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Morphology and Optical Properties of Thin Films of Ga_xSe_{100-x} Nanoparticles

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Measurements of optical constants of thin films of Ga_xSe_{100-x} nanoparticles with $x = 3, 6, 9$ and 12 have been made in a wavelength region 400–900 nm. The experimental results show that the optical absorption follows the rule of indirect transition. The optical band gap and optical constants of thin films have been studied as a function of photon energy. It has been observed that the optical band gap increases with an increase in the Ga concentration in Ga-Se system while, the refractive index, extinction coefficient, real part of dielectric constant and imaginary part of dielectric constant decreases.

Keywords: Chalcogenides, Nanoparticles, Thin Films, Optical Band Gap, Optical Constants, X-Ray Diffraction Pattern, SEM, TEM.

1. INTRODUCTION

Despite being studied for several decades, chalcogenides continue to attract considerable interest and serious research efforts in this direction have been made due to the interesting effects they exhibit.[1,2] Chalcogenide glassy semiconductors have drawn attention of researchers and engineers as a very large group of interesting solids in which unusual physical and chemical phenomena are revealed and as the materials that open new ways in engineering and technology. They are successfully applied in infrared optical engineering, television (camera tubes) and xerography. These materials are of extraordinary importance for technological applications mainly due to their special electronic and optical properties. In particular, when chalcogenide materials are fabricated at nano-scale, their density of electronic states will change in a systematic manner, which strongly influences the optical and electronic properties of the materials.[3–4] Compared with the bulk material, the nano-size semiconductor particles exhibit some unique properties such as nonlinear optical properties,[5–6] quantum size effect[7] and other important physical and chemical properties.[8–9]

A great deal of research into the physics and chemistry of binary and ternary chalcogenides during the past decade has led to a more complete understanding of these materials. This progress has been made possible due to significant advances in material preparation techniques. In recent years, the amorphous chalcogenide thin films have attracted much attention as an advanced and replaceable material due to their interesting electrical, optical and thermal properties.[10–11] Moreover, their potential applications in both mesoscopic and nanoscale research are also demanding. Considerable efforts have been devoted to the synthesis and characterization of nanoscale materials due to their importance in the development of nanotechnologies.[12–17] Their attractive physical properties enable them to play a major role in nanoscale devices. One of the present challenges in materials science is the production of materials at nanometric scale with controlled composition and structure, as the nanometric size can lead to the novel properties. Still the nanoparticles of chalcogenides are not well studied and only few papers are published in this field,[18–21] therefore, there is a lot of scope for the studying these materials at nanoscale. Several workers[22–26] has prepared amorphous and polycrystalline nanoparticle by using several techniques. Therefore, the aim of the present work is to synthesize nanoparticles of amorphous Ga_xSe_{100-x} using physical vapor condensation technique and to study the morphological and optical properties of these nanoparticles.

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