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Photoelectrochemical studies on electrodeposited indium doped CdSe thin films using aqueous bath

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ABSTRACT

Present investigation describes the photoelectrochemical studies of electrosynthesized CdSe and indium doped CdSe (In:CdSe) thin films deposited on stainless steel (SS) substrates. The photoelectrochemical (PEC) studies of both films are carried out with CdSe and In:CdSe(SS)/1 M Polysulfide/C cell. It is observed that indium doping in CdSe enhances the fill factor from 0.56 to 0.63 and photo-conversion efficiency from 0.80% to 2.01%. In order to study the consequence of doping, undoped and indium doped CdSe thin films are further characterized by capacitance-voltage, electrochemical impedance spectroscopy (EIS), spectral response, transient response, speed of response characterization techniques. By using capacitance-voltage measurement, various physical parameters are estimated and accordingly energy band diagrams have been constructed.

1. Introduction

The brisk growth of the world's energy demand from last several decades has brought substantial attention towards the energy scarcity problem [1]. To accomplish this ever-increasing energy demand mankind has been focused towards emerging renewable energy sources such as solar, nuclear, wind, tidal energy etc. Amongst these various renewable sources, solar energy is one of the best substitutes owing several rewards such as pollution free, abundantly available, inexhaustible and permanent source of energy. So, the nonstop conversion of solar energy into electrical energy is essential so as to accomplish the energy need of the present world. It is well known that photovoltaic devices are useful for solar energy conversion. These devices use p-n junction for direct conversion of solar energy into electrical energy. Due to simplicity in junction fabrication and inbuilt storage capacity, semiconductor liquid junction cells have attracted a great deal of interest over p-n junction solar cell [2]. The heart of efficient solar cell is photoelectrode (photocathode/photoanode) material, so appropriate selection of it is a crucial thing. The prime necessity while choosing photoelectrode material is its band gap energy, which should expected to be positioned very close to visible spectrum maxima so as to make competent use of the solar energy spectrum. In this view, II–VI semiconductors have been a center of attention point because of sharp absorption edges, direct band gaps and higher absorption coefficient [3,4]. Cadmium selenide (Eg = 1.7 eV) is one of the binary semiconductors from II-VI group which has fascinated attention of many researchers due to its interesting properties and wide range of applications [5–10]. Various chemical and physical methods have been employed for synthesis of CdSe thin films [11–16]. Increased optical absorption, decreased band gap plus resistivity of a photoelectrode material facilitate to achieve better and efficient performance in solar cell application. This can be done by doping photoelectrode material by suitable dopant like indium [17–24].

In the present investigation, the photoelectrochemical modifications arisen due to indium doping in potentiostatically electrosynthesized CdSe thin films are inspected. Further the effects of indium doping on the capacitance-voltage, band bending, electrochemical impedance spectroscopy, spectral response, speed of response and transient response characteristics of undoped and indium doped CdSe thin films is studied.

2. Experimental details

2.1. Synthesis of CdSe and indium doped CdSe (In:CdSe) thin films

The CdSe and In:CdSe thin films were potentiostatically electrodeposited on mirror polished stainless steel (5 cm × 1 cm × 0.05 cm) and fluorine doped tin oxide (FTO) coated glass substrates (sheet resistance = 15 Ω) using three electrode cell. The cell was composed of three electrodes using substrate as a working electrode, graphite as a counter electrode and saturated calomel electrode as a reference electrode. All

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