

ENVIRONMENT AND ECO-FRIENDLY OF ZnSe ANNEALED STUDY ON BANDGAP AND OPTICAL PROPERTIES SPRAY PYROLYSISED THIN FILM

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Abstract :

Environment and eco-friendly Zinc Selenide (ZnSe) thin films by spray pyrolysis has gained significant interest due to its various applications in different fields such as optoelectronics, photo-sensors and solar cells. Zinc Selenide (ZnSe) thin films by spray pyrolysis has emerged as a cost-effective method to deposit thin films. In the optical properties the absorbance, transmittance, reflectance, optical band gap, extinction coefficient refractive index, are studied. In this research paper, we investigate the band gap for different thickness was estimated within 2.5 -2.7 eV of ZnSe thin films prepared using the spray pyrolysis technique. The XRD shows polycrystalline nature. The study aims to provide understanding into the affect of thickness of anneald ZnSe thin films ,the refractive index using the reflectance data and the applications in optoelectronic devices.

Keywords : ZnSe; thin film; spray pyrolysis; annealing; optical properties; XRD optoelectronics.

Introduction :

The Zinc Selenide (ZnSe) chalcogenid thin film has attracted considerable attention as a material for photosensor devices due to its wide band gap and high transparency in the visible and infrared region. As CdS as window layer in between solar cells but due to environmental issue and toxic We need non-toxic (Cd-free) window layer for thin film based solar cells is a challenging task, The ZnO/ZnS / ZnSe is a compound semiconductors can be applied as an alternate buffer layer in replacement of CdS. Among many methods for preparation of thin film like solution growth technique [1], vacuum evaporation, Chemical bath deposition[2], RF magnetron sputtering[3], thermal evaporation [4], electron-beam evaporation[5]. However spray pyrolysis[6] has came out as a assuring technique for a quality films. This is a famously simple as compared to the other costly methods. Due to wide band-gap of 2.5-2.7 eV and respectable photosensitivity[7], it can be used in semiconductor diode lasers, photo-detectors, solar cells,[8], blue light-emitting devices [9]. Thickness dependant[10] and annealing processes plays the significant influence on the properties of thin films for optoelectronic purpose [11]. But very few reports are available in thickness dependent annealed ZnSe thin film. In this research study, we investigate ZnSe



thin film at 400⁰C and annealed at 100⁰C for 1 hour and the effects of thickness on the optical and structural properties of ZnSe thin films prepared via spray pyrolysis is studied .

Experimental :

The substrates used for the deposition of ZnSe thin films were commercial microscope glass slides .The chemically cleaned glass slides were used for deposition. Before deposition of thin films are cleaned in detergent and rinsed with distilled water. In such a process the solution of the reagents were all prepared with double distilled water. Then the solution is kept in a magnetic stirrer for 5 hour .The glass-sprayer which was designed in our lab[12] is used for spraying the solution of sample. The present paper focused on use of aqueous solution of pure zink chloride (ZnCl₂) and SeO₂ of equimolar concentration to deposit thin film by spray pyrolysis techniques[13] The ZnSe thin films were developed by spray pyrolysis use an aqueous solution of ZnCl₂ and SeO₂ on a pre heated glass substrate kept at 400 °C for 10 min.

The optical properties of ZnSe are investigated by ELICO UV VIS spectrophotometer[14] which was employed to carry out absorbance (a) and transmittance (T) in the wavelength range (380 – 1000 nm) to determine optical constants are shown in Figure 1 .The optical transmittance and absorbance spectra of the ZnSe thin films of different thickness sample is recorded after annealing[13-16].

Result And Discussion :

Analyze the band-gap energy and optical constants such as refractive index and extinction coefficient to study the effect of thickness on the optical properties. The band-gap was calculated from transmission data using absorption coefficient and direct band-gap relation [17]

$$\alpha = \frac{A}{hv} (hv - E_g)^{1/2} \text{ -----1}$$

where h is the Plank's constant, A is constant , v is incident photon energy, and E_g refers the optical band-gap energy.The plot of (αhv)² verses(hv) photon energy for ZnSe annealed thin film for different thickness T₁ < T₂ < T₃ shows straight line. Hence, a straight line tangent to a linear portion which gives the band gap energy



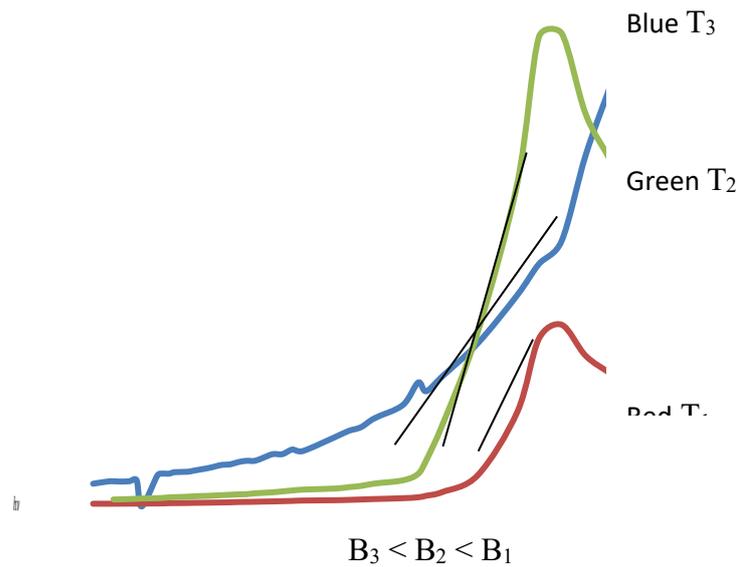


Fig.1 Direct band ZnSe annealed thin film for different thickness $T_1 < T_2 < T_3$

In this work the band gap is in between 2.35 eV to 2.65 eV which in good agreement with the previously reported values. As thickness increases comparatively $T_1 < T_2 < T_3$ the band gap energy of the ZnSe annealed thin film decreased $B_1 > B_2 > B_3$ observed [18]. The XRD patterns of different thickness were recorded with Phillips X-ray diffractometer wavelength 1.542 \AA

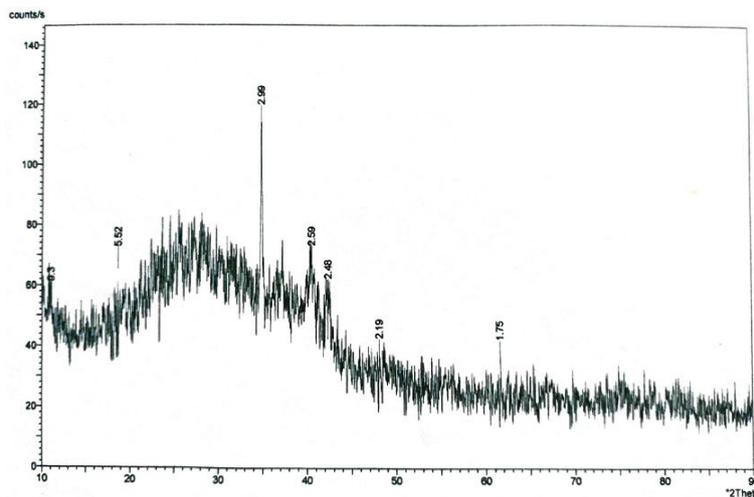


Fig.3. XRD of ZnSe annealed thin film

X-ray diffraction shows the 2θ peaks at 27.45° , 45.57° , and 54.06° shows ZnSe Crystallite size (D) of the film was measured using Scherrer's formula

$$D = \lambda \frac{K\lambda}{\beta \cos \theta}$$

β = the full width at half maximum of the peaks expressed in radians, $K = 0.89$, λ = wavelength of $\text{CuK}\alpha$ radiation, and θ = angle between the incident and scattered X-ray from above the average crystallite size is found to be 40 nm[20]. The SEM of the sample ZnSe shows cotton like morphology [19] as shown in fig 4



Fig.4. SEM of ZnSe annealed thin film

The refractive index μ with wavelength were calculated by using relation[20]

$$\mu = \frac{(1+\sqrt{R})}{(1-\sqrt{R})} \text{-----}(2)$$

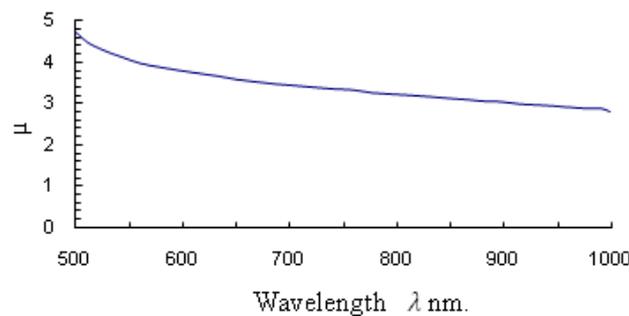


Fig.5 : Refractive index (μ) vs. wavelength (λ)

From the graph it is clear that the refractive index of the films is decreasing with an increase in the wavelength

Conclusion :

By learning the optical spectra, the oscillatory behavior of ZnSe thin film shows the interference pattern with a sharp fall of transmittance. It shows the film has good crystalline properties in nature. It is seen from the optical data, the band-gap energy increased from 2.35 eV to 2.65 eV with decreased thickness. This decrease profitably used in the semiconductor devices. These betterments can be used in devices like photodetectors and in solar cells. The XRD analysis of ZnSe thin film shows that the films are polycrystalline. After annealing the crystallinity and grain size of ZnSe thin films is found improved. Hence by the spray method

the deposited ZnSe thin films is good optical properties used in optoelectronic applications and suggest avenues for future research.

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