Influence of composition on optical and electrical properties of Ge-Se-In thin films

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Abstract:

The optical properties of as-deposited GexSe92-xIn8 (x = 10, 12.5, 15 and 20 at%) have been studied. Various optical constants have been calculated for the studied compositions. The mechanism of the optical absorption follows the rule of non-direct transition. It was found that, the optical energy gap (Eg) decreased with increasing Ge content. This result can be interpreted on the basis of the chemical-bond approach proposed by Bicermo and Ovshinsky. The values of the refractive index (n) and the extinction coefficient (k) increased with increasing Ge content. Annealing of Ge12.5Se79.5In8 films at temperature higher than the glass transition temperature was found to decrease the optical energy gap. Electrical conductivity was measured in the temperature range (300-450 K) for the studied compositions. The effect of composition on the activation energy (\(\Delta E\)) and the density of localized states at the Fermi level \(N(\text{EF})\) were studied. The electrical conductivity measurements show two types of conduction channels that contribute two conduction mechanisms. On the other hand, the electrical resistivity and the activation energy were found to decrease with increasing the annealing temperature. Transmission electron microscope (TEM) investigation indicates the separation of crystalline phase after annealing at the temperatures higher than the glass transition. The results were discussed on the basis of amorphous crystalline transformations.

Keywords:

Chalcogenide glasses; Thin films; Activation energy; Electrical conductivity; Crystallization; Annealing; Extinction index; Refractive index; Chemical bonds; Energy gap; Absorption spectra; Optical constants; Localized states; Chemical composition

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