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Optical Properties of Thin Films of $Ga_{15}Se_{75}Ag_{10}$ Chalcogenide Glasses Before and After Laser Irradiation

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Thin films of chalcogenide glasses of $Ga_{15}Se_{75}Ag_{10}$ with thickness 4000 Å were prepared by thermal evaporation technique. The amorphous nature of $Ga_{15}Se_{75}Ag_{10}$ glasses and thin films was verified by Differential Scanning Calorimeter (DSC) and X-ray diffractometer. The surface microstructure of amorphous and laser irradiated thin films were examined by scanning electron microscope (SEM). The changes in optical properties due to the influence of laser radiation on amorphous thin films of $Ga_{15}Se_{75}Ag_{10}$ glassy alloy were calculated from absorbance spectra as a function of photon energy in the wave length region 300–900 nm. Analysis of the optical absorption data shows that the rule of non-direct transitions predominates. It has been observed that laser-irradiation of the films leads to a decrease in optical band gap while increase in absorption coefficient and extinction coefficient. The decrease in the optical band gap is explained on the basis of change in nature of films, from amorphous to polycrystalline state.

Keywords: Chalcogenide Thin Films, X-Ray Diffraction, Optical Band Gap, Absorption Coefficient, Laser-Irradiation.

1. INTRODUCTION

The study of the optical absorption spectra in chalcogenide glasses provides essential information about the band structure and the energy band gap. Recent applications of chalcogenide glasses in the field of optics include the optical imaging, optical data storage, integrated optics and infrared optics due to their excellent transmittance reaching the far–infrared spectral region effects.[1] The optical behavior of amorphous Se[2–3] changes with alloying with other elements. Among Se-based glasses, metal chalcogenide offers a range of optical band gaps suitable for variety of optical and optoelectronic applications.[4] Today, research on optical properties of materials draws on not only physicists, who used to be the usual traditional researchers in this field, but also scientists and engineers from widely different disciplines.

It is well established that chalcogenide glasses undergo structural changes under the action of external influences such as laser,[5] neutron,[6–7] electron and gamma irradiation.[8–11] 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. 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. Irradiation of chalcogenide glasses may cause displacement of atoms from their lattice sites and ionization or excitation of the electrons of atoms and hence change the physical properties of the materials they pass through depending upon the radiation energy and the dose. Although the effect of gamma irradiation on thermal[9, 11–14] and optical[8, 15–18] properties of chalcogenide glasses has been widely studied, yet less attention has been devoted to the effect of laser irradiation on the optical behavior of chalcogenide glasses.

The present communication reports the effect of laser irradiation on optical properties of amorphous thin films of $Ga_{15}Se_{75}Ag_{10}$ chalcogenide glass. There has been a growing interest in the synthesis and characterization of selenides due to their unique properties in electronics, magnetism and optics, and also wide applications in various fields such as sensors, laser materials, solar cells, infrared detectors, and thermoelectric cooling