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Characterization of (Cd-Zn)S Thin Films

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Abstract: Using chemical bath deposition (CBD) technique, (Cd-Zn)S thin films were prepared on glass substrates Photoconductivity rise and decay spectra was obtained for different ratio of cadmium and zinc. The absorption coefficient (α) was determined from the absorption using (uv-vis spectrophotometer) at a normal incident of light in the wavelength of range (400-1000)nm. We find that the films have energy gap between (2.8ev-3.09ev) and ($\alpha \geq 10^4$ cm^{-1}) means the direct type of transmission.

Keywords: Photoluminescence, Chemical Bath Deposition, Thin Films, CdS.

1. 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.

Photoconductivity studies of II-VI compounds are quite important due to their broad applications in photovoltaic solar energy and thin film transistor electronics [5]. Photoconductivity by visible light in polycrystalline semiconductor films has been reported by many researchers studying a wide range of materials. Photo decay and photo response properties are employed for investigation of photoconductive materials and photovoltaic structures [6]. In order to obtain CdZnS films, there are several deposition methods like vacuum evaporation [7], solution growth technique [8].

Mixed base (Cd-Zn)S has a wider band gap than CdS, which makes it suitable for Phospho-Luminescent screen pigment manufacture etc.[9]. Thus in the present paper (Cd-Zn)S is used as base material. Further $CdCl_2$ has been used as flux which facilitates the incorporation of the rare earth ions into the lattice and also helps in recrystallisation of (Cd-Zn)S [10]. The present work concerns with PC studies of (Cd-Zn)S films prepared at different preparative condition.

2. 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, thiourea, tri-ethanolamine, 0.01 M solutions of cadmium chloride, 0.01M solution of cerium oxide in appropriate proportions in presence of 30% aqueous ammonia. Being insoluble in water, solution of cerium oxide was prepared in sulphuric acid; solutions of all other chemicals were prepared in double distilled water. The pH value of the mixture was ~ 9. After deposition 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 (Cd-Zn)S thin films were prepared on glass substrates in the chemical bath at 60°C. The (Cd-Zn)S thin films are yellowish and have a good adherence to the glass substrate.

3. RESULTS AND DISCUSSION

PC STUDY

When light is illuminated on the film, the photocurrent is high. Initially high value of the photocurrent is due to absorption of photons by the films, which excites the electrons from the VB to the CB. This creates e-h pairs in CB and VB. Most of the electrons are from the surface of the film which moves from VB to CB. Photon absorption increases the process of pair generation initially, which in turn increases the carrier concentration, resulting in high photocurrent.

The photocurrent decreases with time and after some time, the photocurrent is almost constant. Since the recombination of carriers starts becoming effective after some time, the rate of increase of carriers becomes lower and further after, a balance between the generation and recombination gives rise to saturated value of current. When light is turned off, photocurrent decreases abruptly and after a few seconds, it decreases steadily with respect to time. Here surface recombination is very high and it leads to a lower carrier concentration at the surface. The system tends to its initial stage by relaxation process, which gives low and steady decay of photocurrent [11].

The PC rise and decay for CdS and different CdZnS films are shown in fig. Maximum photocurrent was observed in the case of $Cd_{.8}Zn_{.2}S$. In the presence of $CdCl_2$, the maximum current was observed for a volume of 2 ml (0.001M).

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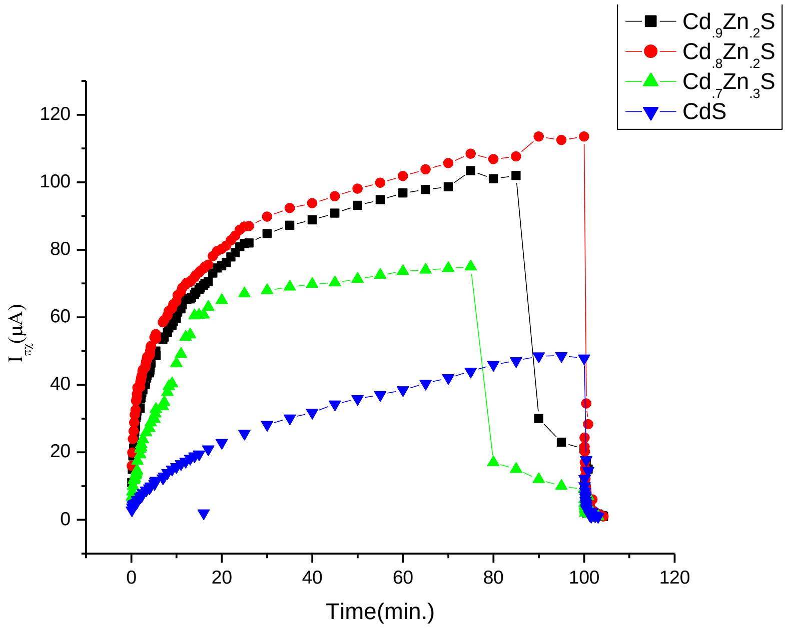

Figure 1 Photoconductivity study of CdZnS with variation of Zn content

Absorption study

The optical absorption edge is determined by the optical absorption method, which is simple and provides for the explanation of some features concerning the band structure of the films. The absorption spectra of these films is shown in Fig. It is clear from absorption spectra that the maximum absorption intensity obtained for $(Cd_{.8}$-$Zn_{.2})S$.

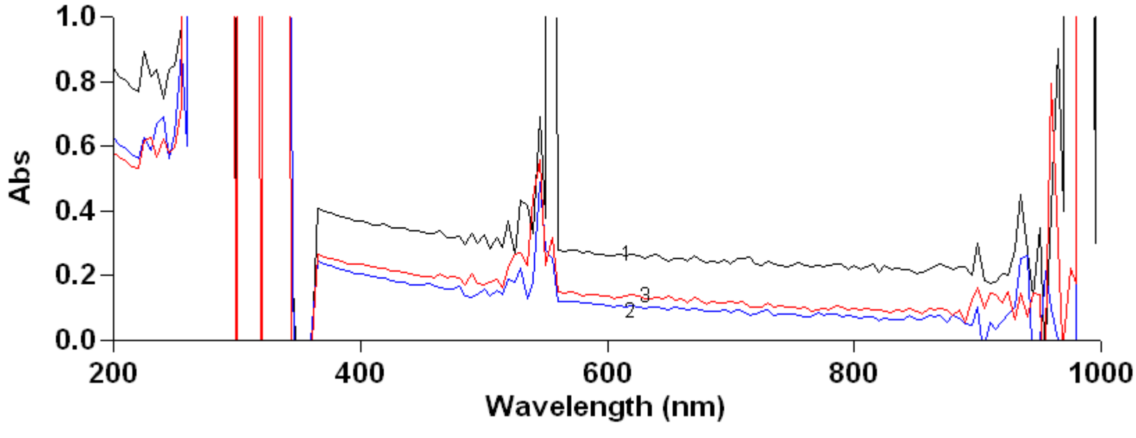

Figure 2 Absorption spectra (1) $(Cd_{.8}$-$Zn_{.2})S$ (2) $(Cd_{.7}$-$Zn_{.3})S$ (3) $(Cd_{.6}$-$Zn_{.})S$

The energy band gap for $(Cd_xZn_{1-x})S$:$CdCl_2$ (x=.6, .7, .8) films is shown in table-.

Film	E_g
CdS	2.8
$(Cd_{.6}$-$Zn_{.4})S$	2.92
$(Cd_{.7}$-$Zn_{.3})S$	3.0
$(Cd_{.8}$-$Zn_{.2})S$	3.09

$(Cd_xZn_{1-x})S$ thin films appear to be a material which has a direct band gap. It has been observed that the plots of $(\alpha h\nu)^2$ versus hυ are linear over a wide range of photon energies which are indicating the direct type of transitions. The intercepts (extrapolation) of these plots (straight lines) on the energy axis give the energy band gaps. The direct band gaps for all the films were determined. With increasing Zn content the energy band gap of $(Cd_xZn_{1-x})S$ thin film increases.

4. CONCLUSION

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. The

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optical absorption spectra of the films under study shows that the absorption spectra mechanism is due to direct transition. In conclusion we can state that the influence of Zn content on the optical properties of CdS thin films is noticeable. The PC rise and decay for CdS and different CdZnS films are shown in fig. Maximum photocurrent was observed in the case of $Cd_{.8}Zn_{.2}S$.

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