Effect of indium doping on the structural and morphological properties of CdSe thin films

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Abstract

Semiconductiong CdSe and indium doped CdSe (In:CdSe) thin films have been synthesized on stainless steel and fluorine doped tin oxide coated glass substrates in an aqueous medium using potentiostatic mode of electrodeposition. The doping concentration of indium has been optimized to 0.15vol% using reliable photoelectrochemical technique. The structural and morphological studies of undoped CdSe and 0.15vol%In:CdSe thin film were carried out using X-ray diffraction and field emisssion scanning electron microscopy.

Keywords: CdSe, Photoelectrochemical, Indium doping, Morphology, XRD.

1. Introduction:

CdSe is a one of the most versatile II-VI semiconductors with band gap (1.7eV) near to visible spectrum maxima. Because of high absorption coefficient, direct band gap, size dependant physical and chemical properties, intrinsic birefringence and luminescent properties it has earned recognizable attention of researchers. These properties promote use of CdSe in various applications as solar cell [1-3], thin film transistor [4], light emitting diode [5], γ-ray detector [6] etc. CdSe thin films have been grown by diverse physical and chemical techniques

Researchers have been trying to alter chemical and physical properties of CdSe material using different techniques to explore its further potential. Doping is one of the ways to alter the optical as well as electrical properties in semiconductor materials [7]. Especially in Photo electrochemical (PEC) cell lower performance of photoanode is attributed to higher values of band gap and electrical resistivity that could be efficiently reduced by doping it with suitable impurity. The performance of CdSe thin film has been enhanced in various applications via doping it with suitable dopant materials.

As doping with trivalent indium is found to enhance conductivity, decrease band gap and also to improve performance of PEC cell significantly thus we have chosen indium as a dopant in synthesis of cadmium selenide thin films. Amongst the various deposition techniques, electrodeposition is simple, economic and low cost technique. By this technique, films can be grown over large area with high scalability, without vacuum and at room temperature [8]. Thus electrodeposition technique was selected for thin film deposition purpose.

The aim of current study is to inspect the influence of volumetric indium doping on structural properties and morphology of electro synthesized CdSe thin film.

2. Experimental details:

2.1 Deposition of CdSe and In:CdSe thin films.

Thin film synthesis was carried out using a three electrode cell with graphite bar (60mm×13mm×4mm) as a counter electrode, saturated calomel electrode (SCE) as a reference electrode and substrate as a working electrode.

All the chemicals used for synthesis ($3CdSO_4.8H_2O$, SeO_2 and $InCl_3$) were analytical reagent grade. Double distilled water was used for preparation of all precursor solutions. With the intention to obtain more photosensitive electrodeposit, a PEC method is used to optimize preparative parameters of CdSe thin film[9]. For this purpose, the PEC cell was fabricated using two electrode configuration, with CdSe as photoanode and graphite as counter electrode. 1M polysulfide (1M NaOH- 1M Na_2S- 1 MS) was used as redox electrolyte. The performance of PEC cell was studied in dark and under illumination intensity 50mW/cm^2.

2.1.1 Deposition of CdSe thin film.

During preparation of CdSe thin film, initially the selenium precursor concentration was varied from 0.1 to 0.0005M keeping the cadmium concentration fixed to 0.05M. Fig. 1 shows variation in Jsc and Voc as a function of selenium precursor concentration at fixed cadmium precursor concentration (0.05M). It is seen that values of Jsc and Voc are increases with increase