Influence of annealing temperature on the structural and optical properties of As30Te70 thin films

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Abstract:

Chalcogenide glasses have attracted much attention largely due to their interesting physical and chemical properties. Though few published articles exist on the As-Te system, little is known about the optical properties of eutectic or near eutectic composition of As-Te system upon heat treatment. Therefore, this paper reports the effects of annealing temperature on the structural and optical parameters of As30Te70 thin films. The bulk and thin films of 150 nm thick As30Te70 chalcogenide glasses were prepared by melt-quenching and thermal evaporation techniques, respectively. The glass transition and crystallization reactions of the bulk samples were investigated using differential scanning calorimetry (DSC). The influence of annealing temperature on the transformation of the crystal structure was studied by X-ray diffraction (XRD), while the surface morphology of the annealed samples was examined using scanning electron microscope (SEM). The optical band gap, refractive index and extinction coefficient were also calculated. The DSC scans showed that the melting temperature remains constant at 636.56 K. In addition, other characteristic temperatures such as the glass transition temperature, the onset crystallization temperature, and the crystallization peak temperature increase with increasing the heating rate. The crystalline phases for the as-prepared and annealed films consist of orthorhombic As, hexagonal Te, and monoclinic As2Te3 phases. Furthermore, the average crystallite size, strain, and dislocation density depend on the annealing temperature. The optical absorption results revealed that the investigated films have a direct transition, and their optical energy gap decreases from 1.82 eV to 1.49 eV as the annealing temperature increases up to 433 K. However, the refractive index, extinction coefficient, dielectric constant and the ratio of free carrier concentration to its effective mass, increase with increasing the annealing temperature.

Keywords:

chalcogenide glasses; As-Te system; thin films; structural, optical parameters; thermal evaporation

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