Study the effects of annealing temperature on some optical properties of Se:2%As thin films

*G. H. Mohammed

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Abstract:

The optical gap (E_{opt}) and tailing(ΔE) for Se:2%As thin films prepared by vacuum evaporation as a function of annealing temperature are studied in the photon energy range (1.0 to 5.4) eV. Thin film of Se:2%As was found to be indirect gap with energy gap of (1.978 , 2.082 , 2.120 , 2.230) eV at annealing temperature (295 , 370 , 445 , 520)K respectively.

The E_{opt} and ΔE of Se:2%As films as a function of annealing temperature showed an increase in E_{opt} and a decrease in ΔE with the temperature. This behavior may be related to structural defects and dangling bands. The absorption coefficient for Se:2%As films exhibits exponential dependence on photon energy obeying Urbach's rule in the absorption edge.

Introduction:

It will know that the structure and properties of amorphous semiconductors are sensitive to the method of preparation [1]. For example, evaporated films of germanium and arsenic chalcogenides have X-ray-diffraction and optical absorption properties that are significantly different from the corresponding bulk glasses [2-3]. However, annealing temperature reduces this difference, and the properties of the resulting annealed films are indistinguishable from those of bulk glasses.

The trigonal Se is made of Se chains, while monoclinic Se is composed of Se_8 rings with different stacking of the rings. A-Se has often been taken as being a mixture of Se chain and Se_8 rings [4].Selenium is a typical chalcogenide glassy semiconductor and is contain two kinds of molecule, polymeric chains and nonnumeric rings and inherent defect states called valence-alternation pairs (VAP). The creation of VAPs is described by reaction[5]:

$2Se_2^{\circ} = Se_1 + Se_3^{+}$

Where the subscripts denote the covalent coordination and the superscripts- the charge states

Optical properties of V-VI compounds have been studied in various publication [6-9]. The optical band gap and the localized states width are found to depend on the composition. Still the properties of the prepared materials are highly dependent on the preparation condition, leading to difference in the values of the parameter connected with electrical properties, optical properties, glass transition temperature, crystallization ... etc.

The optical absorption coefficient for many amorphous and glassy materials is found to obey the relation[10-11] :

$(\alpha h\upsilon) = \beta (h\upsilon - Eopt)^r$ ----------(1)

where β is a constant, r is a number between 1 and 3 and Eopt is the optical energy gap.

*Department of Physics ,College of Science, University of Baghdad , Jadirya-Baghdad-IRAQ.: e- mail: ghusson_hameed@ yahoo.com