The Effects of γ – Rays on The Optical Constants of ZnS Thin Films

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Abstract

ZnS thin films were grown onto glass substrates by flash evaporation technique, the effects of γ – rays on the optical constants of ZnS these films were studied. It was found that γ – rays affected all the parameters under investigation.

Key words: thin film, flash evaporation, ZnS, optical properties.

Introduction:

Zinc sulphide are widely used in many optical and electronic areas owing to its wide band gap (3.7 eV), high refractive index, and high dielectric constant[1-2] , low optical absorption in the visible and infrared spectral region [3].

It can thus be used for the fabrication of optoelectronics devices such as blue light emitting diodes, electroluminescent devices, electro-optic modulator, optical coating, n-window layer for thin film heterojunction solar cells, photodetector and especially photovoltaic devices [4-9], recently ZnS we used as in the treatment of wastewaters [10]. Various techniques have been employed to prepare ZnS thin films, such as successive ionic layer adsorption and reaction (SILAR) [11], glancing angle deposition [12], solution growth technique (SGT) [13], rf-magnetron sputtering [14], chemical bath deposition [15], pulsed laser deposition[16],atomic layer deposition[17] and chemical spray pyrolysis [18].

This research an attempt to fabricate ZnS using flash evaporation technique and study the optical constant of the as prepared thin films before and after exposure to γ – radiation.

Materials and method:

Polycrystalline ZnS thin films were grown on preheated glass substrates up to 100 ^oC by flash evaporation technique. High purity of ZnS (Aldrich company 99.99%) were was evaporated by a molybdenum boat filament in a high vacuum chamber (pressure about 10^{-6} torr).

During the deposition of ZnS films, the boat and substrate were kept about 10 cm apart, this long distance results in the formation of quite uniform films, prior to deposition, the glass substrate were cleaned aqua – regia and washed in distilled water and isopropyl alcohol. The deposition rate was 0.8 nm/s to obtain films with thickness of a bout 0.5±0.05 μm. Optical and transition spectra were recorded by double beam UV/VIS (Shimadzu Corporation Japan). in the wavelength range (300 -900) nm. A ^{60}CO gamma – rays used to irradiate the thin films under investigation. A computer program was used to obtain the results concerning extinction coefficient, refractive index, real and imaginary

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part of dielectric constant before and after irradiation.. XRD analysis was made using Philips x-ray diffractometer with filtered Cu K_α radiation source.

Results and Discussion:

The XRD spectrum of both unirradiated and irradiated ZnS in figure (1) suggesting Cubic phase (JCPDS card, No. 5-0566). It is seen that the peaks are more broadened and shifted to higher diffraction angle when the film is exposure to gamma particles. The optical properties of the film were determined from the transmission and reflection measurements in the rang (300-900) nm .

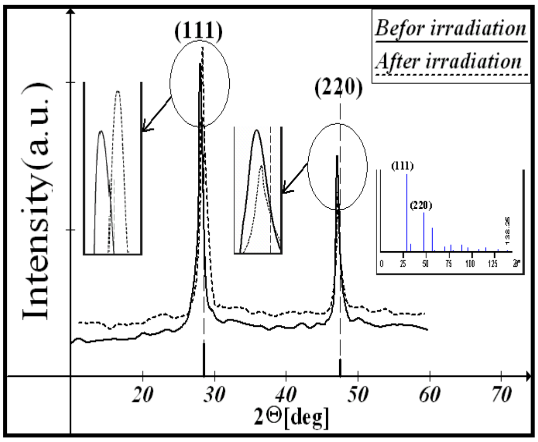

Fig. (1) XRD pattern of irradiated and unirradiated ZnS films.

For a better understanding of the effect of γ-irradiation on the optical properties of the investigated film, it is necessary to determine some optical constants such as the refractive index (n) and the extinction coefficient (k).Any absorbing medium can be characterized by the complex refractive index (n-_ik) and complex dielectric constant $(\varepsilon_1 - i\varepsilon_2)$. The values of refractive index and extinction coefficient have calculated using the following relations [19]:

$$R = \frac{(n-1)^2 + k^2}{(n+1)^2 + k^2} \quad \text{........(1)}$$

$$k = \frac{\alpha\,\lambda}{4\pi} \quad \text{........(2)}$$

Where R is the reflectance and λ is the wavelength of the incident light .

Figure (2) shows the variation of refractive index with wavelength. the wavelengths ranging from (380 – 530 nm), the value of refractive index decrease as the wavelength increase while the values of irradiated ZnS films within the same range increased, this variation may be attributed to various factors, such as the crystallinity of the film, density, electronic structure and the defects thus, the high value of the refractive index is an indication of high density of the film. Figure (3) shows the extinction coefficient (k_0) as a function of wavelength. k_0 increases for irradiated sample because of increasing structural defect with gamma radiation and high value of extinction coefficient suggests low quality transparent films.

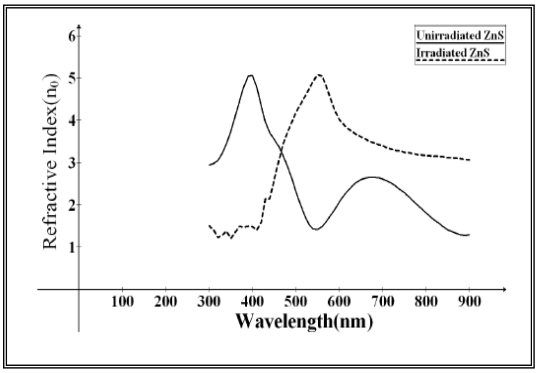

Fig.(2) Refractive Index vs. wavelength.

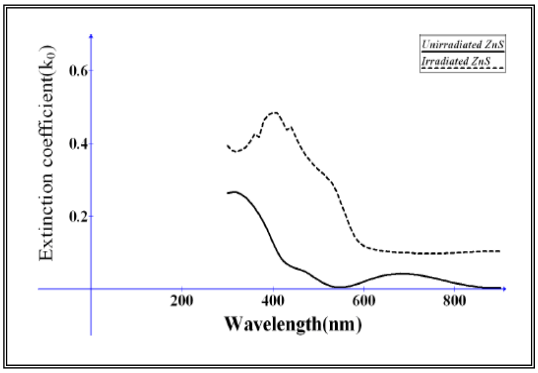

Fig. (3) Extinction coefficient vs. wavelength.

The dielectric constants consists of real part (ε_1) & imaginary part (ε_2) ,the variations of them with photon energy were determined and shown in figure (4)&(5), the variation of (ε_1) could be attributed to the same reason of the variation of refractive index.

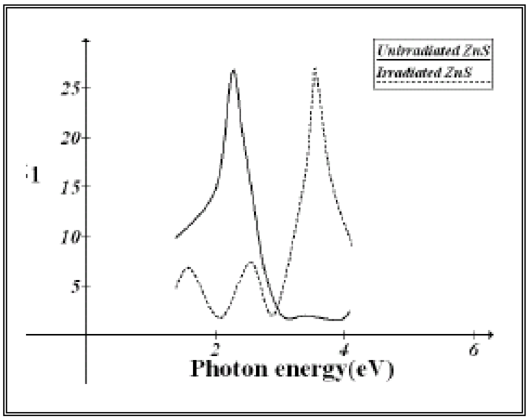

Fig. (4) ε_1 vs. Photon energy.

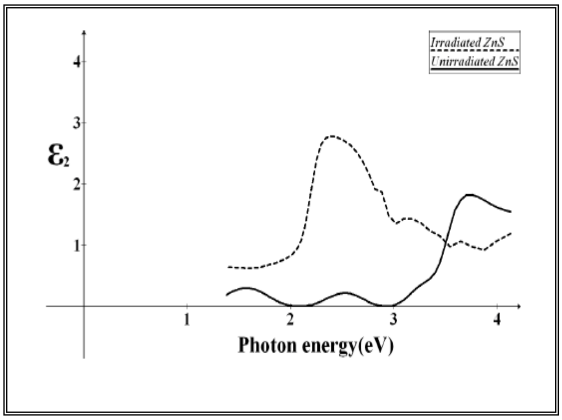

Fig. (5) ε_2 vs. Photon energy.

We can observe that the variation of **ε_1** has similar trend to the variation of refractive index because of smaller values of $(k_0)^2$ in comparison with $(n_0)^2$ where ($\varepsilon_1=(n_0)^2-(k_0)^2$),while the variation of **ε_2** mainly depends on the variation of k_0 values which are related to the variation of α .

Conclusions:

The actions of irradiation by gamma ray on ZnS thin film are:

- ❖ The peaks of XRD are more broadened and shifted to higher diffraction angle when the film is exposure to gamma particles ,
- ❖ Increasing the absorption coefficient and extinction coefficient,
- ❖ **ε_1** has similar trend to the variation of refractive index and
- ❖ **ε_2** values are related to the variation of α .

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تأثير أشعة كاما على الثوابت البصرية لأغشية كبريتيد الخارصين الرقيقة

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الخلاصة:

حضرت أغشية كبريتيد الخارصين على قواعد من الزجاج باستخدام طريقة التبخير الوميضي .

درس تاثير اشعة كاما على الثوابت البصرية لاغشية كبريتيد الخارصين لقد وجد بان اشعة كاما قد اثرت على كافة العوامل قيد الدراسة.