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## STUDY OF STRUCTURAL AND OPTICAL PROPERTIES OF CdSe AND DOPED CdSe ANNEALED THIN FILMS

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### Abstract

The Chemical bath Deposition technique (CBD) is used for the CdSe and CdRuSe thin film preparation. The formed films were annealed at 250°C under vacuum. The films were deposited on FTO glass plates. The obtained films were characterized by XRD, SEM/EDS and UV- visible spectrophotometer. XRD study reflects the hexagonal structure of CdSe and Ru doped CdSe. The doped films were further studied using SEM, which show the Perfect nature of doping material. The UV- visible study reflects the transmittance and band gap.

**Keywords:** - Chemical deposition, band gap, Grain size, optical properties etc.

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**Introduction:** - The CdSe films have been studied widely since its application in solar energy and optoelectronic devices.(1-3) In the area of chemical deposition, the spray pyrolysis(4),electrochemical deposition (5), Chemical bath deposition(6), and SILAR method(7,8) were used for the deposition of CdSe thin films. The thermal evaporation (9), laser ablation method (10) and electron beam evaporation technique(11), were used in physical deposition in vacuum for the deposition of CdSe thin films. The n-type cadmium selenide semiconductor(1.75eV) is important because of its wide application in solar energy and use in various fields like electrophotography devices, optoelectronics, light amplifiers,

photodetection etc. The research is done regarding the relative study of optical and structural properties of CdSe and Ru doped CdSe films (12-13) The Chemical bath deposition technique is economically viable and proved better than other.(14)

### Experimental details: -

The CdSe and Ru doped CdSe films used for the study were deposited using the Chemical bath deposition technique on FTO(Fluorine doped Tin oxide glass plates) Stock solutions of CdSO<sub>4</sub>(1M), sodium selenosulphite, NaOH(1M) & pure Triethanolamine were previously prepared and used. The NH<sub>3</sub> is used to maintain the P<sup>H</sup> of the solution to 10.5± 0.1.

Preparation of Pure CdSe thin films:- 10 ml CdSO<sub>4</sub> (1M) was taken in beaker & 5 ml TEA (Triethanolamine) was

added to it. To this solution 3 ml of NaOH (1M) and 20 ml Ammonia (14N) were added. The  $P^H$  of the solution was maintained to  $10.5 \pm 0.1$ . The total volume was made to 200 ml by adding distilled water. The reaction mixture was kept in oil bath containing FTO glass pieces (Size 75 mm $\times$ 25mm $\times$ 2mm) attached to the substrate holder. The temp of bath was maintained to 60 $^{\circ}$ C and rotations per minute of the remi rotor was nearly 70. The addition of sodium seleno sulphate was done externally during the rotation. To obtain quality films nearly 90 min. will be required.

Preparation of Ru doped CdSe thin films:-

The procedure opted for the preparation was similar to that used for formation of CdSe films in addition the Ru+3 in the form of RuCl<sub>3</sub> (0.008M) was added externally during stirring. Sodium seleno sulphite (0.025M) obtained by refluxing Selenium Powder (5g) with anhydrous sodium sulphite (12g) in 200ml distilled water for 9 hrs.(15)

The X-ray diffractogram was recorded using Bruker diffractometer (Cu K  $\alpha$  radiation) in  $2\Phi$  range of 20-80 $^{\circ}$ . Collected XRD -pattern were analyzed for qualitatively for phase identification. The optical absorption spectra were obtained in the wavelength range 200-800 nm by using Hitachi-330 double beam spectrophotometer at room temp. The Scanning electron microscopy

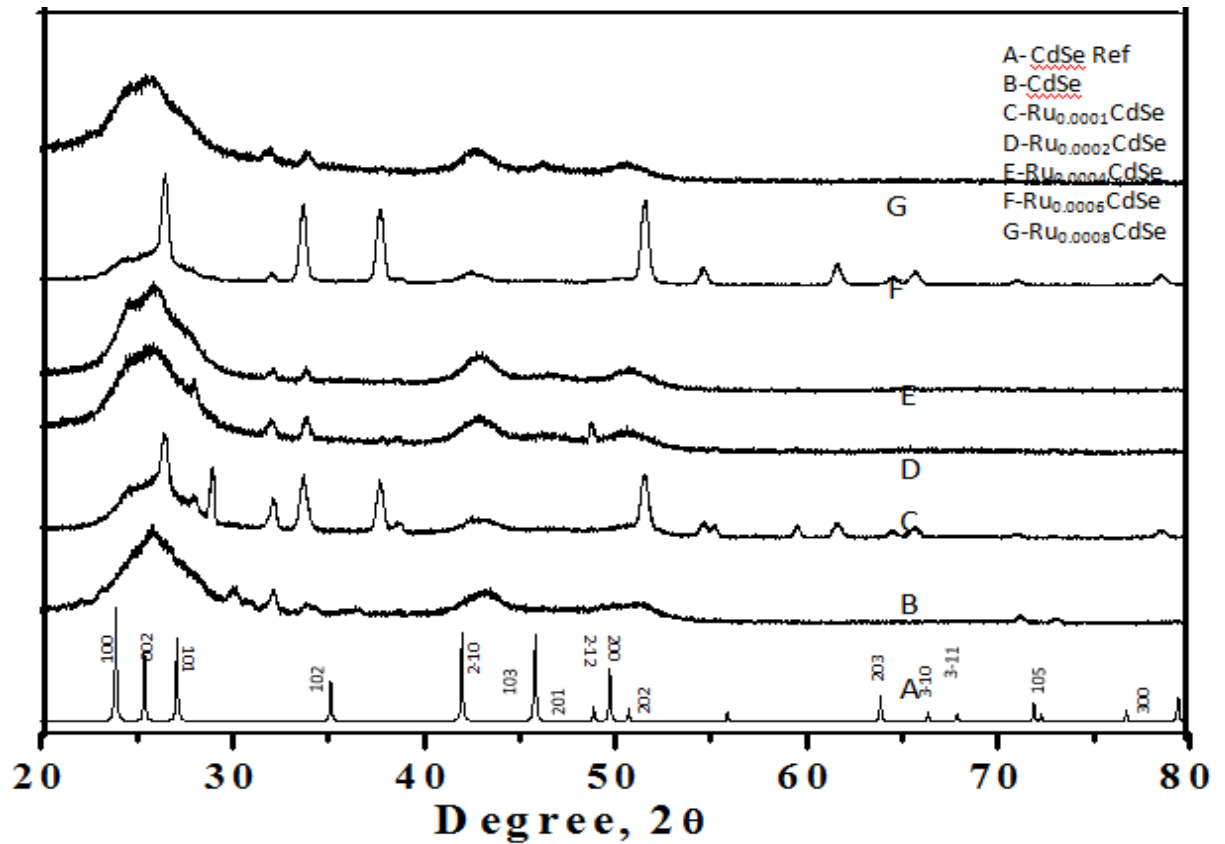
(SEM) was done for the surface morphology of the samples using Nova nano SEM NPEP 303.

#### The Optimum Condition For The Deposition Of CdSe :-

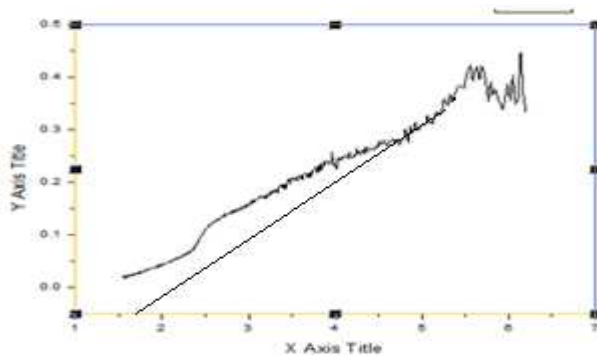
- 1) Deposition Temperature =  $55 \pm 2^{\circ}$ C
- 2) Speed of substrate rotation =  $70 \pm 2$  rpm.
- 3)  $P^H$  of the reaction mixture =  $10.5 \pm 0.1$ .
- 4) Deposition time = 90 minutes

#### Result and Discussion:-

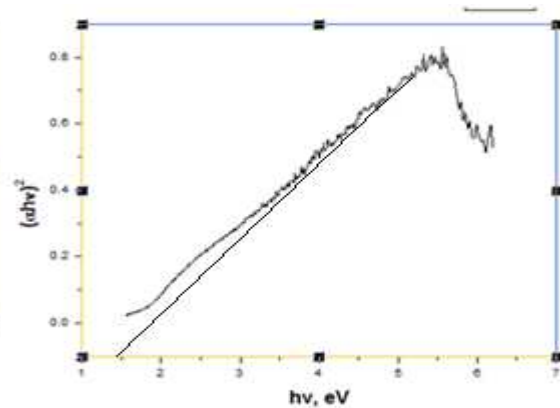
XRD pattern of various Ruthenium doped CdSe samples prepared in this study Viz, CS1((B), RCS1(C), RCS2(D), RCS3(E), RCS4(F), are shown in **fig 1**. Where A is the reference CdSe pattern. Reported by D. K. Freeman, S. L. Mair & Z. Bornea; Acta Crystallographica, Sec. A; 1977,33,35. 359. Comparison of XRD patterns of samples prepared in this study with the theoretical XRD pattern confirms crystallization of samples in hexagonal symmetry with space group p63mc. During the XRD data evaluation we found that the 100 reflection centered at the 23.88 $^{\circ}$ , 002 at 25.39 $^{\circ}$  & 101 at 27.10 $^{\circ}$  of CdSe is emerging as only one broad peak. The change in the lattice volume due to Ru doping cannot be tracked accurately using the present data.



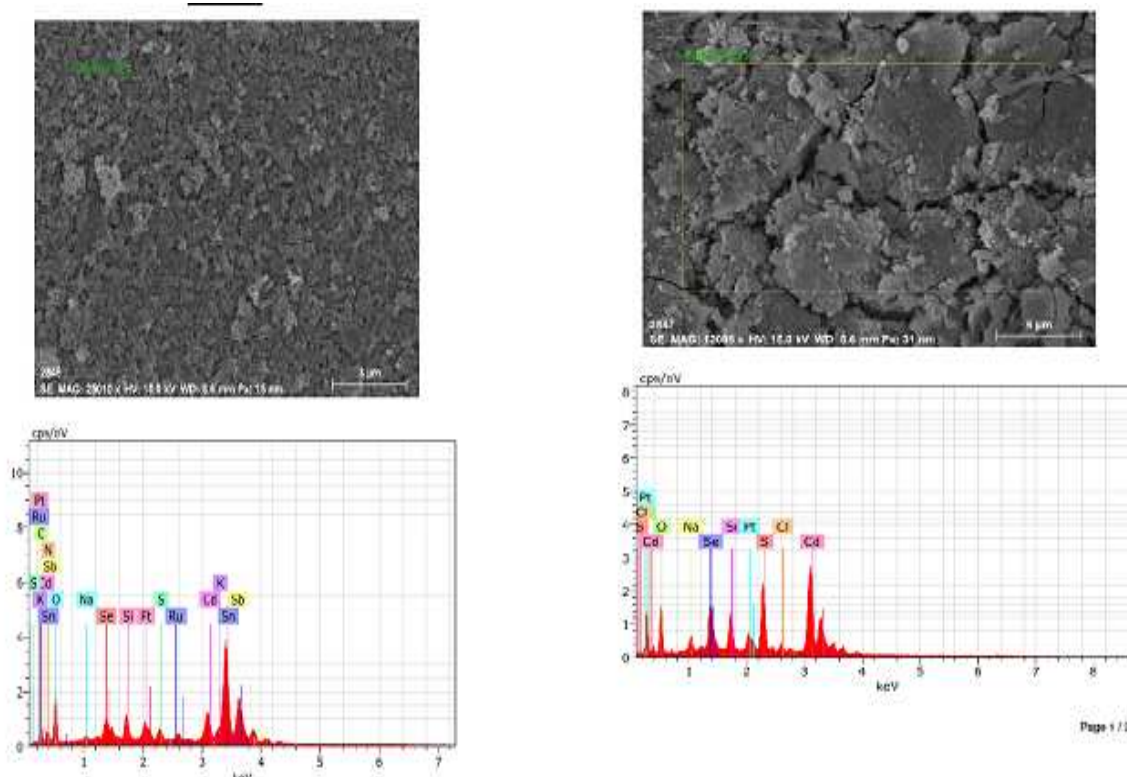
Optical properties have been studied for samples in the 200-800nm wavelength range. The band gap for pure CdSe as well as Ru doped CdSe films were estimated from the variation of  $(\alpha h\nu)^2$  vs  $h\nu$  curves. (8) From the calculation the energy band gap was found to be 1.75 eV for CdSe films.



**Fig.2.**  $(\alpha h\nu)^2$  vs  $h\nu$  of CdSe



**Fig.3**  $(\alpha h\nu)^2$  vs  $h\nu$  of Ru Doped CdSe films.



**Fig. 4** SEM/EDS of Ru doped CdSe

SEM/EDS of Pure CdSe

SEM (Scanning electron Microscopy) images were given in **Fig. 4** for pure CdSe and Ru doped CdSe annealed at 250°C under pressure in vacuum. The SEM images show the regular grain size of the CdSe material, good surface uniformity & high compactness. The fine particle size and narrow distribution of particles. Ru doping did not have a significant effect on the surface morphology of CdSe.

**Conclusion:** - Pure CdSe and Ru doped CdSe thin films were obtained by simple chemical bath deposition technique. The films were found to be stable

polycrystalline with hexagonal structure. The optical study reflects the band gap to be 1.75 eV. The small amount of Ru doping has been discussed in terms of substitutional dissolution of Ru<sup>+3</sup> ions in CdSe lattice.

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