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Effect on Optical Properties of Aluminum/ Indium Doped Cds Thin Films Prepared by Spray Pyrolysis

Physics

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ABSTRACT

Thin films of Aluminum and Indium doped CdS are prepared by spray pyrolysis method. Spray pyrolysis is a simple and inexpensive method to prepare thin films on large area. From the transmittance studies of Aluminum and Indium in the form of AlCl3 and InCl3 doped CdS, the optical band gap (Eg) decreases. This result is in contradiction to the work of bodh et al who stated that addition of aluminum or Indium, no effect on optical band gap.

Introduction

The Socio-economic progress of nation has led to the increase of per capita energy consumption. Therefore the conventional energy sources are fast depleting one of the biggest problems to world about conventional energy source so there is an urgent necessary of alternate renewable energy sources for the survival of mankind. One such possible source is the solar energy. However for the varied energy need of man, the direct conversion of solar energy into electrical energy is highly desirable. This can be achieved by photovoltaic cells. Solar cells are used in satellites and space vehicle in their solar panels and even used in lightening of streets in some villages of India.

CdS is an important II-VI group compound semiconductor material. It has various useful applications in thin films devices [1-3]. The interest in optical properties was largely confirmed to the use of reflecting film in interferometry. To prepare thin films of desired properties, usually composite films are prepared.

In this paper we have reported effect on optical properties of Aluminum-doped CdS thin films prepared by simple, inexpensive spray pyrolysis method.

Experimental Details

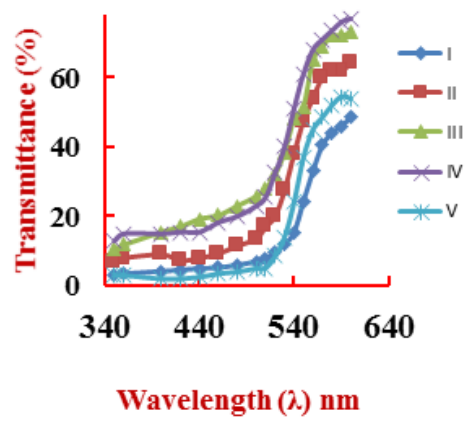
Aqueous solution of cadmium chloride, thiourea, Aluminum chloride and Indium tri-chloride were used for spraying the films. The molarity of each solution was 0.1 M. The chemical used was of AR grade. The temperature of the substrate was maintained at 300^0C, which was the most suitable temperature for the production of composite films CdS: Al_2O_3 thin films. Proportion of $CdCl_2$ and thiourea was adjusted 1:2.2 by volume in the spraying mixture so as to obtain CdS thin films. The excess sulphur was nacessory to obtain CdS thin films. The deposited films showed sulphur deficiency [4, 5] when the ratio of solution was taken 1:1 by volume.

Thickness of the films was 0.175 μm measured by weighing method and Michelson-interferometer. The colour of CdS thin films was deep yellow. When doping of $AlCl_3$ solution done, colour of the films becomes faint yellow.

Optical study

Optical absorption of the films was studied on UV-1800 Shimadzu Spectrophotometer at room temperature between wavelength 350 nm to 700 nm. Fig.1 shows the transmittance vs wavelength for different percentage of Aluminium and Indium.

Fig. 1 Wavelength vs Transmittance of (I) 10% Al in CdS, (II) 10% Al in CdS, (III) 5 % Al in CdS (IV), Pure CdS and (V) 10 % In in CdS thin films



The observations are recorded for five different samples i.e (I) 10% Al in CdS, (II) 10% Al in CdS, (III) 5 % Al in CdS (IV), Pure CdS and (V) 10 %. From the fig. 1 absorption coefficient (α) was determined at various wavelengths for all films by using the following relation,

$$\alpha = \frac{1}{t}\log\left(\frac{I_0}{I}\right) \quad (1)$$

Where,'t' is the thickness of the films. Io and I are the intensities of incident and transmitted radiation respectively. To obtain band gap plotting a graph between $(\alpha h\nu)^2$ vs hν shown in fig.2. From each curve when extrapolated makes five different intercept on the hν axis which gives values of optical band gap for the five different percentage of Aluminum deposited on CdS thin films are shown in table. 1

Fig.2 Show the graph between $(\alpha h\nu)^2$ vs hν for (I) 10% Al in CdS, (II) 10% Al in CdS, (III) 5 % Al in CdS (IV), Pure CdS and (V) 10 % In in CdS thin films

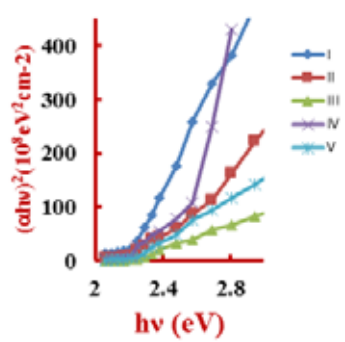


Table. 1 Variation Al and In in CdS thin films with Energy band gap

Sr. No	% of Al And In in CdS Solution	Eg (eV)
1	10 % Al	2.33
2	10 % Al	2.32
3	5 % Al	2.37
4	Pure CdS	2.47
5	10 % In	2.39

Result and Discussion

The optical energy gap for CdS films was found to be 2.47 eV. This value agrees with the value obtained by other workers [6-8]. When CdS is doped with aluminum, the value of forbidden energy gap changes slightly. It was observed with 10 % $AlCl_3$ solution in spraying liquid the band gap. While with 5 % $AlCl_3$ solution in the spraying liquid was found to be 2.37 eV. From this result we draw a conclusion that addition of $AlCl_3$ solution in spraying solution decreases the band gap. This result is in contradiction to the work of Bodh Raj et al [7] who states the addition of Al has no effect on band gap. When 10 % of $InCl_3$ is used in the spraying, the band gap is found to be 2.39 eV which is less than pure CdS band gap.

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