Effect Of Environment, Alpha And Beta Particles On Lightly Doped Of SMS Film Germanium Junctions

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Abstract

The lightly doping of Al and As with germanium material were prepared using thermal co-evaporation technique to deposit SMS film junctions with (0.1wt%) concentration and (800±10nm) thickness. The prepared films were exposed to environment, natural radionuclide (Ra^{226}) emitted alpha and (Sr^{90}) emitted beta particles after heat treatment with various fluences .The (J-V) characteristics refer to high shifting in both forward and reverse biases consisted of three different parts corresponding to different current mechanisms. The first part of (J-V) characteristics correspond to low bias and shows an ohmic behavior which depends on the possible parallel conductance of defects which can be found in the film layers. The second part where V= f^{-1}(J) relationship is exponential, is due to the schottky diode, which results from the contact of semiconductor-metal. The third part is related to bias of relatively higher voltage and is described by linear with ohmic contact. The space charge region is expanded and lead to perturbation in bulk resistivity and its percentages and damage percentages in forward and reverse biases as a result to environment ,increase in bulk resistivity and its percentages, saturation current density, breakdown voltage as result to alpha fluences, As the radiation fluence increases, the concentration of defects, which are introduced by radiation, increase resulting the decrease in current., but it was observed that the bulk resistivity and its percentages, damage percentages decrease after every stages of beta exposure, the damage coefficients (D_J) or (D_V) are decrease as the influence of beta particle increase. The film is showed to be very sensitive to environment and radiation, so that its properties change after every dose.

Keywords: semiconductor-metal-semiconductor, thin film, doping, environment, beta particle, alpha particle, thermal evaporation, SMS junction, radiation.

الخلاصة:

حضرت غشية ألمفارق بسمك (±۸۰۰۱۰) نانومتر نوع (شبه موصل – معدن – شبه موصل) باستعمال تقنية التبخير الحراري المشترك بتركيز واطئ (۰.۱%) .عرضت بعض الأغشية للجو والبعض الآخر لدقائق ألفا المنبعثة من عنصر الراديوم ۲۲٦ والآخر إلى دقائق بيتا المنبعثة من عنصر السترونتيوم ۹۰ بفيوض مختلفة بعد إجراء معاملة حرارية . أشارت مميزات (كثافة التيار – الفولتية) إلى وجود إزاحة كبيرة في كلا الانحيازين الامامي والعكسي المؤلف منحنيها من ثلاثة أجزاء في ضوء ميكانيكية مرور التيار . تميزت الخواص في الجزء الأول بانحياز واطئ ولها سلوك اومي والتي تعتمد على المواصلة التي تظهر نتيجة العيوب التي تتواجد في طبقات الغشاء . الجزء الثاني من المنحني اعتمادا على المعادلة (J) $V=f^{-1}$،ظهر بأنه أسي وهو يتعلق بدايود شوتكي والذي يظهر من تماس شبه موصل – معدن. أما الجزء الثالث فيظهر عند الفولتيات العالية نسبيا المسلطة على الغشاء والموضحة أيضا بواسطة التماس الاومي . عندما يزداد التأثير الإشعاعي ، فان تركيز العيوب الناتجة من الإشعاع ،تظهر نقصان في التيار المار. يؤدي ذلك إلى جعل منطقة شحنة الفراغ ممتدة ، أشارت النتائج الى حدوث اضطراب في قيم المقاومية الحجمية ونسبة التغير في المقاومة الحجمية ونسبة الضرر وكثافة تيار الإشباع وفولتية الانهيار نتيجة التعرض الجوي. بينما تزداد هذه العوامل نتيجة التعرض لدقائق ألفا لعدة فيوض.بينما يقل معامل الضرر بعد كل تعرض لهذه الدقائق. أما تأثير إشعاع بيتا ،فلوحظ نقصان المقاومية الحجمية ،ومعامل الضرر نتيجة التغير في كثافة التيار(D_J) أو التغير في الفولتية (D_V)وزيادة نسب التغير في المقاومة الحجمية ونسب الضرر بعد كل مدة من التعرض لإشعاع بيتا . لقد تبين أن هذه الأغشية حساسة جدا للمحيط وللإشعاع بحيث تتغير كثيرا بعد التعرض معتمدا في ذلك على الجرعة الإشعاعية الممتدة.

1.Introduction

The germanium atom substitutes with an arsenic or aluminum atom by covalent bonds formed(Sze,1981).The most fifth doping elements go to substitutional sites in networks of material, such that the displaced germanium transfers to the free surface (Nerbert,1971). Small quantity of impurities has large effect on electrical

characteristic(Ravi,1981). (Hu, 1987) supposed clustering four arsenic atoms which formed tetragonal at interstitial natural position of silicon lattice(Von,et. al,1987). (Flangan & Klontz, 1978) studied effect of radiation in n-type more than p-type because of defect production at low temperature. The cross section of secondary defects is non-proportional to impurity concentration, the probability of this defect decrease with decreasing Fermi level, which describes in term of free migration of primary defect(Urli, et al.,1976). It was found that the data of doped Ge with As at temperature range (150-240°C) agreement in characteristic of some data taken from irradiated germanium by electron accomplish with (Brown)(Carton,et al.1976). (Mora et al., 1972) studied the effect of neutrons on electrical properties of heavily doped (1-8)$\times 10^{18}$cm^{-3} (p-type) of GaAs. They studied transition from semiconductor to metal. They were irradiated small rectangular wafers of heavily doped germanium with arsenic or antimony to form n-type by fast neutron of doses (2-5)$\times 10^{14}$ n/cm^2(Yoshikawa,et al,1985). (Mch Hardy & Fitzgerald, 1985) presented research about the effect of different electronic irradiation intensities on the calcogenates (Si, Se, Te) films with As and Ge covered with silver. (Srivastava et al., 1986) prepared Ge film using thermal evaporation vacuum techniques on glass substrate at room temperature. (Fuknoka, Noboru et al., 1992) measured the value of single crystal Ge resistivity after neutron irradiation. (Al-Bassam, 1996) prepared amorphous pure and doped germanium films by thermal co-evaporation process and irradiated with alpha and beta particles and observed shifting in (J-V) characteristics. (Alekandrov et al., 1999) studied the influence of electrically inactive impurities such as carbon, oxygen, nitrogen and fluorine on the formation of donor centers in silicon layers implanted with erbium. (Shevchenk, 1999) indicated to influence of annealing on the dislocation-related electrical conductivity of Ge n-type single crystals with donor conc. of (3*10^{12}cm^{-3}) was formed at(760 ^{o}C) to strains. (Oszwaldonski et al., 2001) found the structural properties of InSbBi and InSbAsBi thin films prepared by flash-evaporation method using a mixture of powders. The electrical sheet conductivity and dominated the recombination current due to the generation and trapping center(Road,et al,2003). (Ashoor et al., 2004) studied irradiated pure and doped amorphous germanium films with antimony. It showed that d.c. conductivity of n-type film increase with gamma radiation. (Al-Bassam, 2001) deposited p-GeAl (0.1wt%) films by thermal co-evaporation and irradiation with fluency alpha and beta up to 10^9 particle/cm^2, moreover to atmospheric exposure. (Al-Bassam, 2004) prepared lightly As doped Ge films (0.1%wt) and irradiated with alpha particle emitted from (Ra^{226}). (Georgakakos,2010) studied the influence of alpha particle irradiation and temperature on ALGaAs/GaAs/AlGaAs hetrojunction structures on (I-V) and (C-V) characteristics with (180K-440K) and radiation of alpha particles (5MeV) at fluences changing from (4.9 $\times$10^{10} cm^{-2}) to (1.57$\times$10^{12} cm^{-2}) by Al schottky contacts at test structures.(Yamazaki,2011) studied the diluted ferromagnetic semiconductor Z$_{1-x}$Cr$_x$Te doped with iodine and nitrogen. It was concluded that the Cr ions in the undoped I-doped and lightly N-doped samples are divalent (Cr^{+2}),while trivalent (Cr^{+3}) coexist in the heavily N-doped sample.(Schrimpf et al,2011) studied radiation effect in new materials for nano-devices. It was exposed to radiation posses significant challenges for electronic devices. The aim of the project is to obtain the effect of alpha and beta particles in addition to environment on (J-V) characteristics, and some electronic properties of device SMS junctions using in nuclear laboratory systems, and other computerized devices.

2.Theoretical Calculations

When a particles have entered into thin films with certain solid angle, some electrical changes appear as result of defects, depending on the energy of particles and type of film. To compute the flux of radiation (particle/cm^2.sec), we used the equation (Nicholas,1976):

$$\phi = \frac{\text{no.of particle/s}}{\Omega A_s} \qquad (1)$$

where A_s (cm^2) is the source area, and Ω is the solid angle that can be calculated from the equation (Sasuki,1976) :

$$\Omega = \frac{1}{2}(1 - \frac{d}{\sqrt{d^2 + R_d{}^2}}) \qquad (2)$$

R_d (cm) is the radius of the exposed area, d (cm) is the distance between the emitted source and exposed area.

For (J-V) characteristic, the function relation is $J = f(V)$ or $V = f^{-1}(J)$ or another function $V = g(J)$ is used.

So, it could be find the resistivity $(\Omega \cdot cm)$ directly by using the equation (Nerbert,1971):

$$\rho = \frac{\Delta V}{\Delta J}\left(\frac{1}{l}\right) \qquad (3)$$

Such as l(cm) is the length of the film. To find of damage coefficient (D) (Amp/cm) is used the equation(Fertwarst,et al,1992):

$$\frac{\Delta I}{v} = D.\phi \qquad (4)$$

Where v (cm^3) is the volume of the exposed area, ΔI is the variation in current.

The maximum range R$_{max}$. (Material independent) of beta particle can be computed from empirical formula given by Katz and Penfold(Cember,1996):

$$R_{max}.\rho(gm/cm^2) = \begin{cases} 0.412 E_\beta^{1.265-0.0954\ln E_\beta}, E_\beta \langle 2.5 MeV \\ 0.530 E_\beta - 0.106, E_\beta \rangle 2.5 MeV \end{cases} \qquad (5)$$

Where E_β is the maximum beta energy in MeV. The thickness (t$_d$) of the material gives a generic quantifier which various absorbers can be compared(Nicholas,1983):

$$t_d (gm/cm^2) = \rho(gm/cm^3) \times t \ (cm) \qquad (6)$$

Also by Appling the Bragg-Kleeman rule for one material(Nicholas,1983):

$$\frac{R_1}{R_2} = \frac{\rho_1}{\rho_2} \cdot \frac{\sqrt{A_1}}{\sqrt{A_2}} \qquad (7)$$

Where ρ_i and A_i are the density and atomic weight respectively and R_i is the distance of particle in material, then effective atomic weight was found from the equation (Nicholas,1983):

$$A_{eff.} = \sum_{i=1}^{L} \frac{w_i}{\sqrt{A_i}} \qquad (8)$$

Where L is the no. of elements and w$_i$ is the concentration of element.

The effective atomic number and atomic weight of alpha particle effect is given by(Nicholas,1983):

$$Z_{eff.} = \Sigma W_i Z_i \tag{9}$$

From equation (3) and (4), it was introduce the another equation of damage coefficient:

$$D_V = \frac{|V_2 - V_1|}{\phi l^2 \rho} \tag{10}$$

Where $V=Al$, $\Delta J = \Delta I/A$

From Boltzmann equation(Sasuki,1976):

$$J = J_S (e^{\frac{V}{\eta V_T}} - 1) \tag{11}$$

Such that $V_T = kT/q$, $\eta=1$ for germanium:

$$\frac{J + J_S}{J_S} = e^{\frac{V}{V_T}}$$

$$V = V_T \ln(\frac{J}{J_S} + 1) \tag{12}$$

Derive eq. (11) with respect to V produce:

$$\frac{dJ}{dV} = \frac{J_S e^{\frac{V}{V_T}}}{V_T}$$

$$C = \frac{J + J_S}{V_T} \tag{13}$$

Where C represents the conductance of p-n junction also(Mill,Man-Halkiad,1972) :

$$\sigma_v = \left(\frac{J + J_S}{V_T}\right)\left(\frac{l}{wt}\right) \tag{14}$$

Where σ_v is the bulk conductivity of the film $\left(\Omega.cm^3\right)^{-1}$.

From eq.(2-11):

$$\Delta J = \Delta J_S \left(e^{\frac{V}{V_T}} - 1\right) \tag{15}$$

Substitute eq.(2-4) in eq.(2-15) and if :

$$e^{\frac{V}{v_T}} \rangle\rangle 1 \quad \text{and} \quad V \rangle\rangle V_T \quad \text{at}$$

$$\tag{16}$$

$$D_J = (J_{S2} - J_{S1})\frac{e^{\frac{V}{V_T}}}{\phi l}$$

It can be produced the damage equation in terms of hyperbolic function(Havery,et al,1986):

$$\cosh v = \frac{e^v + e^{-v}}{2} \qquad (17)$$

By analyzing produce:

$$e^{2v} - 2e^v \cosh v + 1 = 0$$

$$e^v = \cosh v \pm \sqrt{\cosh^2 v - 1}$$

But

$$\cosh^2 v - \sinh^2 v = 1$$

So

$$e^{\frac{V}{V_T}} = \cosh(\frac{V}{V_T}) \pm \sinh(\frac{V}{V_T}) \qquad (18)$$

Equation (16) becomes(Al-Bassam,1996):

$$D_J = (\frac{J_{S2} - J_{S1}}{\phi l})(\cosh(\frac{V}{V_T}) \pm \sinh(\frac{V}{V_T})) \qquad (19)$$

This equation represents the damage coefficient of lightly p-n and SMS junction films in the case of current density variation before and after exposure to nuclear radiation and environment.

In the case the current density and voltage are changed; equation (15) becomes:

$$\Delta J = J_{S2} e^{\frac{V_2}{V_T}} - J_{S1} e^{\frac{V_1}{V_T}} \qquad (20)$$

Connect between equations (2-16) and (2-18) produce(Al-Bassam,1996)):

$$D_V = \frac{1}{l\phi}\{J_{S2}\left(\cosh(\frac{V_2}{V_T}) \pm \sinh(\frac{V_2}{V_T})\right) - J_{S1}\left(\cosh(\frac{V_1}{V_T}) \pm \sinh(\frac{V_1}{V_T})\right)\} \qquad (21)$$

This equation represents the damage coefficient as result to the change in saturation current density and voltage variations of p-n junctions.

3.Experimental details:

The films were deposited on hot glass substrate $(100^{o}\,C)$ by (Edward's system) using thermal co-evaporation technique from two separate source for the host (Ge, 99.9wt%) and dopants (Al,0.1%wt,As,0.1%wt) to form SMS junction film under vacuum system about $(10^{-5}\text{-}10^{-6}$ torr). The rate of deposition was about ($6\,\overset{o}{A}/s$). The heat treatment was about (393K) for (30min.) by using digital thermometer $(\pm 5K)$ .The deposition was at five stages. The total thickness of the film was $(800\pm 10)nm$ with aluminum ohmic contact on the film was made prior to exposure to radiation as electrodes. The films were mounted on two sides at (0.2, 0.4 cm) distances and exposed to particle radiation at (300K) with (Ra^{226}) source emitted alpha particle its activity is $(10^{-6}mCi)$ and (Sr^{90}) source emitted beta particle its activity$(5\times 10^{-3}mCi)$ for three period times respectively . The other specimens SMS junctions exposed to environment. Measurements of d.c. electrical resistivity were preformed on three thin film specimens of well-characterized homogeneity.

The rate of count activity of the source was obtained by using silicon surface barrier-layer detector and scintillation (NaITI) detector. The samples were carefully kept in a glass chamber evacuated to (0.1) torr pressure.

The measurement of the film thickness can be estimated by equation (Carton,et al,1976) :
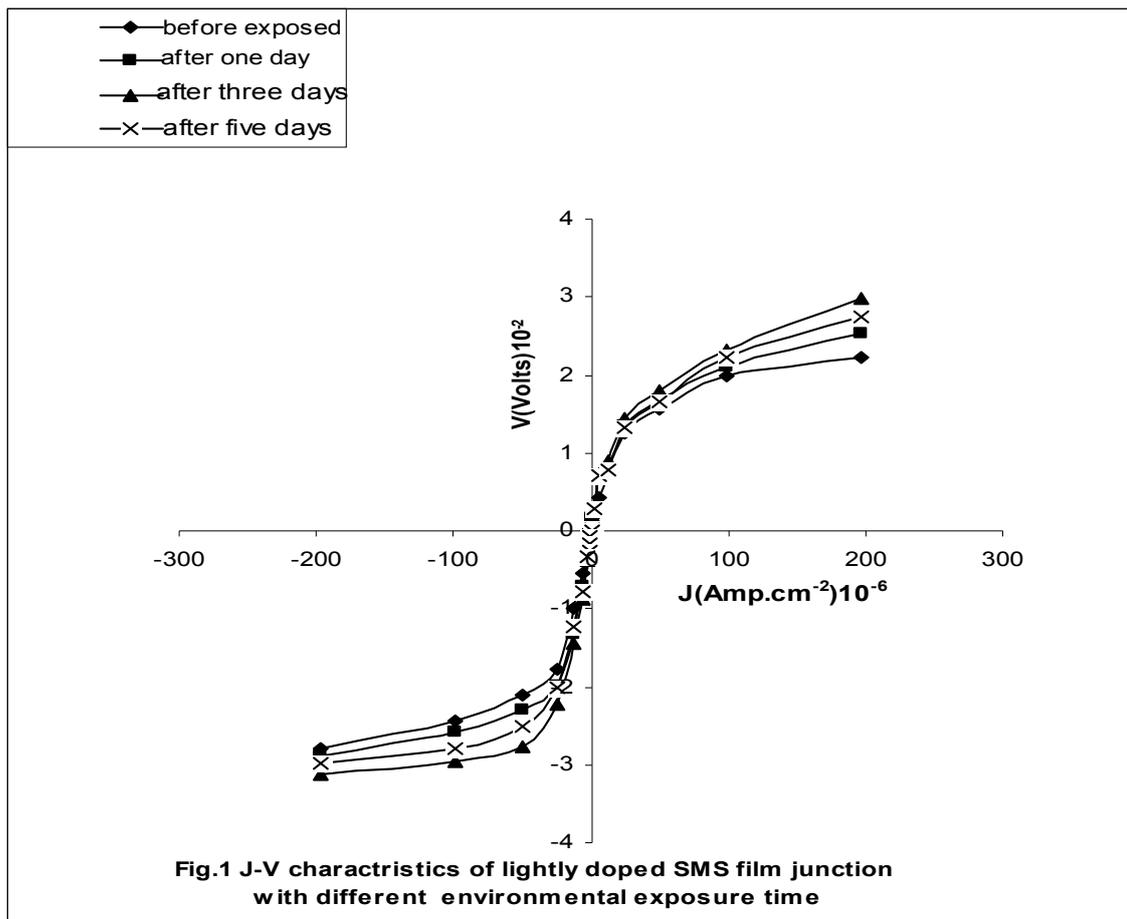
$$t = \frac{m}{2\pi r^2 \rho \cdot r^2}$$

(22)

Where m (gm) and ρ (gm/cm^3) are the mass and density of materials. r(cm) is the distance between the evaporated source and the glass substrate.
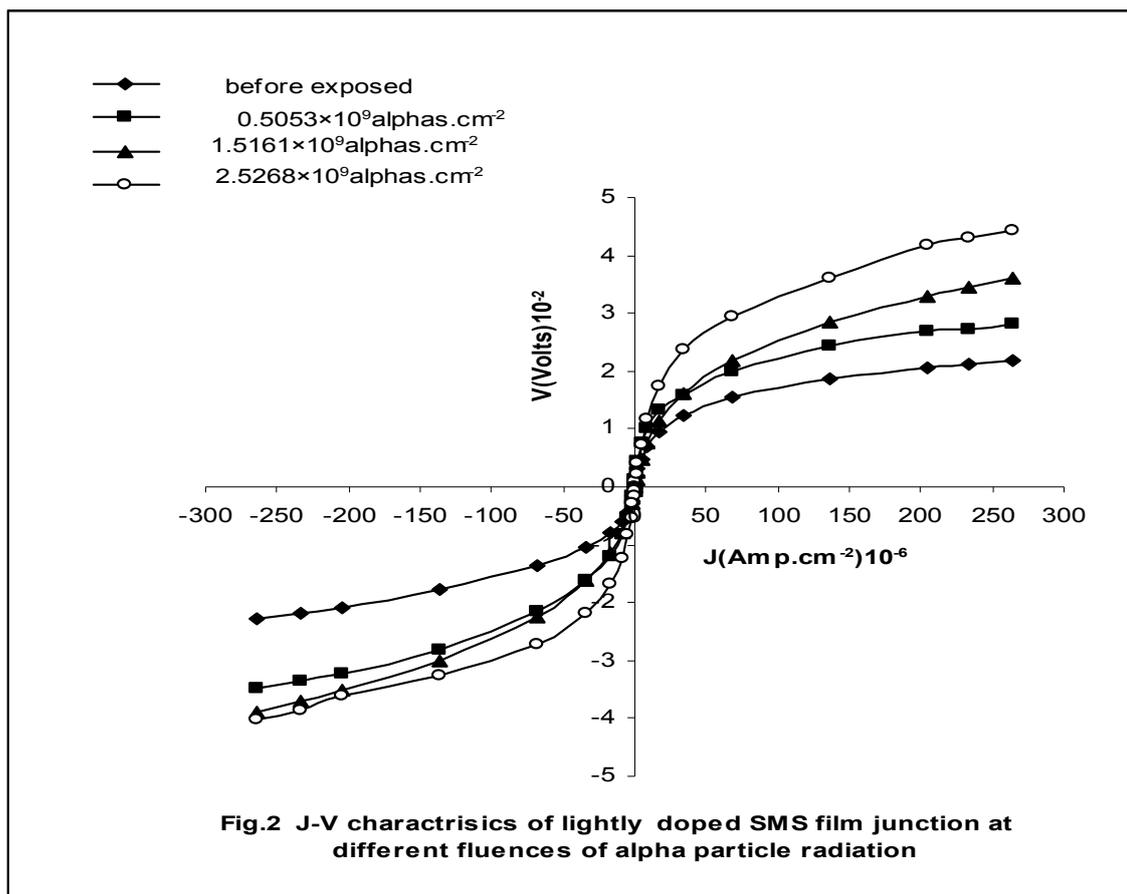
4.Results and Discussion

For light concentration doping germanium with aluminum (0.1wt%) and arsenic (0.1wt %) to form SMS film junctions respectively. It causes shifting in J-V characteristics as result of environmental, alpha and beta particles exposures.

4-1 Effect of atmosphere, alpha and beta exposure on (J-V) characteristics of lightly doped SMS film junction:
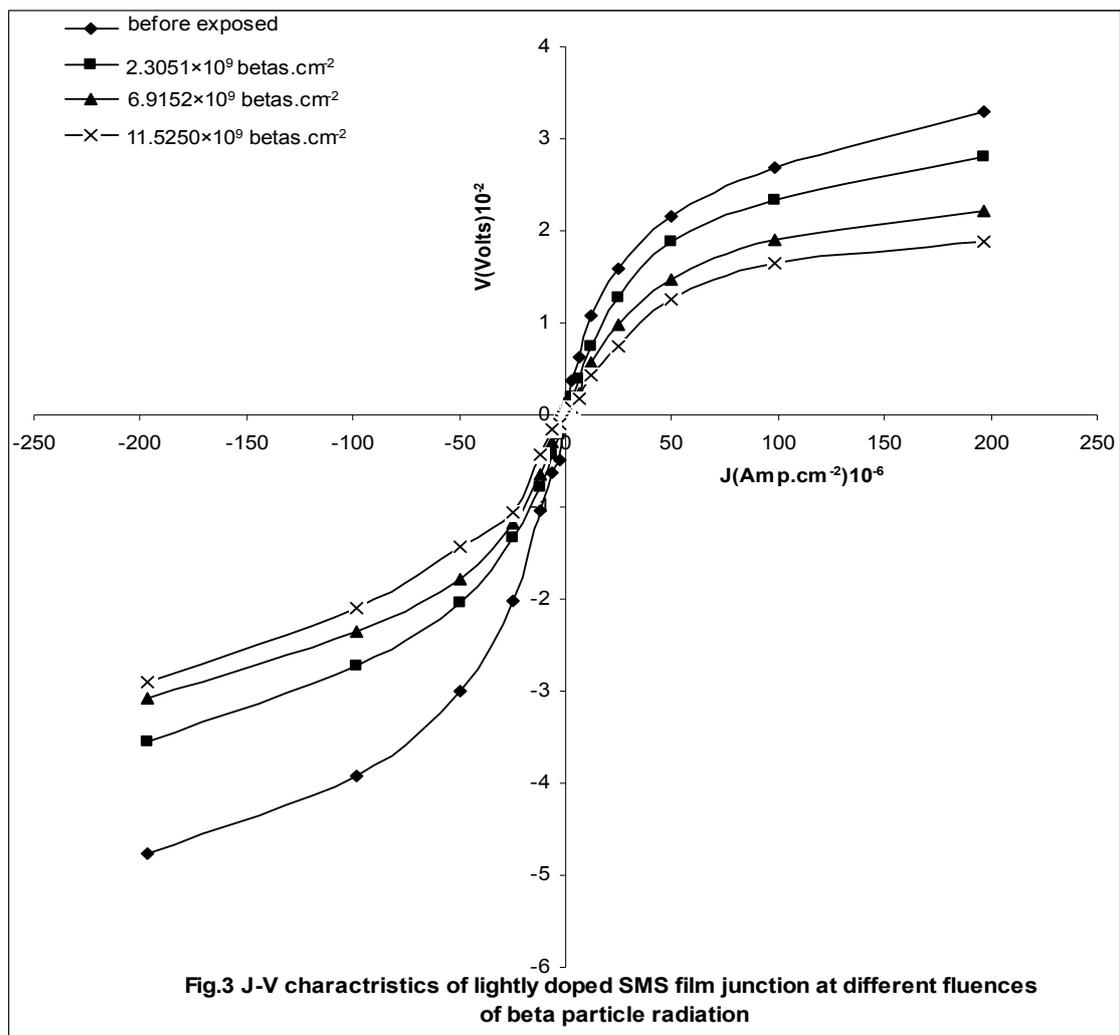
(Fig.1) Indicates a large shifting in (J-V) characteristics as a result of sensitive film to atmosphere. The oxidation phenomena of n and p-types that contain a low density of arsenic atoms and aluminum atoms respectively, have occurred in SMS film. There are three different parts corresponding to different current mechanisms. The first part of (J-V) characteristics correspond to low bias and shows an ohmic behavior which depends on the possible parallel conductance of defects which can be found in the film layers. The second part where V= f^{-1}(J) relationship is exponential, is due to the schottky diode, which results from the contact of the metal. The third part is presented at bias of higher voltage and is described by linear relationship V=f^{-1}(J) with ohmic contact in two forward and reverse biases are also shown in (Fig.2) and (3). The shifting are different in both. (Fig.2) shows varying in (J-V) characteristics as a result to alpha exposure radiation with different doses. The shifting in curve was very high, because the effect of alpha radiation on region between n and p type is occured, the connection of germanium atoms contains the dangling bonds inter film with clustering defects as a result of incident of alpha radiation, moreover the generated of defects from impurities of aluminum and arsenic atoms after deposition. Also the alpha particles change the state of the oxidation surface film, or change the oxidation sites. This means that the high shifting in (J-V) characteristics obtained as a result to alpha particle effects at barrier region. Also this leads to decreasing in current density and increasing in bulk resistivity percentages as shown in table1. (Fig.3) indicates to (J-V) characteristics before and after different periods of exposure to beta particles. The shifting in the graph is lower than alpha fluence, because the fast energetic electrons are transmitted in the film generated point defects . The shifting in (J-V) characteristic especially in forward bias is the largest, because the effect in reverse bias is low, and the width of potential barrier is large, these leads to low change in reverse current. The first and second parts of the shifting curves are almost coincidence, however , it wasare not taken into account, because the shifting of the curves are little, but it appeared in the highest voltages.

Fig.1 J-V charactristics of lightly doped SMS film junction with different environmental exposure time

Fig.2 J-V charactrisics of lightly doped SMS film junction at different fluences of alpha particle radiation
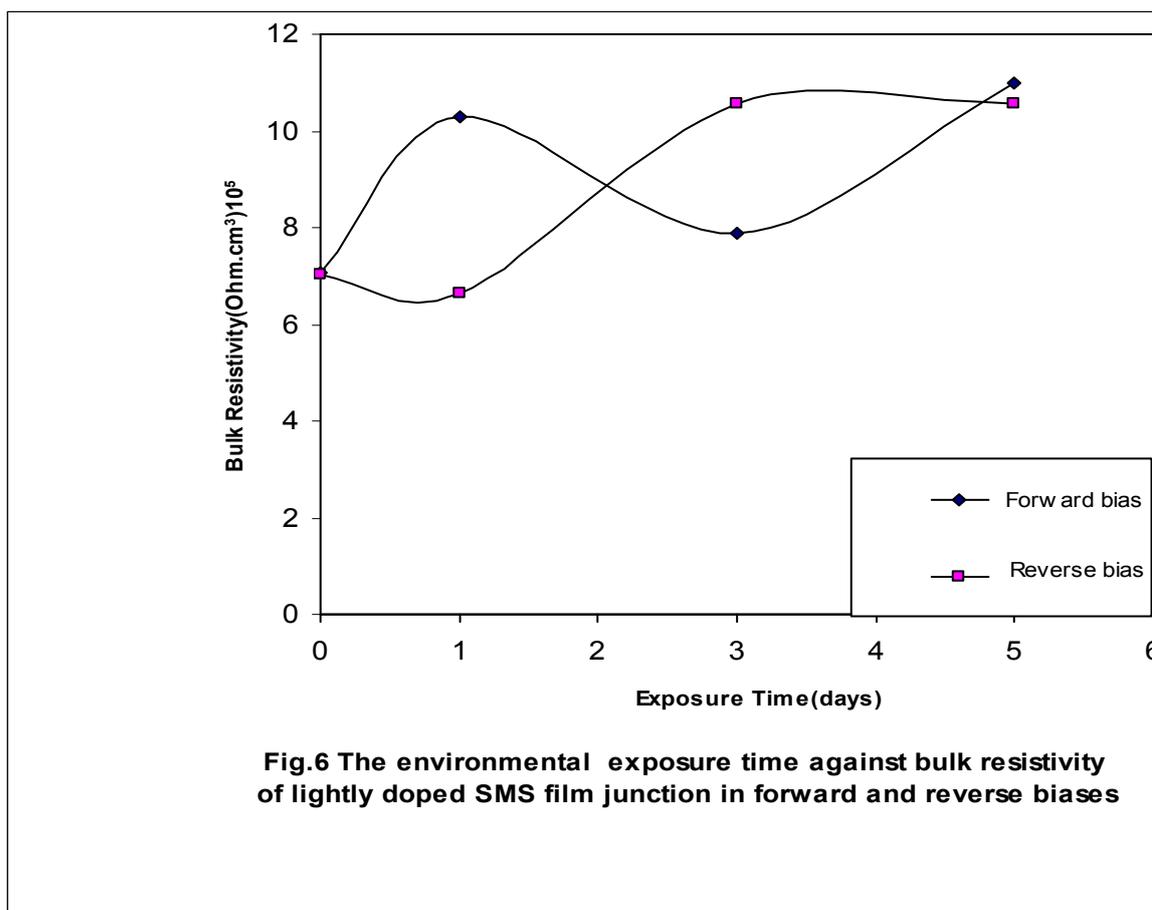
4-2 Effect of atmosphere, alpha and beta exposure on saturation current and breakdown voltages of lightly doped SMS film junction:

It was observed that the saturation current density and break down voltage increase as the exposure time increase in three types of exposure as shown in (Fig.4) and (5),but it begin to decrease after the third stage, it re-repeat the disordered atoms to take best another sites. The saturation current densities are appeared because of Al layer, existing between n and p types, generated diffusion of aluminum atom as a surface impurities in both p and n types. The point defects (vacancies) have generated continuously until reach saturation defect state, moreover to low atmospheric exposure effects. It was observed that the damage coefficient decreases after every stage of exposure, because the generated defect begins to be stable continuously even reach to the final stage. The non-linear of ohmic (J-V) characteristics is attributed to jumping the voltage values or raise resistance at these values and the biases. Also because of amorphousation, and inhomogenity of the film as a result of precipitation factors, it was produced a disordered zones and cascades of clusters. This means that the sites of host and impurity atoms are in dispersion positions due to preparation factors, or the structure of the thin film is an amorphous, however there are a different values of calculated factors with respect to film samples, even plus or minus some nanometer thicknesses .

Fig.3 J-V charactristics of lightly doped SMS film junction at different fluences of beta particle radiation

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Fig.6 The environmental exposure time against bulk resistivity of lightly doped SMS film junction in forward and reverse biases
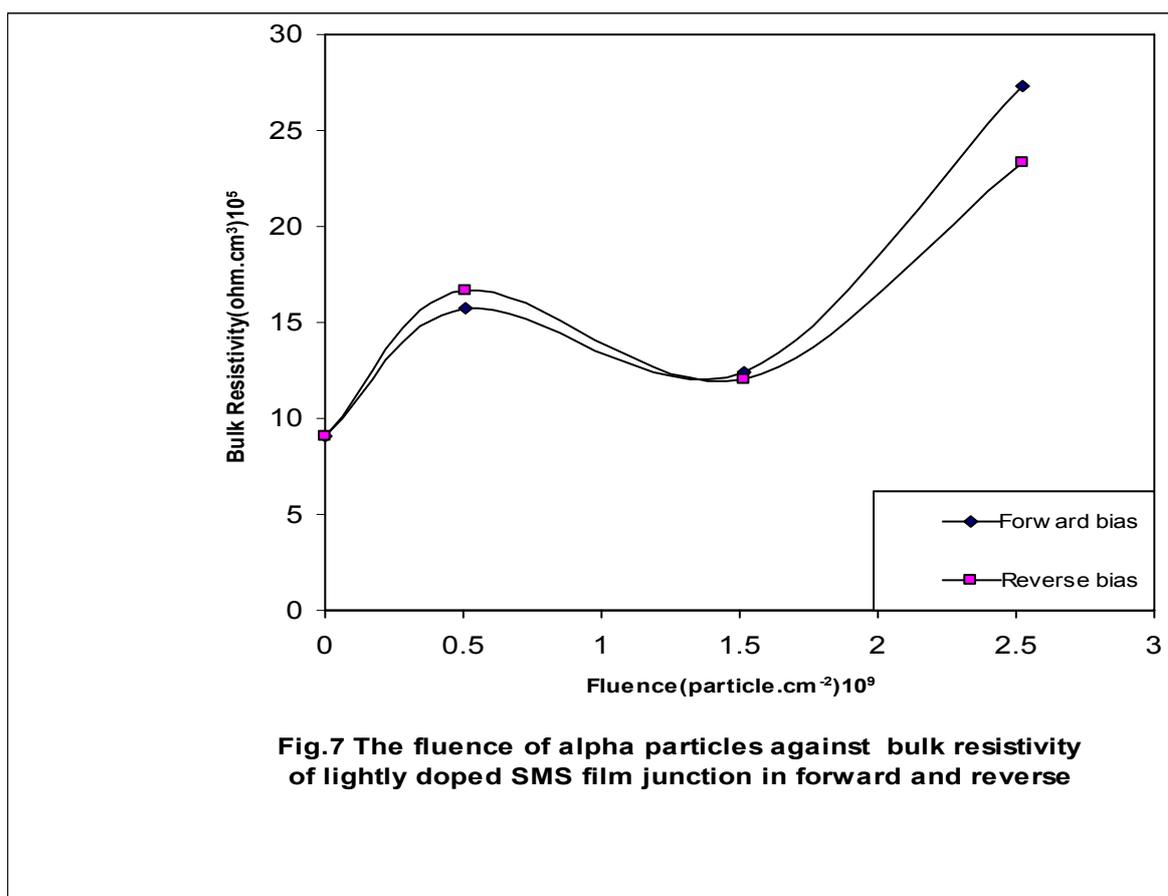
4-3 Effect of atmosphere, alpha and beta exposures on bulk resistivity of lightly doped SMS film junction:

The different values of bulk resistivity in first and second parts of the curves are non-clear, however it was untaken into account. This was a clear at the greatest voltages.

The change in bulk resistivity increase as the exposed periods of environment increase, but return to intermediate values in forward and reverse biases. The bulk resistivity of the film was varied after every stage of exposure time in three types of exposure, because the atmospheric(oxidation, humidity, dust) factors occur a perturbation in equilibrium of low donor and acceptor density carriers, permit to oxidation film and leads to increasing of oxygen contents in p and n sides of SMS junctions. However the connections of (Ge-Al) and (Ge-As) contains low oxygen atoms, lead to passing a different current in the film, also these variations occur, because of unstable of arsenic atom and can be easily oxidized, this related to chemical affinity, in addition to a weak connection of arsenic and germanium atoms. as shown in (Fig.6). The manners of (SMS) film junctions with (0.1%) are similar to p-n junction at (0.5 and 2% germanium films(Albassam,1996), because the doping is occurred as result to metal (Al) deposition existing between p and n, so that the impurities are regarded enough to obtain the clear bias, or generation of potential barrier. The bulk resistivity increases in both biases as shown in Fig.6, these increasing are occurred, because the oxidation leads to connections of dangling bonds with oxygen atoms, caused little increase in bulk resistivity, or become unstable.
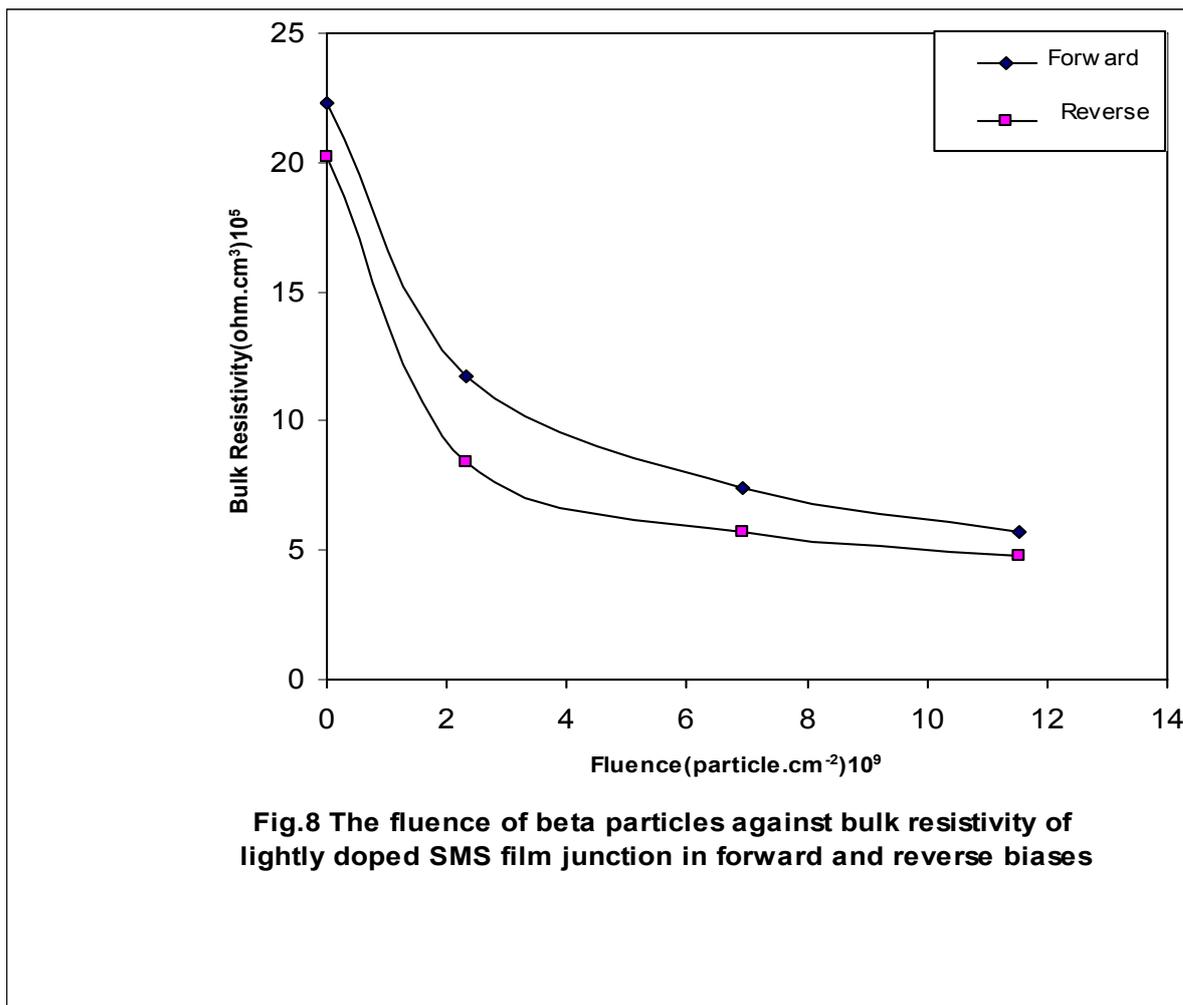
While it was noted that the bulk resistivity continuously increase when the SMS junction exposed to alpha radiation as shown in (Fig.7), because it was created vacancy defects occupy, at the most, the surface states. Also if alpha fluence increases on prepared film, the value of the bulk rsistivity increasing, because the density of defects increase, lead to increase in resistivity. These changes in forward bias is more than reverse bias. In other mean, the value of damage coefficient that produced in forward is greater than reverse. This was described from the values of damage percentages is the greatest in forward as shown in table 1. As the radiation fluence increase, the concentration of defects, which are introduced by radiation increase resulting decrease of current, the space charge region is expanded due to defects (gaps and inter-grid atoms) which are introduced during radiation, resulting in the decrease of capacitance (Georgakakos,et al.,2010). The values of bulk resistivity in forward is lower than in reverse biases as result to alpha effects, because of large width of potential barrier . Also it was observed that beta particles are penetrate out side the film after some tunneling created interior the film, so that beta particles attribute the conductivity of the film, hence the bulk resistivity decrease after more fluence exposure, or the position of disordered atom become more geometrical ordered and more connections with dangling bonds (low amorphousation), so it contributed the electrons in n-type and holes in p-type, the bulk resistivity have a low decrease at the final stage of exposure as shown in (Fig.8). This means obtaining the stable as a result of effect, but it observed the, the current increase too when the beta fluence increase. This because of defect generation after exposure as result to displaced impurity atom or the host atom on two sides of junction. The partial destroy of potential barrier that is occurred lead to change in resistivity values at second and third stages and hence the film becomes stable for long duration time. The creation of vacancy defects in amorphous structure leads to decreasing donor levels, which trapped donor centers that means increasing of carrier's contribution. The occurrence irregular atomic displacements as a result of beta particles, decrease dangling bonds and then more the ordered zones. The decreasing dangling bonds is facilitate the transitions from covalent band to conduction band, or create additional energy levels in the region of energy gap. The interpretations of different manners of alpha and beta particles directed to lightly doped germanium is certainly different because of different in charge and mass of particles. The kind of defect and its extension in material(semiconductor) change the most electrical and electronic properties. This gives some selection rules to control for example, conductivity or energy gap after discrete fluence of particle radiation, in stead of required doping.   .

Fig.7 The fluence of alpha particles against bulk resistivity of lightly doped SMS film junction in forward and reverse

4-4 Effect of atmosphere, alpha and beta exposures on variation density current per unit volume of lightly SMS film junction:

(Fig.9) refers to the variations in current per unit volume as result to environmental effect, it was increased as the exposure time increased, in both forward and reverse biases. Some different between biases is obtained, because the width of potential barrier in reverse bias is greater than forward bias related to the oxidation of film. (Fig.10) represents the change in current per unit volume passing in the SMS film before and after exposed to alpha particle doses, the variation is high in the beginning of exposure, after that, the change decreases, or the damage coefficient decreases, that can be obtaining from the slope of the graph in forward and reverse biases, but in reverse is the lowest. This is because, the alpha particles is relatively large size, however its need to more energy to reach the barrier region, and create point defects interior the film.

It was noted that the variations in current per unit volume as result to expose to beta particle, made the damages inter the film, the value of damage coefficient is constant which obtained from the slope of straight line as shown in (Fig.11). The energetic beta particles can be easily transmitted into the film to create point defects with stable position. But the change in reverse is the greatest compare with forward bias, because the beta particles affected on potential barrier, compare with alpha particle effects at the same film thickness.
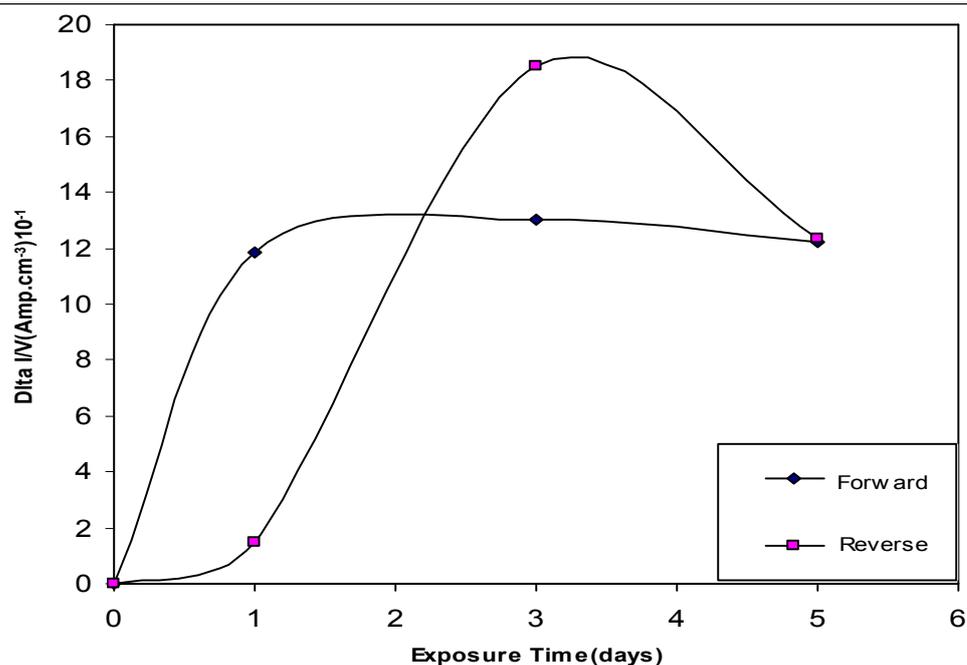
Fig.8 The fluence of beta particles against bulk resistivity of lightly doped SMS film junction in forward and reverse biases

Fig.9 The environmental exposure time against a change in current per unit volume of lightly doped SMS film junction in forward and reverse biases

Fig.10 The fluence of alpha particles against variation current per unit volume of lightly doped SMS film junction in forward and reverse biases

Fig.11 The fluence of beta particles against change in current per unit volume of lightly doped SMS film junction in forward and reverse biases
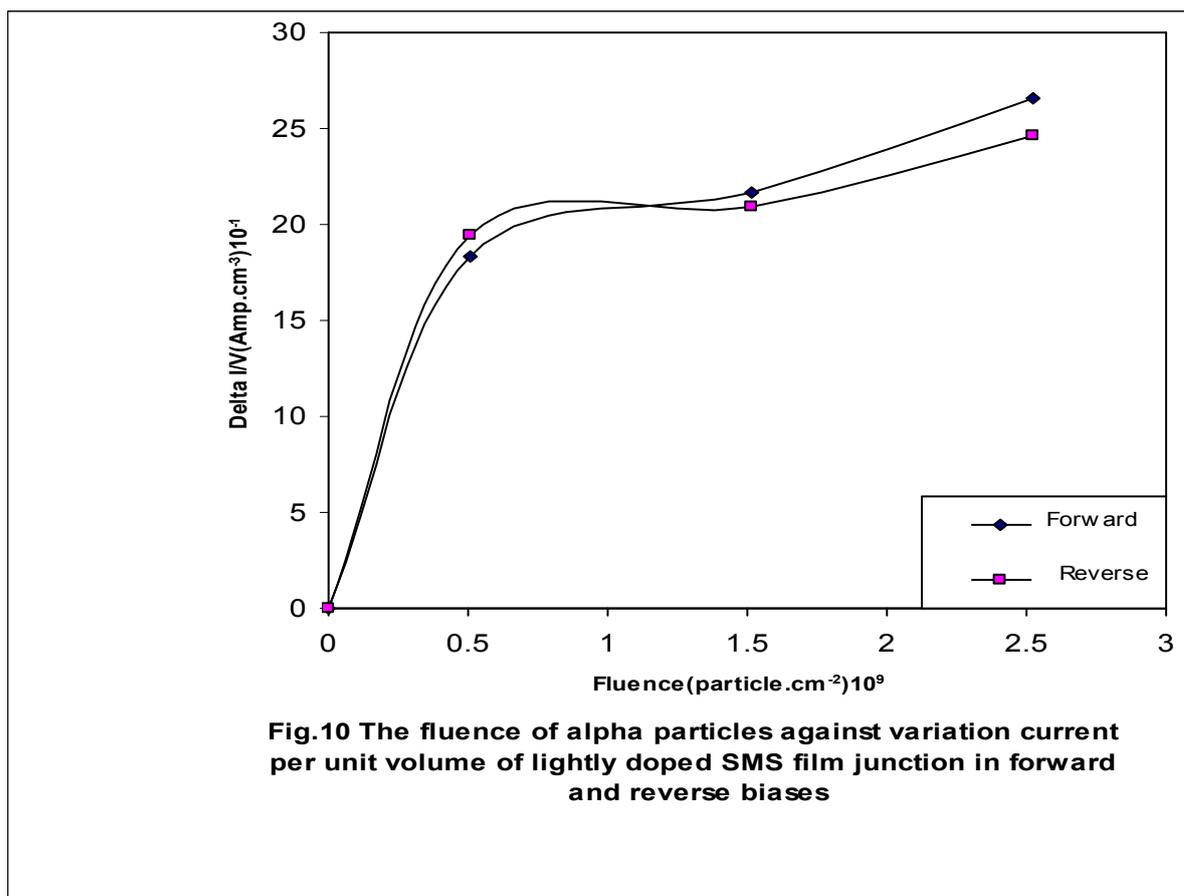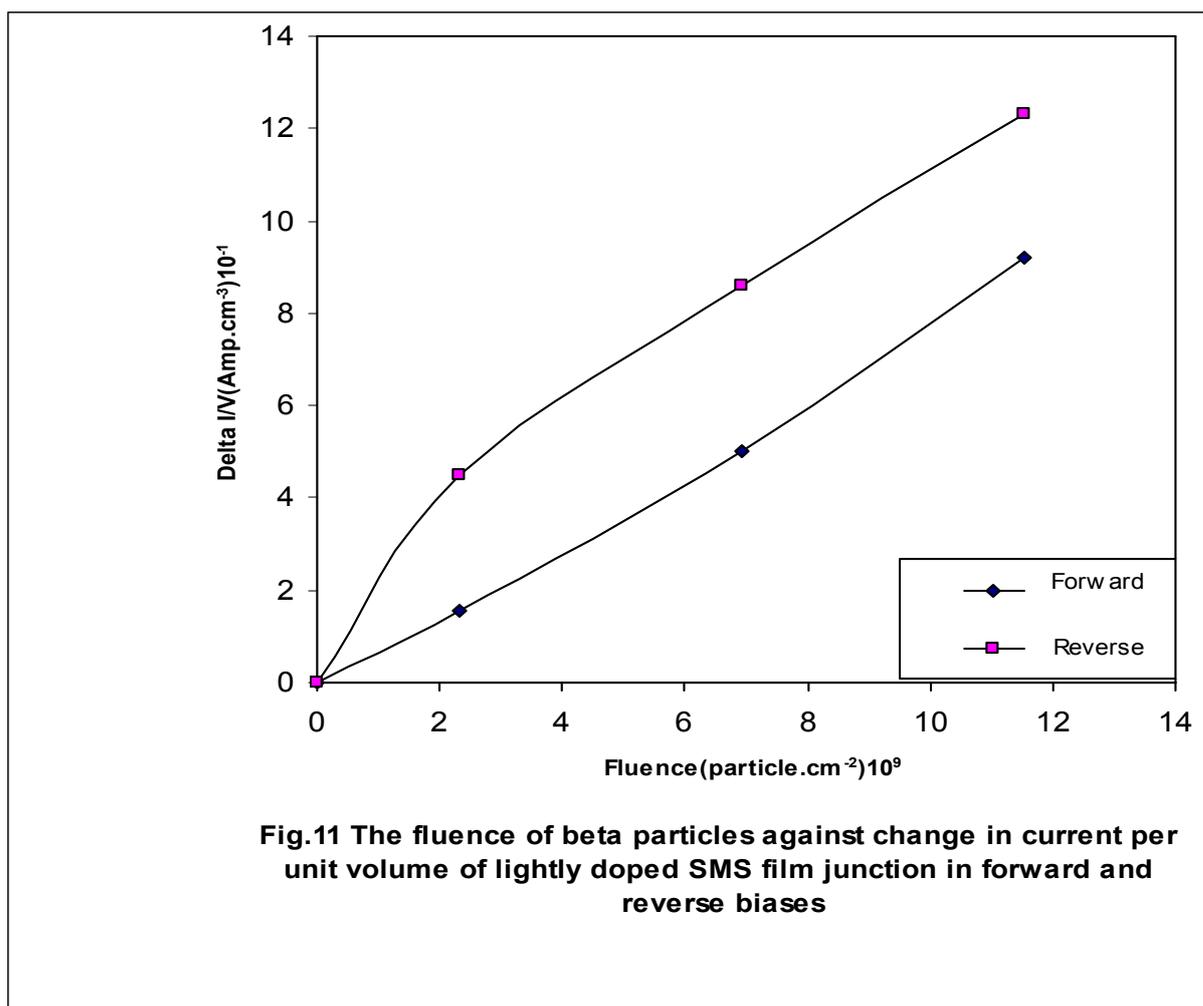
4-5 Effect of atmosphere, alpha and beta exposures on bulk resistivity and damage percentages of lightly doped SMS film junction:

Table 1. indicates the bulk resistivity and damage variation percentages in forward and reverse biases. The bulk resistivity percentages increase with values (55.80%) and (49.98%) in both forward and reverse biases respectively, after the final stage of environmental exposure. The table indicates the damage percentages with (49.75%) in forward and (50.25%) in reverse after 5 days of atmosphere exposure. But the values of resistivity variations and damage percentages are (199.62%) and (90.99%) for forward, and (156.52%) and (84.57%) for reverse biases respectively, as result to exposed to alpha radiation. The damage percentages as a result to alpha effect increases with increasing fluences of alpha particles in two biases. But the bulk resistivity percentages become high in forward and lower in reverse as a result to alpha effect. The effect of beta particle on SMS junction is lower than alpha effect with value (74.74%) in forward and (76.39%) in reverse for bulk resistivity percentages and (293.8%) in forward and (333.33%) in reverse for damage percentages. The bulk resistivity percentage after the third stage of exposure shows an increase in both biases with low ratios. The damage coefficients is relatively high in the first stage of exposure of (10^{-10}Amp.cm^{-1}) order and decrease after the final stage of exposure. The damage coefficient as a result to change in current and as a result to

change in voltages decrease as alpha fluence increasing, in forward and reverse biases, but increase in forward and decrease in reverse biases for beta fluence effect .These changes in values are because of defect generation in p ,n and depletion layer of SMS junction films between n, metal, and p to occurring capture of electron produce by n type. The heavy incident particle create collisions and with host atom at most. The absorption converts at least a portion of energy from the alpha particles into electron-hole pairs for collection by the one p-n junction in the layer of semiconductor material(Cember,1996).The value of D_J for alpha effect is greater than beta effect on

Exposure type	Fluence (days)	$\rho_o\text{-}\rho/\rho_{o\%}$		$J_o\text{-}J/J_o\%$		D_J $_{*10}^{-10}$Amp.cm^{-1}		D_V $_{*10}^{-10}$Amp.cm^{-1}		D_J/D_V	
		F	R	F	R	F	R	F	R	F	R
A.E	1	45.81	5.42	48.10	6.06	-	-	-	-	-	-
	3	11.86	50.23	53.03	75.12	-	-	-	-	-	-
	5	55.80	49.98	49.75	50.25	-	-	-	-	-	-
Alpha	1	72.25	82.91	62.71	66.57	36.20	38.43	36.19	38.43	1.0000	1.0002
	3	36.09	32.06	74.29	71.71	14.29	13.79	14.29	13.79	1.0000	1.0002
	5	199.62	156.51	90.99	84.57	10.50	9.61	10.36	9.76	1.0163	0.9841
Beta	1	48.27	58.26	50.00	122.20	0.68	1.58	0.68	1.96	0.9984	1.0001
	3	67.34	71.67	60.00	233.30	0.72	1.25	0.72	1.25	0.9999	1.0000
	5	74.74	76.39	93.80	333.30	0.79	1.07	0.80	1.07	0.9999	1.0002

the film. The errors ratios were very little between D_J and D_V in forward and reverse biases.

Table1. describes the variation bulk resistivity and damage percentages, damage coefficient as a result to change in current densities and voltages, and its errors in forward and reverse biases of lightly doped SMS junction

5.Conclusions

It can be concluded the following:

1- The lightly doped SMS junction film have high effects on (J-V) characteristics after exposed to environment, alpha and beta radiations.

2-The shifting in forward bias is more than reverse bias in SMS junction in most of exposure, and the effect of alpha is more than beta particles .

3-The SMS junction is the best to make devices and is sensitive to environment and radiation.

4- The bulk resistivity of the film junction increases for environment and alpha effect in both biases , but decrease as a result to exposed to beta radiation in both biases.

5-The saturation current densities and break down voltages increase in the first and second stages of exposures and decreasing at the third stage of exposure.

6-The bulk resistivity and damage percentages have high changed after the final stage of exposure.

7- The damage coefficients decrease as result to alpha and beta after every exposure, except in forward bias for beta effect, it is increasing.

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