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Effect of Temperature on Structural Properties of Spray Pyrolytically Deposited CdZnSe Thin Films

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Abstract: ***Spray pyrolysis is a simple and inexpensive method to prepare thin films on large substrate area. CdZnSe thin films were prepared by using aqueous solution of cadmium chloride, zinc chloride and selenium dioxide of 0.01 M of each. From the X-ray diffraction studies it reveals that deposited films exhibits polycrystalline cubic structure with preferred orientation along (220) plane. It also reveals that crystallite size is increases as temperature increase upto optimised temperature (300^{0}C) and it is maximum at this temperature.***

Keywords: spray pyrolysis, CdZnSe thin films, structural properties

1. Introduction

II-VI semiconductor materials is attributed to their wide sprayed use for the opto-electronic devices as well as in solar cells fabrication. Zinc and cadmium chalcogenides are the promising for improving II-VI semiconductor based device performance. The band gap value of CdZnSe ternary semiconductorscan be varied from 1.7 eV (CdSe) to 2.7 eV (ZnSe) with the composition parameter [1,2]. ZnSe/CdZnSe is lasing at 500 nm. In order to have true blue, violet or even ultraviolet laser diodes, and to have better optical and carrier confinements, higher band gap materials are needed. The optical properties of alloy semiconductor films can be varied by changing their composition and his can be exploited . $Cd_{1-x}Zn_xSe$ thin films posses band gap less then 2 eV. $Cd_{1-x}Zn_xSe$ can be assume to be an ideal alternative material since its composition can be simply controlled. The development of low cost solar cells depends on the exploitation of films and thus CdS, CdTe, or CdTe films obtained under various experimental conditions require comprehensive electrical characterization.

There are number of thin films deposition methods, such as chemical deposition vacuum evaporation, chemical vapour transport, r.f. sputtering flash evaporation and chemical spray pyrolysis. We have chosen spray pyrolysis method due to simple, inexpensive, easy to handle to prepare thin films on large substrate area (1-3).

2. Experimental Details

The thin films of CdZnSe prepared by spraying the aqueous solution of cadmium chloride, zinc chloride and selenium dioxide on pre-heated glass substrate. The molarity of each solution was used as 0.01 M. Biological glass plate used as substrate. The temperature of the substrate was maintained at temperature 250^{0}C, 275^{0}C, 300^{0}C and 325^{0}C and was measured by pre-calibrated copper constantan thermocouple. The sprayer was move to and fro to avoid the formation of the droplets on the substrate and insure instant evaporation. The spray rate was maintained at 3.5 ml/min at the pressure 12 kg/cm^2. Thickness of the films was measured by weight difference method on unipan microbalance. X-ray diffraction pattern were taken on phillips difractometer with the Cukα-radiation of wavelength 1.542 A. XRD pattern were measured at angle 2Θ between 10 to 80.

3. Results and Discussion

Structural Properties

The structural properties of spray pyrolystically deposited CdZnSe thin films was investigated by X-ray diffraction pattern using Cukα radiation with wavelength λ= 1.54 A^0 . Fig 1 shows typical X-ray diffraction of CdZnSe thin films deposited at various temperature such as 250^{0}C, 275^{0}C, 300^{0}C and 325^{0}C on glass substrates.

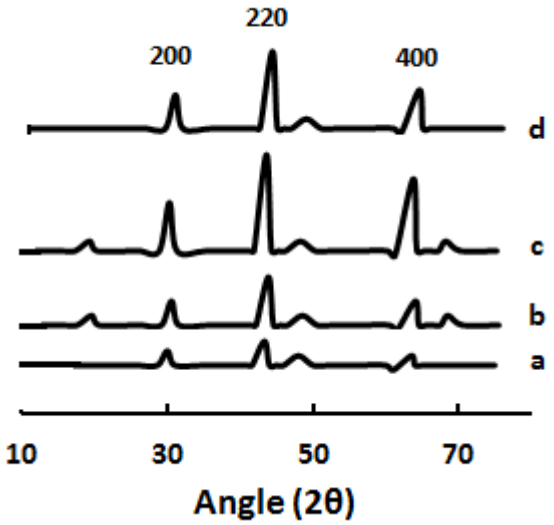

Figure 1: X-ray diffraction of CdZnSe thin films deposited at various temperature such as a) 250^{0}C, b) 275^{0}C, c) 300^{0}C and d) 325^{0}C

From the X-ray diffraction data d_{hkl} –interplaner spacing was calculated by using the bragg's relation,

$$2d_{hkl} \sin\theta = n\lambda \quad (1)$$

Where λ-the wavelength of X-ray used θ-be the angle n-the order number.

The lattice constant of cubic structure of CdZnSe thin films was calculated by using relation,

$$1/d^2=h^2+k^2+1^2/a^2 \quad (2)$$

Each peaks in diffraction pattern were indexed and corresponding value of lattice spacing 'd' were calculated using a above relation (2) and Compared with JCPCDS data standards(5). The similar diffraction peak where observed by Mahaligam et al (6) and Celelettin et al (2). All the peaks identified are from CdZnSe and hence no additional lines corresponding to individual elements of Cd, Zn and Se are present.

The crystallite size of the films was calculated from the x-ray diffraction data using the full width at half maximum intensity and Debey- Scherrer formula,

$$D=0.9\lambda/\beta\cos\Theta \quad (3)$$

Where β-full width at half maximum peaks in radian,Θ-the Braggs diffraction angle at peak position in degree,D-the crystallite size.

The crystallite size D were calculated using the maximum intensity peaks (220) plane are 50 nm, 60 nm, 75 nm and 65 nm for the films prepared at temperature 250^0C, 275^0C, 300^0C& 325^0C respectively. It was observed that if the preparation temperature of the films increases crystallite size also increases upto the optimised temperature 300^0C. After increases the temperature (325^0C), the crystallite size decreases. Due to the removal of defects in the lattice with increase in preparation temperature. The similar results were reported by mahalingam et al (6) by electrodeposited CdZnSe thin films at various bath temperature. They stated that the crystalline size increases with bath temperature and decrease in microstrain with bath temperature. This shows that the X-ray diffraction studies reveals that the deposited films are exhibit polycrystalline cubic structure with preferential orientation along (220) plane.

4. Conclusion

Thin films of CdZnSe were deposited on biological glass plates as a substrate by spray pyrolysis method. The X-ray diffraction studies reveals that the deposited films are exhibit polycrystalline cubic structure with preferential orientation along (220) planes. It was also observed that the crystalline size of the films increases upto the optimised temperature and it is decreases if temperature further increase. This shows that crystallite size of the films is maximum at optimised temperature at 300^0C. No phase transformation is observed for films prepared at various temperature.

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References

[1] Y.D. Tembhurkar, A.S. Meshram and O.P. Chimankar," Optical and electrical properties of CdS thin films prepared by spray pyrolysis." International Journal of Scientific Research. Volume 3, 2014, PP.30-32, December 2014.
[2] Y.D. Tembhurkar, "Study of optical band gap of solid solution ZnSe thin films by spray pyrolysis," Accepted for publication in Dec. 2016 International J. of Science & Research.
[3] N.F. Mott, E.A. Devis, "Electronic process in Non-crystalline materials," Calendran Press Oxford (1979).
[4] M. Celalettin Baykul, Nilgun Orhan, "Band alignment of $Cd_{1-x}Zn_xS$ produced by spray pyrolysis." This solid films, 518(2010) 1925-1928.
[5] JCPDS card no. 89-4174.
[6] T. Mahalingam, V. Dhanasekaran, S. Rajendran, Luis Ixtlico and P.J. Sebastian. "Electro-Synthesis and studies on CdZnSe thin film." J. of new material for electrochemical system, 15 xxx-xxx (2012) 1-15.