The effects of ß raddiation on the optical properties of GERMANIUM SELENIDE semiconductor.

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Date of acceptance 15/9/2004

Abstract

Study was made on the optical properties of $Ge_{20}Se_{80}$ thinfilms prepared by vacuum evaporation as radiated by (0,34,69) Gy of ß ray.The optical band gab E_g and tailing band ΔE_t were studied in the photon energy range (1 to 3)eV. The a-$Ge_{20}Se_{80}$ film was found to be indirect gap with energy gap of (1.965,1.9 , 1.82) eV at radiated by ß ray with absorption doses of (0,34,69)Gy respectively.The E_g and ΔE_t of $Ge_{20}Se_{80}$ films showed adecrease in E_g and an increase in ΔE_t with radiation. This behavior may be related to structural defects and dangling bonds.

Introduction

Investigation of transport properties in amorphous semiconductors have been of great interest because of their potential technological application. On the basis of various physical properties ,convalently bonded amorphous semiconductors have been classified into two main categries, that is tetrahedrally bonded such as Ge,Se and III-IV compounds, and chalcogenide or Ion-pair semiconductor whhich includes the chalcogenide elements (S,Se,and Te) and their component l-loys[1]. Interest in the properties of germanium chalcogenides started more than a decade ago. There are through experimental studied of fundamental optical properties, namely on the GeS,GeS_2,GeSe,$GeSe_2$ and Te[2-5]. Crystals resulting in some picture of the basic features of their electronic structure.The optical absorption coefficient for many amorphous and glassy materials is found to obey the relation:

$$\alpha\hbar\upsilon=\beta(\hbar\upsilon-Eopt)^{r} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where β is a constant, r is a number between 1 and 3 and Eopt is the optical energy gap. The relation was first derived by Tauce and Colleagues[6] who assumed that the electron density of states at band edges in regions of localized states is a parabolic function of energy .Davis and Mott[7] obtained the same relation. The width of the tails of localized states at the band edges can

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be estimated using the Urbach relation[8]:

$\alpha \upsilon = \alpha_0 \exp(\hbar\upsilon/\Delta E)$ ....(2)

where α_o is a constant and ΔE is a measure of the extent of the band tailing in the band gap of the material and determined from the reciprocal of the slope of Lnα against photon energy.This report will give results of a systematic study of the optical properties of a-$Ge_{20}Se_{80}$ thin films radiated at different absorption doses of ß radiation. The physical processes in radiated semiconductors are attracting considerable attention [9,10].Some data on the influence of ß radiation on the a-$Ge_{20}Se_{80}$ films will be given below.

Experimental

The purity of the materials are (99.999% pure),were weighted in proportion to their atomic percentages and sealed in an evacuated quartz tube to $\sim 10^{-2}$ Torr and kept in a furnace whose temperature was raised to 950 C°. The ampoules were rocked frequently for (8)h in order to ensure a homogeneous melt and then the melt is quenched in water. Thin films of the alloys were prepared at room temperature by vacuum evaporation in abase pressure 10^{-5} Torr. The thicknesses of films were measured using Tolonsky and crystal monitor methods. The glassy nature of the samples were investigated using X-Ray diffraction. Spectral characteristics in the wavelength rang (200-1100)nm were measured using UV-visible recording spectrophotometer(UV-160 Schematize). To study the effect of ß radiation on the optical properties of the samples we used the source of $^{90}Sr/Y^{90}$ for the emission of ß radiation. The samples were radiated for (24h) and (48h) with the absorption doses (34Gy) and (69Gy) respectively .The absorption coefficient(α) calculated from the relation :

$\alpha = 2\cdot303\ (A/t)$ ....(3)

where A was the absorbance and t was the thick ness of the films.The optical band gap calculated from the intercept of $(\alpha\hbar\upsilon)^{1/2}$ data plotted as function of photon energy.

Results and discussions

X-ray analysis at room temperature showed the absence of any peak, which indicated that the films were amorphous. Fig.(1) shows the plots of absorption coefficient (α) versus photon energy ($\hbar\upsilon$) at different absorption doses of ß radiation . As evident from fig.(1), (α) varies exponentially with ($\hbar\upsilon$) in the measured range of (α). The absorption edge of the samples which are not radiate in a good agreement with the result on $Ge_{20}Se_{80}$ glass reported by Toghe et.al.[11] and by Nang et.al.[3].Fig.(2) show plots $(\alpha\hbar\upsilon)^{1/2}$against photon energy of $Ge_{20}Se_{80}$ films deposit at room temperature and radiated by ß ray. The extrapolated value of the indirect energy gap were(1.965,1.9,1.82)eV at absorption doses (0,34,69)Gy respectively as shown in fig.(3).The value of energy gap at room temperature is in a good agreement with Kumar et.al.[12] and T.Nang et.al.[3]. Fig.(4) shows the plot of Ln α against photon energy of a-$Ge_{20}Se_{80}$ films deposited at room temperature. The reciprocal of the slope of curve give the value of corresponding ΔE (0.5, 0.57 , 0.64) eV at absorption doses (0,34,69)Gy respectively. Table I shows the values of E_g and ΔE_t for a-$Ge_{20}Se_{80}$ films radiated at different absorption doses .

Table I:The value of E_g &ΔE_t for a-$Ge_{20}Se_{80}$ thin films.

Absorption doses(Gy)	E_g (eV)	ΔE_t (eV)
0	1.965	0.5
34	1.9	0.56
69	1.82	0.64

From fig.(2) and table I we observed that ß radiation reduced the energy gap changes the edge absorption toward lower energies, the effect become stronger on increase in radiation doses we also observed that ß radiation did change the value of Eg but not the linear of the dependence of $(\alpha h\nu)^{1/2}$ with (hv) obtained from the radiated films. The increasing in absorption doses changes the density of localized state to a higher values as well as the localized state near the edges which lead to increase the structure defects such as dangling bonds,void, that lead to decrease the energy gap E_g. The band tailing is a function of structural defects,therefor it decrease with increasing the absorption doses as shown in fig.(4) and table I.

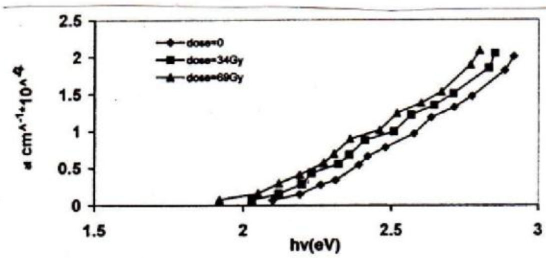

Fig.1:show plots(α)against photon energy of a-$Ge_{20}Se_{80}$ thin films at different absorption doses.

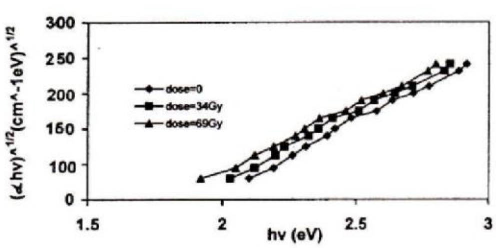

Fig.2:show plots $(\alpha h\nu)^{1/2}$ against photon energy of a-$Ge_{20}Se_{80}$ films at different absorption doses.

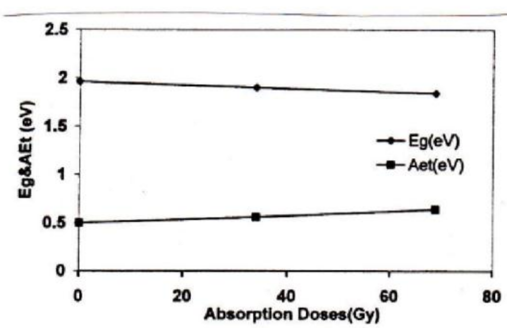

Fig.3 :show the value of energy gap Eg & bond tailing ΔE against absorption doses of a-$Ge_{20}Se_{80}$ thin films.

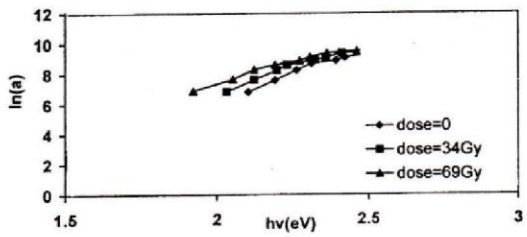

Fig.4:show plots of (lnα)against photon energy of a-$Ge_{20}Se_{80}$ thin films at different absorption doses of β.

Conclusion

The optical transmission and absorption of a-$Ge_{20}Se_{80}$ films with thicknesses of 300 nm and radiated by different absorption doses of ß radiation have been measured in order to drive data on the absorption edge and band tailing . They found to be an indirect energy gap . The $E_g$for a-$Ge_{20}Se_{80}$ films showed a decrease from a value of 1.965eV to 1.9eV & 1.82eV when they radiated by ß ray at absorption doses of (0,34,69)Gy respectively. While ΔE showed to be increases with increasing the absorption doses. These results may be related to an increase in voids and dangling bonds.

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تاثير اشعاع بيتـــا على بعض الخواص البصرية لاغشية الجرمانيوم سيلينايد العشوائية

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الخلاصة

تمـــتدراســـة بعض الخواص البصريـــة لاغشيـــة a- $Ge_{20}Se_{80}$ المحضرة بطريقة التبخير الحـــراري في الفراغ كدالة لدرجة حرارة التلدين ضمن مـــدى طاقة الفوتـــون (1-3) eV ، لقد وجـــد ان لاغشـــية $Ge_{20}Se_{80}$ فجوة للطاقة غير مباشرة وبقيم (1.82,1.9,1.965) eV عند تشعيعها باشعة بيتا وبجرعـــات امتصاصية (0 ,69,34) Gy على التوالي . نتائج (E_{opt}) و(ΔE) لاغشية $Ge_{20}Se_{80}$ اظهرت تنـــاقص في فجوة الطاقة البصرية وريادة في عرض الذيول مع التشعيع .هذا السلوك قد يعود الى عيوب الـــتركيب والاواصر المتدلية التي تشكلت خلال مراحل التشعبع المحتلفة.