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Annealing and laser irradiation effects on optical constants of $Ga_{15}Se_{85}$ and $Ga_{15}Se_{83}In_2$ chalcogenide thin films

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ABSTRACT

Chalcogenide thin films finds extensive applications in optical imaging, optical recording, integrated optics, optical communications and microelectronics. Optical constants (absorption coefficient, refractive index and extinction coefficient) of amorphous, thermally annealed and laser irradiated $Ga_{15}Se_{85}$ and $Ga_{15}Se_{83}In_2$ thin films deposited by thermal evaporation onto chemically cleaned glass substrate, were calculated from absorbance and reflectance spectra as a function of photon energy in the wavelength region 400–900 nm. Analysis of the optical absorption data shows that the rule of non-direct transitions predominates. It has been found that the absorption coefficient increasing with increasing the exposure time of laser irradiation and also by increasing photon energy. The optical band gap decreases with increasing annealing temperatures. The refractive index (n) decreases, while the extinction coefficient (k) increases with increasing annealing temperature. The laser irradiated thin films showed a decrease in optical band gap and absorption coefficient with increasing exposure time of laser irradiation. The values of refractive index (n) increases and extinction coefficient (k) decreases with increasing exposure time of laser irradiation. The results have been analyzed on the bases of thermal annealing and laser irradiation effects in the chalcogenide thin films.

1. Introduction

Chalcogenide thin films have attracted much attention and has been systemically studied over the last three decades. They continue to attract the vivid interest of both experimental and theoretical work in view of their fascinating properties. A major advantage of chalcogenide thin films pertains to the controlled response to external stimuli such as laser irradiation, heat treatment etc, which renders them suitable for many advanced applications such as optical data storage, optical sensors, fiber amplifier, ultrafast optical switches, optical computing etc. [1–3]. Optical absorption measurements are used to obtain the band structure and the energy gap of binary and ternary chalcogenide thin films, because the analysis of the optical absorption spectra is one of the most productive tools for understanding and developing the energy band diagram of both crystalline and amorphous materials. Due to the technological importance, the optical properties of chalcogenide thin films have been subjected to a lot of investigations [4–8]. In recent years, efforts are being made to develop chalcogenide based erasable optical storage media. Thermal processes are known to be important in inducing crystallization in semiconducting chalcogenide glasses. The optical storage based on the amorphous–crystalline phase transition utilizes the large optical reflectivity and optical absorption changes obtained in some semiconductors-semimetal thin films by heat treatment or laser irradiation [9]. Laser induced changes in amorphous chalcogenides are an object of systematic investigations with a view to better understanding the mechanism of the phenomena taking place in them as well as their practical applications. In the production of flat panel displays, laser crystallization increases the carrier mobility in thin film transistors. A lot of research work [10–17] is going on the effect of laser irradiation, annealing, ultraviolet irradiation, γ-irradiation etc on optical properties of amorphous thin films.

In the present research work, the effect of heat treatment and laser irradiation on optical constants of $Ga_{15}Se_{85}$ and $Ga_{15}Se_{83}In_2$ chalcogenide thin films have been studied by analyzing the absorption and reflection spectra in the spectral range of 400 nm–900 nm. We have used Se as a major content because of its wide commercial applications in many industrial fields, such as

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