are direct and the absorption coefficient α was obtained from the transmittance data using the relation:

$$\alpha = (1/d)\ \ln(1/T) \qquad (5)$$

where d and T are the thickness and the transmittance of the films. The absorption coefficient (α)[Mujdat Caglar *et al*,2009].

Fig. 6 represents the value of direct transitions, which was estimated from Tauc relation according to the following equation: [Lin, C.Y. *et al*,2007]

$$\alpha = \ln(I_0/I)/d \qquad (6)$$

The value of the optical energy gap utilizing Fig. 6was3.0**8**eV the highest value was for ZrO_2 thin film is exposed to gamma rays (Cs^{137}) thicknesses 330nm .and optical energy gap utilizingFig.7 was3.0**2**eV the highest value Also was for thicknesses 450nm. Optical energy gap utilizing Fig.8 was3.00eV the highest value Almost to the extent was for thicknesses 550 nm.

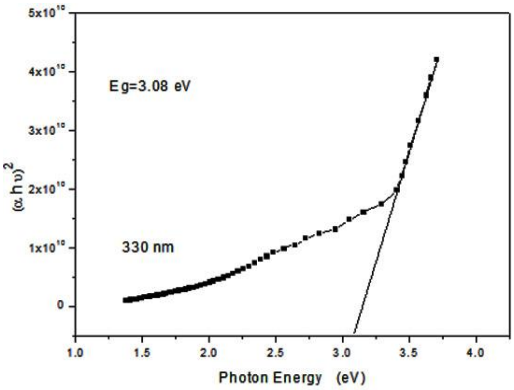

Fig. 6 ZrO_2 thin film is exposed to gamma rays (Cs^{137}) thicknesses 330nm

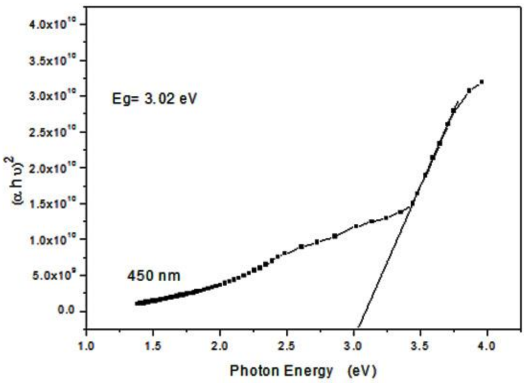

Fig. 7 ZrO_2 thin film is exposed to gamma rays (Cs^{137}) thicknesses 450 nm

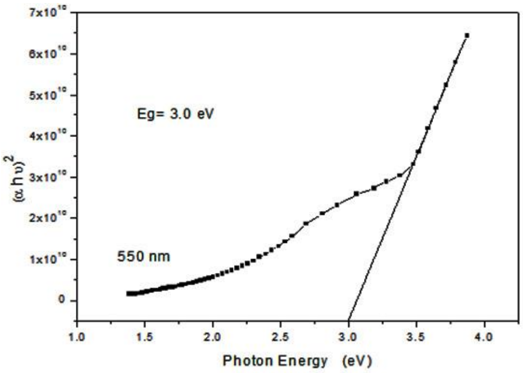

Fig. 8 ZrO_2 thin film is exposed to gamma rays (Cs^{137}) thicknesses 550 nm

It can be seen from Fig. 9 that the value of the extinction coefficient decrease at the 459 nm and extinction coefficient increase at the 331 nm. Extinction coefficient known, as the amount of energy absorbed in the thin film represents (complex refractive coefficient) The Extinction coefficient (k) was calculated from the absorption coefficient (α) using the formula:[Luo K *et al*,2009]

$$K=\alpha\lambda/4\pi \qquad (7)$$

The absorption edges shifted across the higher energy quarter and showed no explicit change with increasing, the deposition times.

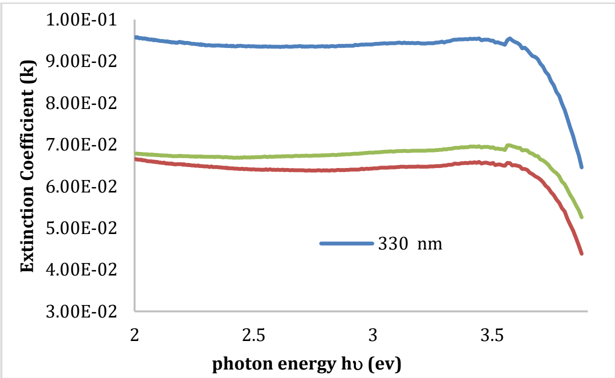

Fig. 9 Extinction coefficient versus photon energy for ZrO_2 thin film is exposed to gamma rays (Cs^{137}) different thicknesses

Fig.10 show the value of the refractive index was calculated by the following [Brunet *et al*,2011]

$$R= [(n_o-1)^2+k_o]/ [(n_o-1)^2+k_o^2] \qquad (8)$$

It can Illustrates the refractive index a decrease trend when increase the deposition time ,the resonance for how peaking density for the film and possibility have not continuous, many void still exist in the films and many defects due to lose arrangement. [Kralik B *et al*,1998].

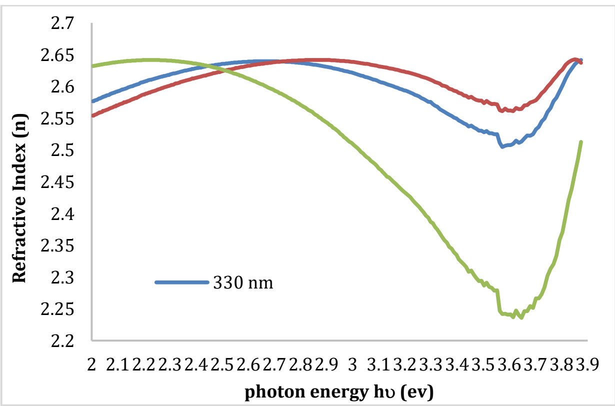

Fig. 10 Refractive index versus photon energy for ZrO_2 thin film is exposed to gamma rays (Cs^{137}) different thicknesses

Figure 11 below observed important trends in the dielectric functions are the dependence on thickness and using the formula real (ε1) part of dielectric functions of these films [Yusoh *et al*, 2012]

$$\varepsilon_1=n_o^2-k_o^2 \qquad (9)$$

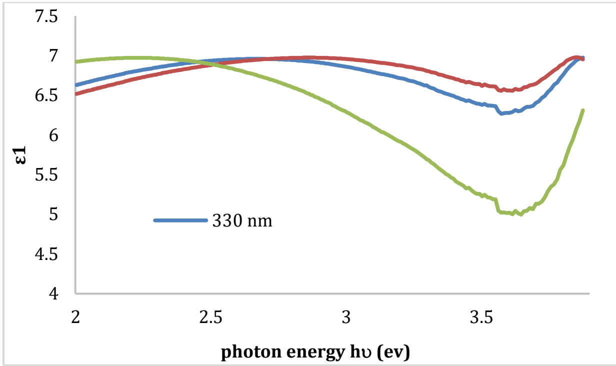

Fig. 11 Thin film is exposed to gamma rays (Cs^{137}) different thicknesses

Figure 12 below shows the imaginary (ε_2) part of dielectric functions of these films.

$$\varepsilon_2=2n_ok_o \qquad (10)$$

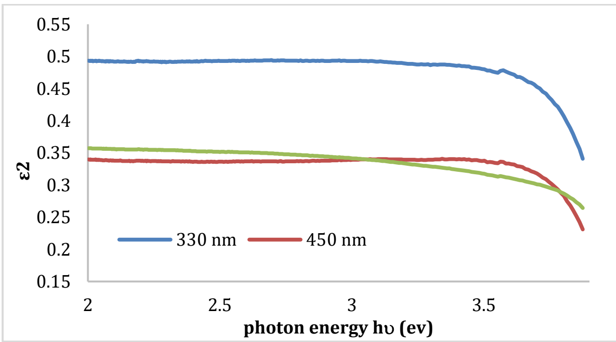

Fig. 12 Thin film is exposed to gamma rays (Cs^{137}) different thicknesses

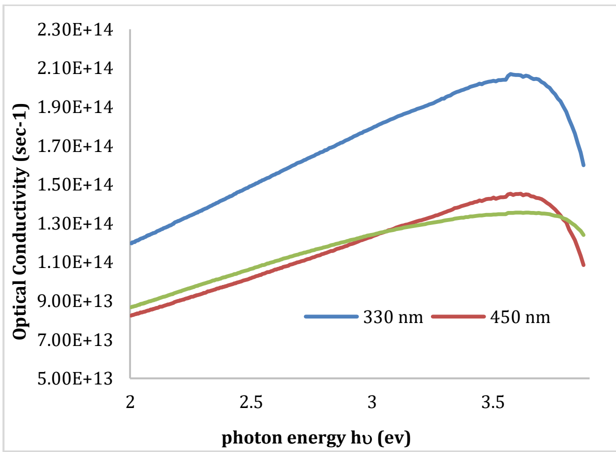

Fig. 13 Thin film is exposed to gamma rays (Cs^{137}) different thicknesses

Figs. 13 above we used, mathematical equation below for finding the value of the optical conductivity [A. Ivashchenko *et al*,2007]

$$\sigma = (\alpha nc / 4\pi) \quad (11)$$

The value of the optical conductivity was vary photon energy from 2to 2.9 volts and highest value of the film thickness at 331 nm.

Conclusions

Thin films of ZrO2 have been successfully prepared by the chemical spray pyrolysis is technique. XRD patterns reveal that all the films were polycrystalline with a preferred orientation along (111) plane. The effect of gamma rays on these films were investigated reaching to the following conclusion that the radiation affect the crystal structure by decreasing the order of crystallinity the optical properties were also affected.

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