Structure and Optical Properties of Cdse:Ga Thin Films Prepared by Thermal Evaporation Method

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Abstract

Cadmium Selenide (CdSe and CdSe:Ga) alloy has been prepared successfully in an evacuated quartz tube at a pressure (10^{-2} Torr). The structure of the CdSe alloy (powder) was tested by X-ray diffraction (XRD) and found as a polycrystalline (hexagonal) structure. CdSe and CdSe: Thin films have been deposited with a thermal evaporation process on the glass and Si substrates. The aim of this kind of study was to determine the ultrastructural morphology and optical properties of pure CdSe and Ga doped films produced using a method of thermal evaporation. The effect of Gallium on the structural and optical properties of CdSe thin film were doped at 0, 1, 3 and 5%. For all Ga doping ratios, the structural features such as the size of the grain and the micro strain of the thin film have been clarified with XRD technique and XRD pattern. The chosen orientation (002) for all prepared film has been polycrystal structures (hexagonals). With an increase in Ga from 37,54 to 21,37 nm, the grain volume decreases. AFM and SEM were used to study the morphology and surface roughness of the CdSe pure and doping films. All films were homogeneous with a characteristic spherical grain size depending on Ga concentration. The roughness of the films increases with the increase of Ga dopant. UV-Visible spectra photometer is used to investigate the visible properties such as absorption, absorption coefficient and energy gaps in thin films. The absorption value subsequently increased with Al doping concentration of localized states in the band gap of the films increases with the increasing of Al dopant, where optical energy gap values decreased with increasing the proportion of the doping in the range between 1.74 and 1.62. The grain size for pure and Ga- doped CdSe of thin films were decreased with Ga ratios. The absorption coefficient determined depends on photon energy incident (hv), the energy gap of the semiconductor as well as the form of transitions. In conclusions, CdSe and CdSe:Ga were successfully prepared from pure elements Cd, Se and Ga. XRD patterns showed the CdSe and CdSe:Ga films are polycrystalline of hexagonal structure directions by Ga doping that orientated a peak became less intensity from undoped CdSe film. The XRD patterns and AFM measurements of Ga-doped and undoped CdSe thin films agree with each other of the grain size within nanocrystal range and decrease as Ga doping concentration increases. AFM images indicate that the increasing in Ga doping that showed smooth surface films compared to the CdSe films. The optical bands gaps of the films have a direct band transition and slightly decreased with the increasing Ga doping.

Keyword: CdSe, Ga, Thin films, XRD, AFM, Optical properties.

1. Introduction: Due to their large absorption coefficients, the optical band gap 1.74 eV at room temperature and high photosensitivity, cadmium selenide (CdSe) is a promising material for the thin films with the compound II-VI semiconductors. [1, 2]. Usually, CdSe is a n-type material which has an interested for their applications as photoconductors [3], solar cells [4,5], thin film transistors [6,7], gas sensors [8.9]. The preparation of CdSe thin films there are different methods have been used such as pulsed laser deposition technique [10], thermal evaporation technique [11], spray deposition [12], electrodepostion [13], chemical bath deposition [14], molecular beam epitaxy (MBE) [15]. A higher