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Investigation of structural and optical properties of 100 MeV F^{7+} ion irradiated $Ga_{10}Se_{90-x}Al_x$ thin films

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Present work focuses on the effect of swift heavy ion (SHI) irradiation of 100 MeV F^{7+} ions by varying the fluencies in the range of 1×10^{12} to 1×10^{13} ions/cm^2 on the morphological, structural and optical properties of polycrystalline thin films of $Ga_{10}Se_{90-x}Al_x$ ($x = 0$, 5). Thin films of ~300 nm thickness were deposited on cleaned Al_2O_3 substrates by thermal evaporation technique. X-ray diffraction pattern of investigated thin films shows the crystallite growth occurs in hexagonal phase structure for $Ga_{10}Se_{90}$ and tetragonal phase structure for $Ga_{10}Se_{85}Al_5$. The further structural analysis carried out by Raman spectroscopy and scanning electron microscopy verifies the defects or disorder of the investigated material increases after SHI irradiation. The optical parameters absorption coefficient (α), extinction coefficient (K), optical band gap (E_g) and Urbach's energy (E_U) are determined from optical absorption spectra data measured from spectrophotometry in the wavelength range 200–1100 nm. It was found that the values of absorption coefficient and extinction coefficient increase while the value of optical band gap decreases with the increase in ion fluence. This post irradiation change in the optical parameters was interpreted in terms of bond distribution model.

Keywords: thin films; chalcogenides; swift heavy ion irradiation; optical band gap; Urbach's energy

1. Introduction

The binary composition of group III metal (Ga, In, TI) and group VI chalcogenide (S, Se, Te) shows great diversity of properties having potential applications in the field of optoelectronics. Moreover, the most unique structural feature of GaSe is the existence of layers in which the each layer consists of four atomic planes in the following sequence Se-Ga-Ga-Se. The intralayer bonds are very strong mostly covalent in nature, whereas interlayers are bonded together by weak van der Waal's interaction. GaSe is an indirect band gap semiconductor [1] mostly used in various optoelectronic devices such as solar cells [2], photodiodes and photoresistors [3], IR detector [4] and electrodes in electrochemical lithium cells [5]. The main focus of this study is on photovoltaic solar cell application of compound semiconductors. In case of photovoltaic solar cells, the direct conversion of incident light into electric current takes place by p-n or p-i-n semiconductor junction devices. This conversion efficiency of broad incoming spectrum into

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