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Research Paper

XPS,EDAX and FT-IR Analysis of Annealed Electron Beam Evaporated Cdse Thin Films

Physics

KEYWORDS : CdSe films; electron beam evaporation; annealed;EDAX;XPS;FT-IR

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ABSTRACT

Cadmium selenide (cdse) thin films on glass substrates were prepared by electron beam evaporation technique at various substrate temperatures and annealed at room temperature (RT), 100, 200 and 300 o C respectively. Elemental and compositional analysis were accomplished using, Energy dispersive analysis of X-ray (EDAX), and X-ray photoelectron spectroscopy (XPS) .The CdSe films were characterized by Fourier transform infrared spectroscopy (FTIR).

INTRODUCTION

Semiconductor nanocrystalline materials have been deeply investigated in the last decade because of their application in many areas of research. Semiconductor nanocrystallites physical and chemical properties are found to be strongly size dependent [1-4]. Nanocrystalline semiconductors have been used in electronic, optoelectronic and solar energy conversion devices. CdSe is a direct band gap material belonging to II-VI group, possessing excellent optoelectronic properties. It is used as an n-type window layer material in thin film solar cells and it is the suitable candidate for photovoltaic applications [5-7].

The deposition of CdSe thin films was made using different deposition methods such as, thermal evaporation [8], pulsed laser deposition (PLD) [9], electrodeposition [10], spray pyrolysis [4], successive ionic layer adsorption and reaction (SILAR) [11] and chemical bath deposition (CBD) [12, 13]. Among these methods, EBE is one of the most promising methods for making high quality thin films for photovoltaic applications because it is an efficient and reasonably cost effective method.

CdSe films have been prepared by EB evaporation technique at room temperature and annealed at different temperatures were characterized by Energy dispersive analysis of X-ray (EDAX), and X-ray photoelectron spectroscopy (XPS) .The CdSe films were also characterized by Fourier transform infrared spectroscopy (FTIR). The results are presented and discussed in detail.

MATERIALS AND METHODS

Dry CdSe powder was shaped into pellets,taken in a graphite crucible and kept in water cooled copper hearth of the electron gun (Hind Hivac electron beam evaporation unit). The pelletized CdSe targets were heated by means of an electron beam collimated from the dc heated tungsten filament cathode. The surface of the CdSe pellet was bombarded by electron beam with an accelerating voltage of 5 kV . The evaporated species from CdSe pellet were deposited as thin films on glass substrates at different substrate temperatures in the range RT – 300 °C under a vacuum of 10^{-6} Torr . The different preparation parameters such as source to substrate distance (15 cm) and partial pressure (10^{-6} Torr)have been varied and optimized for depositing uniform, well adherent and transparent films. The elemental composition was found using an energy-dispersive X-ray (EDX) spectrometer attached with the HITACHI Model S-3000H SEM instrument.), and X-ray photoelectron spectroscopy (XPS) .The CdSe films were characterized by Fourier transform infrared spectroscopy (FTIR).

RESULTS AND DISCUSSION

1. ELEMENTAL AND COMPOSITIONAL ANALYSIS

The presence of the constituent elements in the EB deposited and annealed CdSe films and their composition percentage play an important role in modifying their materials properties. EDAX and XPS analysis have been carried out and the results are presented for the CdSe films deposited and annealed at various temperatures in this section.

1.1 Compositional Analysis by EDAX Results

The presence of Cd and Se elements in the evaporated films deposited at different substrate temperatures of RT, and annealed at 100, 200 and 300 oC were studied by EDAX analysis. The corresponding EDAX spectra are shown in Fig. 1.1 a, b, c and d. All the films are found to be nearly stoichiometric but a slight excess of Cd has been observed. The Cd excess may be due to its higher sticking coefficient compared to

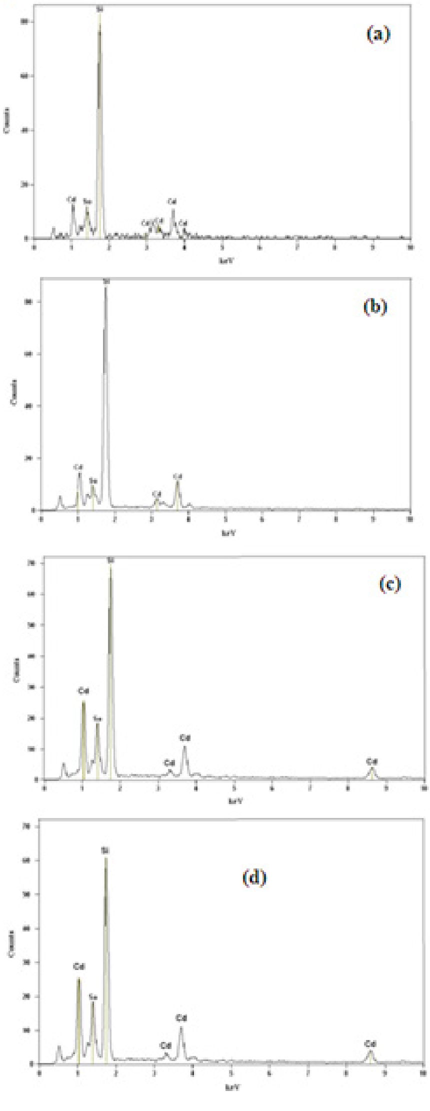

Fig. 1.1. EDAX spectrum for the CdSe films deposited at (a) RT and annealed at (b) 100, (c) 200 and (d) 300 oC

that of Selenium, when they are deposited under high vacuum and higher substrate temperature Velumani et al [14]. But, CdSe films deposited by electrochemical route contained selenium excess as reported by Tomkiewiez et al [15] and Skyllas Kazcos and Miller [16] which is attributed to the mobility of selenium atom than cadmium atom leading to the incorporation of selenium content in the electrodeposited CdSe films.

0.2 Elemental Analysis by XPS

Elemental and chemical state of Cd and Se present in the CdSe films were analyzed by X-ray photoelectron spectroscopy (XPS) results. The survey scan and narrow scan of Cd and Se of CdSe film annealed at 200 oC is shown in Fig.1. 2 a, b and c respectively.

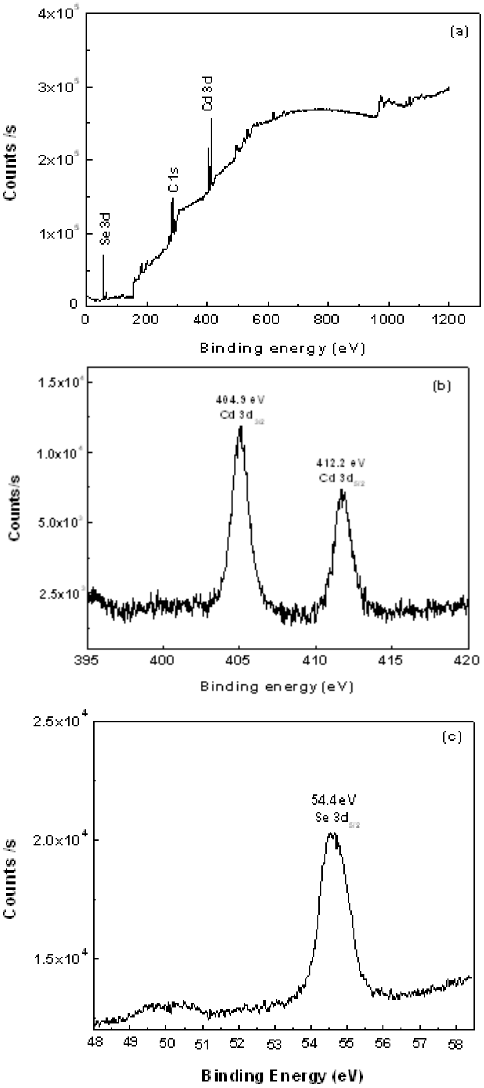

Fig.1. 2 XPS spectra of CdSe film annealed at 200 oC (a) survey scan and (b) narrow scan of Cd and (c) narrow scan of Se

The two strong peaks at 412.2 and 404.9 eV correspond to Cd $3d_{3/2}$ and Cd $3d_{5/2}$ binding energies. The peak at 54.4 eV, measured in the Se energy region is attributed to the Se 3d transition. The binding energies for Cd and Se are in good agreement with the reported values [17]. No significant variation was observed in the XPS spectra with variation of substrate temperature. Hence CdSe film deposited and annealed at 200 oC substrate temperature only showed in Fig.1.2. Further, these peaks confirm the presence of Cd and Se in Cd^{2+} and Se^{2-} states respectively. No other peaks related to other states observed, which confirms the high quality of the CdSe films prepared in the present study.

2. FT-IR ANALYSIS OF CdSe FILMS

The CdSe films EB evaporated at RT, and annealed at 100, 200 and 300 oC were characterized by FT-IR spectral studies. The corresponding FT-IR spectra with %T are shown in Fig. 2.a, b, c and d respectively. The bands observed at 2356,1275, 669, 572, cm^{-1} are the finger print spectral peaks of CdSe film formation. These peaks show increasing %T intensities with increasing substrate temperature. This observation shows the increased crystalline nature of the EB evaporated films. Further, there is no absorption in the spectral region 2500 – 3500 cm^{-1}, which confirms the purity of the CdSe films without any moisture and contamination from vacuum pump oil.

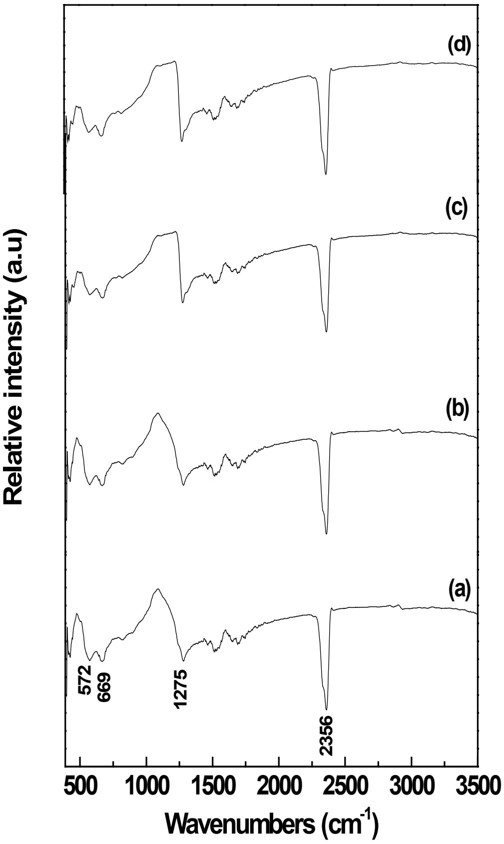

Fig.2. FT-IR spectrum for the CdSe films deposited at (a) RT and annealed at (b) 100, (c) 200 and (d) 300 oC

CdSe thin film deposited and annealed at 200 oC using EB evaporation technique show that the formation of high quality CdSe films with nano grain size distribution was revealed by FT-IR were supported by other data by XPS and EDAX analysis.

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