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RESEARCH ARTICLE

STRUCTURAL AND OPTICAL PROPERTIES OF ZNSE THIN FILMS PREPARED BY SPRAY PYROLYSIS TECHNIQUE

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ABSTRACT

The optical properties of the films were investigated in the wavelength range of 380-1000nm. The optical band gap energy was 2.5 and 2.6eV. The structural, optical properties of ZnSe thin films were investigated by using the techniques X-ray diffraction (XRD), optical transmittance measured, morphological studied by using Scanning election microscope (SEM). The films were crystalline in nature. The absorption coefficient (α) and band gap were calculated using transmission curves. Optical transmittance measurement indicates the existence of direct allowed optical transmission with a corresponding energy gap in the range of 2.5-2.6 eV. The grain size of the deposited ZnSe films observed to be the small and is within the range of 12 to 32 nm.

INTRODUCTION

ZnSe is a semiconductor which has 2.70 eV band gap energy [1]. ZnSe has been applied to many devices such as hybrid solar cell [2], green-blue LED [3], Laser Source [4, 5] etc.

The growth of energy of II-VI compound semiconductors has attracted considerable attention due to their novel physical properties and wide range of application in optoelectronic devices. II-VI compound semiconductors such as Sulphide (S), Selenide(Se) and Telluride (Te) of cadmium (Cd), Zinc (Zn), mercury (Hg) are of interest as high- refractive index materials in multilayers. Optical coatings since they all have low absorption over a broad wavelength range [6].

Among the II-VI compound semi-conducting materials, ZnSe is used as a window layer for the fabrication of thin films solar cells. It is mainly used as a protective and antireflection coating for infrared operating eletrochromatic thermal –control surfaces because its band gap permits a large number of photons to reach the absorber layer [7, 8]. ZnSe has superior optical transmission with extremely low bulk losses from scattering and absorption. The effect of different deposition parameters such as pressure, substrate temperature and annealing on properties of ZnSe is an area of interest these day [9, 10].

MATERIALS AND METHODS

For deposition of thin films, highly polished and throughly cleaned using liquid detergent. Then it kept dilute nitric acid. After this, they are cleaned using distilled water [10]. The ZnSe thin films layers were obtained on the optical glass plate from liquid of AR quality 0.5 M ZnSo4 and 0.5 M Selenium dioxide at 300^0C temperature. As deposited films were characterized through the structure, surface morphology and optical characteristics [11, 12].

RESULTS AND DISCUSSION

Fig. (3b) and (4b) shows the transmission spectra of as-deposited thin films. The transmittance spectra showed minimum transmission at shorter wavelengths whereas maximum transmission, in the wavelength range 215-255 nm. From the transmission data, nearly at the fundamental absorption edge, are calculated by using equation,

$\alpha = 1/d.\ln(1/T)$

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In Fig (3a) and (4a), the absorption of ZnSe films shows high in the UV region makes the material useful in formation of p-n junction solar cells with other suitable thin films materials for photovoltaic application. These results agree with the report in [13].

In order to calculate the optical band gap, we use the Taue relation,

$\alpha h\upsilon = B(h\upsilon - E_g)^n$

Where α is the absorption coefficient, B is a constant, $h\upsilon$ energy of incident photons and exponent n depends on the type of transition , n may have values ½, 2, 2/3 and 3 corresponding to the allowed direct, allowed indirect, forbidden direct and forbidden transition respectively [14].

Fig.(3e) and (4e) show the plot between $(\alpha h\upsilon)^2$ and $h\upsilon$ for the thickness, t=0.5831µm and 0.5275µm. Extrapolation of the linear portion of the curve to $(\alpha h\upsilon)^2 = 0$, gives the optical band gap value for the deposited films. The calculated band gap Eg energies were 2.6 and 2.5 eV (direct transition) for ZnSe thin films. Structural analysis of the films has been made by using an X-ray diffraction in the 2θrange 10^0 to 70^0. The particle size is calculated from the scherrerformula:

$D = 0.94\lambda/\beta \cos\theta$

Where λ is the wavelength of the X-rays and 2θ is the angle between the indicent and scattered X-rays, and β is the full width at half maximum.

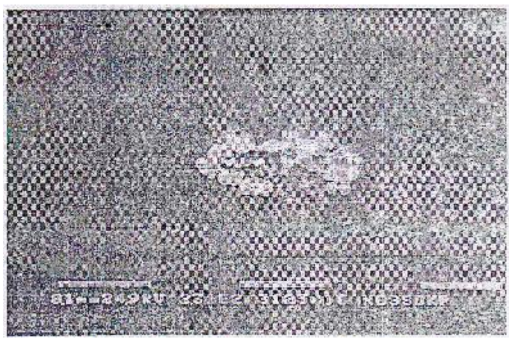

Fig. 1 SEM image of ZnSe thin film

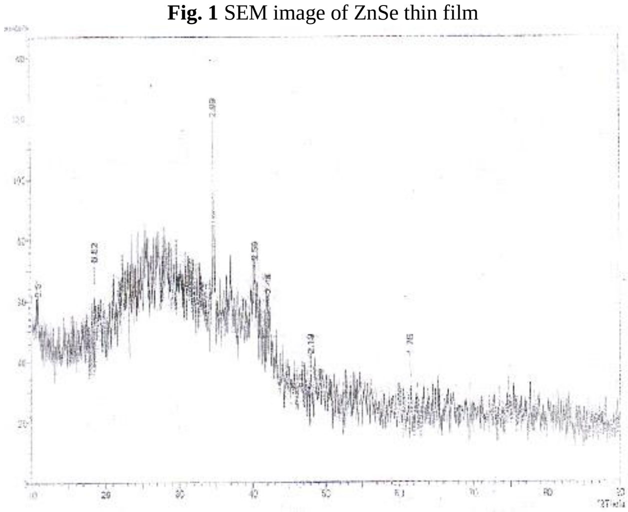

Fig. 2 XRD pattern of ZnSe thin film.

Fig.1 shows SEM, image of the film deposited at thickness t =0.5831µm.The SEM image of ZnSe film on glass substrate revealved that the deposited films posses a smooth surface[15].

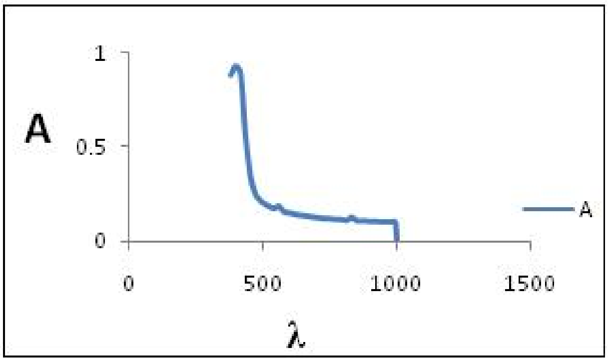

Fig. 3a Absorption spectra of ZnSe thin film, t=0.5831 µm

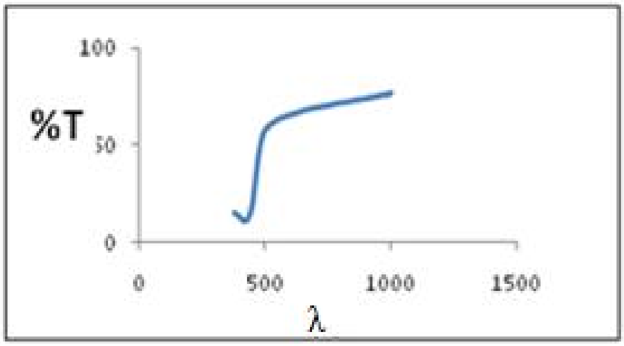

Fig. 3b Transmission spectra of ZnSe thin film, t=0.5831 µm

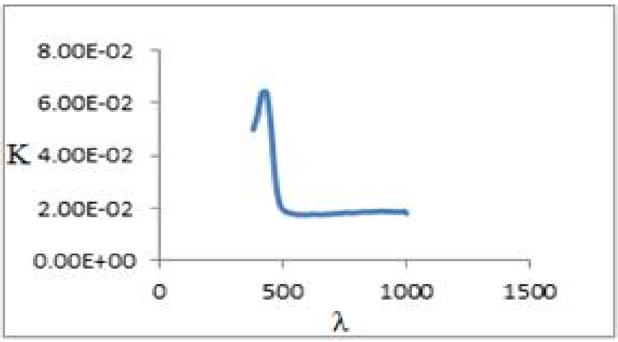

Fig. 3c Variation of extinction coefficient with wavelength, t=0.5831 µm

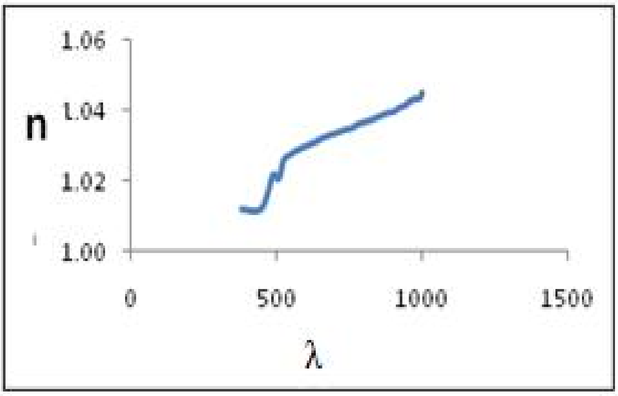

Fig. 3d Variation of Refractive index with wavelength, t=0.5831 µm

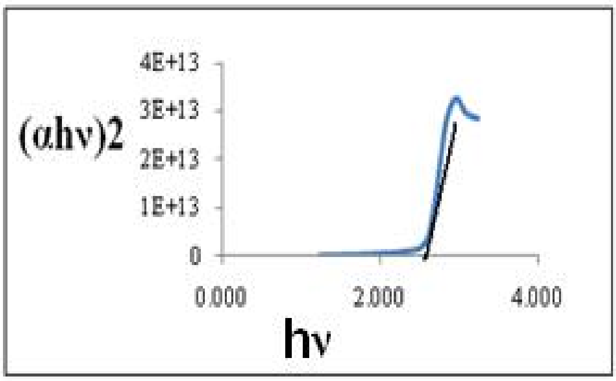

Fig. 3e Photon energy hυ (eV), t=0.5831 μm

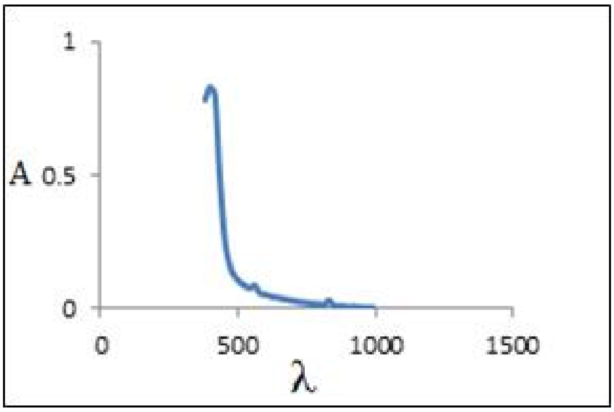

Fig. 4a Absorption spectra of ZnSe thin film, t=0.5275 μm

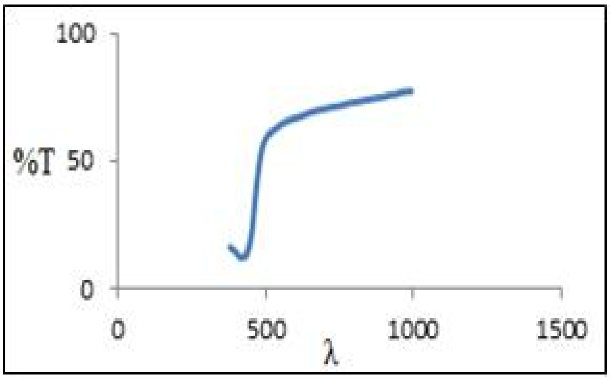

Fig. 4b. Transmission spectra of ZnSe thin film, t=0.5275 μm

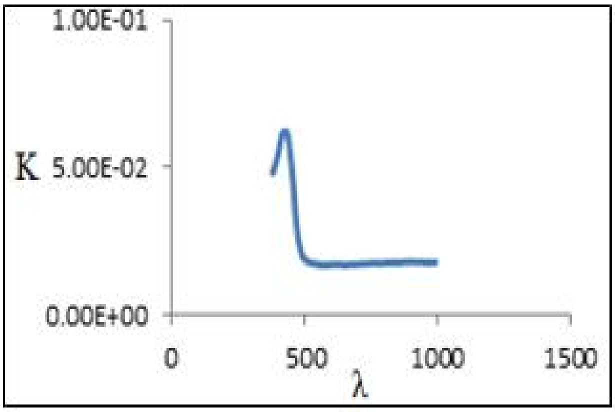

Fig. 3c Variation of extinction coefficient with wavelength, t=0.5275μm

CONCLUSION

The ZnSe films prepared on glass substrate by using spray pyrolysis technique. The ZnSe film has direct band gap of 2.5 and 2.6eV and found to be in good agreement which makes it a good material for optoelectronic applications .From the about discussion it can be concluded that the refractive index of ZnSe thin film decreases with the increases wavelenthand extinction coefficient increase with the wavelength.

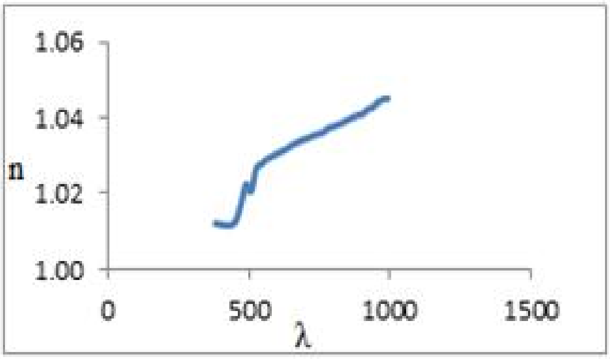

Fig. 4d Variation of Refractive index with wavelength, t=0.5275 μm.

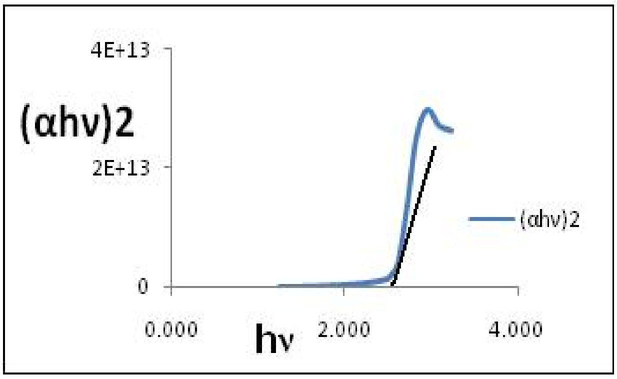

Fig.4e Photon energy hυ (eV), t=0.5275 μm

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