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Optical Charactterization and Fractal Dimensional Analysis of CdZnS Thin Films

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ABSTRACT

Using chemical bath deposition technique, cdzns thin films has been prepared on glass substrates. Room temperature photoluminescence analysis in the 400-700 nm emission wavelength ranges for the excitation energy 365nm show the green emission band related to exciton-donorcomplexes formed in presence of S / excess Cd are observed in the PL emission spectra of different cdzns films. Some properties related to nanocrystalline effects are also found. The influence of variation of ratio of cadmium and sulphur was studied on the PL emission intensity of cdzns thin films. Fractal dimensional analysis is also very useful in the characterization of thin films. In this paper characterization of thin film has done by fractal dimensional analysis of Atomic Force Microscope image of cdzns thin film.

Keywords: Photoluminescence, Fractal Dimension, Chemical Bath Deposition, Thin Films, cdzns.

I. INTRODUCTION

Cadmium sulphide is a suitable window layer for solar cells [1-3] and also finds applications as optical filters and multilayer light emitting diodes [2], photo detectors [3], thin film field effect transistors [3-5], gas sensors [6], and transparent conducting semiconductor for optoelectronic devices [7]. Among the various known methods to synthesis cds thin films; the reliable, simple and cost effective route is one using the chemical bath deposition (CBD) technique.

The wide technological applications of cds type materials make the PL studies important. Some of the important applications of PL are lamp phosphors and display devices, xerography and IR detectors etc. PL edge emission was extensively studied in cds by several workers [8-10] and was related to excitonic transitions involving donor/acceptor-exciton complexes [4]. Similarly PC of cds and cdse were extensively studied by Bube and co-workers [11, 12]. The effect of alloying of cds, cdse and other II-VI group compounds on the PL and PC properties has attracted the interest of research workers in recent years. The rare earth ions are well known to form efficient luminescent centers as they show.

Distinct absorption and emission transitions within the 4fn shell configuration [13, 14]. Mixed base cdzns has a wider band gap than cds, which makes it suitable for Phospho-Luminescent screen pigment manufacture etc [15]. The present work concerns with PL studies of cdzns films prepared with varying concentration of Cd and Zn. There are many techniques to by which we analyze an AFM image as box counting method, power spectrum method, triangulation method and standard deviation method [16, 17] .

Fractal Dimensional analysis of AFM images of cdzns thin film is also done in this paper.

II. EXPERIMENTAL DETAILS

The films were prepared by dipping microscopic glass slides of dimension 24 x 75 mm in a mixture of 1 M solution of cadmium acetate, 1 M solution of thiourea, tri-ethanolamine, 0.01 M solutions of cadmium chloride in appropriate proportions in presence of aqueous eposition the films were sprayed with distilled water to wash out the uneven overgrowth of grains at the surface and dried in open atmosphere at room temperature (RT). The cdzns thin films were prepared on glass substrates in the chemical bath at 60°C. The cdzns thin films are yellowish and have a good adherence to the glass substrate.

III. RESULTS AND DISCUSSION

PL Emission Spectra

The chemically deposited (Cd-Zn)S:cdcl2 thin films were uniform and consisted of small nanocrystalline grains. The preparation of cds thin films by CBD is governed by the chemical reaction within the solution of reactants. It was reported that at lower temperatures the surface of the cds thin films is rough, but as the temperature remains constant (at 60°C), the film surface becomes more uniform [13]. The photoluminescence (PL) emission spectra of the different (Cd-Zn)S:cdcl2 films under the excitation energy of 365 nm wavelength have studied.

The effect of time on PL emission intensity has shown in fig.-1. The maximum PL emission intensity occurs at 520nm. It is also observed that there is a blue shift occurs in emission peak for increasing concentration of Zn content. Because for zns the band gap is 3.7 ev and for cds the band gap is 2.4 ev so for (Cd-Zn)S a blue shift in PL emission intensity occurs for increasing band gap (Fig.1). The principle of PL measurements is to create carriers by optical excitation with photon energy above the band gap of the films (2.4ev). Electrons and holes ammonia. Solutions of all other chemicals were prepared in double distilled water. The ph value of the mixture was ~ 9. After d relax to their respective ground states in

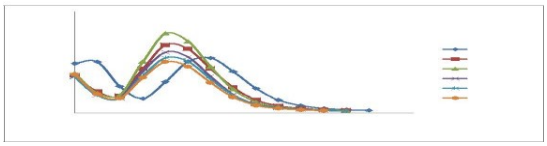


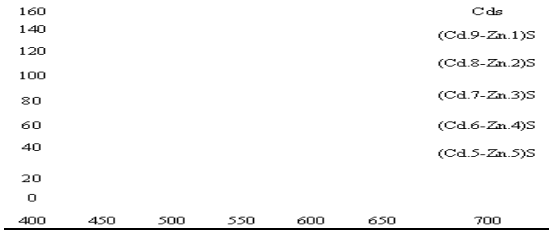
Figure 1

The Conduction and valence band. They can then recombine radiatively as most free carrier or excitations. When light energy input is applied to the film there is an electronic transition between two energy levels,

E1 & E2 (E2 > E1), with the emission of wavelength λ, where $\frac{hc}{\lambda} = E_2 - E_1$.

Invariably E1 and E2 are part of two groups of energy levels so that instead of a single emission wavelength a band of wavelength is observed [13].

The highest emission appears at (Cd1-S0.9) concentration and with increase in concentration of sulphur, the intensity of emission spectra is found to decrease. Therefore this concentration was used for the (Cd.8-Zn.2)S films doped with cdcl2 . This result has shown in Figure 2.



Wavelength

Figure 2. Effect of Variation of concentration of Zn

IV. FRACTAL DIMENSIONAL ANALYSIS

In this paper aimed to determine the fractal dimension of AFM images of cdzns films by box counting method, power spectrum method and Triangulation method. The input images are original AFM images of cdzns thin film. Figure 3

shows the 3D view of cdzns film. AFM image shows that the thickness of film is about 500 nm.

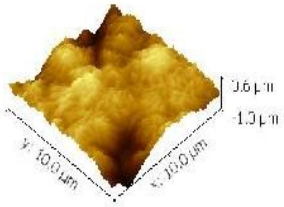


Figure 3. 3D view of cdzns Thin Film

Table 1. Fractal Dimension Values

Method used for fractal dimension	Fractal Dimension
Box Counting Method	2.27
Power Spectrum Method	1.92
Triangulation Method	2.32

V. CONCLUSION

Intense PL emission spectra obtained for the nanocrystalline structured cdzns films. Films were prepared at different concentration of contents and preparative conditions and it has observed that the PL intensity peak observed for the sample cdzns prepared at 60°C for 60 minutes. Shift in wavelength for emission peak also observed indicating the substitution of impurity in the crystal lattice. Based on the optical investigation of the films, the following results were obtained. The maximum transmission value is obtained for (Cd.7-Zn.3)S film. In conclusion we can state that the influence of Zn content on the optical properties of cds thin films is noticeable. Fractal dimension analysis has also being studied for cdzns film and it has found that fractal dimension by all the three methods are more or less equal. Box counting method is the easiest one among all the three methods. Knowing the fractal dimension of AFM images are very useful in applications in different fields like formation of window materials for solar cells, optical devices, photo conducting materials and other opto-electronic devices.

VI. REFERENCES

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