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معامل التأثير العربي 1.5
العدد 19

مجلة التربوي
مجلة علمية محكمة تصدر عن كلية التربية
جامعة المرقب

العدد التاسع عشر
يوليو 2021م

هيئـــة تحرير
مجلة التربوي

- المجلة ترحب بما يرد عليها من أبحاث وعلى استعداد لنشرها بعد التحكيم .
- المجلة تحترم كل الاحترام آراء المحكمين وتعمل بمقتضاها .
- كافة الآراء والأفكار المنشورة تعبر عن آراء أصحابها ولا تتحمل المجلة تبعاتها .
- يتحمل الباحث مسؤولية الأمانة العلمية وهو المسؤول عما ينشر له .
- البحوث المقدمة للنشر لا ترد لأصحابها نشرت أو لم تنشر .

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ضوابط النشر:

يشترط في البحوث العلمية المقدمة للنشر أن يراعى فيها ما يأتي :

- أصول البحث العلمي وقواعده .
- ألا تكون المادة العلمية قد سبق نشرها أو كانت جزءا من رسالة علمية .
- يرفق بالبحث تزكية لغوية وفق أنموذج معد .
- تعدل البحوث المقبولة وتصحح وفق ما يراه المحكمون .
- التزام الباحث بالضوابط التي وضعتها المجلة من عدد الصفحات ، ونوع الخط ورقمه ، والفترات الزمنية الممنوحة للتعديل ، وما يستجد من ضوابط تضعها المجلة مستقبلا .

تنبيهات :

- للمجلة الحق في تعديل البحث أو طلب تعديله أو رفضه .
- يخضع البحث في النشر لأولويات المجلة وسياستها .
- البحوث المنشورة تعبر عن وجهة نظر أصحابها ، ولا تعبر عن وجهة نظر المجلة .

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Influence of annealing and Hydrogen content on structural and optoelectronic properties of Nano-multilayers of a-Si:H/a-Ge: H used in Solar Cells

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Abstract

Nano-multilayers (NMLs) of a-Si:H/a-Ge: H were prepared at 200°C by alternating deposition from SiH_4 and GeH_4 plasmas in a computer-controlled four chamber glow-discharge deposition system with capacitive coupled diode reactors. IR spectroscopy and scanning electron microscope (SEM) were used to study the structural changes after annealing at 300 and 450°C for 8 h. The annealed multilayers exhibit surface and bulk degradation with formation of bumps and craters. The electrical measurements results reveal that the increase of electrical conductivity, while optical energy gap is decreased with increasing the annealing temperature and/or time is partially due to formation of H bubbles in the Ge layers and partially due to crystallization effects. On the other hand it was found that the activation energy of crystallization deduced from the annealing time dependence of the conductivity using Avrami's equation is structural dependent.

Keywords Nano-multilayers (NMLs), a-Si:H/a-Ge: H, structure, electrical conductivity, crystallization, Avrami's equation

I. Introduction

Amorphous silicon based semiconductors Nano-multilayers (NMLs) of a greet interest for device applications. Nano-multilayers of a-Si:H/a-Ge:H are used as a new type of narrow bandgap materials for amorphous silicon-based solar cells [1]. High efficiency solar cells are necessary to convert solar energy to electrical energy at low cost [2]. Since the quality of a-$Si_{1-x}Ge_x$:H is not as good as that of a-Si:H, some attempts were carried out to improve the optical and electrical properties of a-$Si_{1-x}Ge_x$:H by producing it from ultrathin layers of a-Si:H/a-Ge:H [3-9]. In this paper, the effect of hydrogen dilution and hydrogen bond configuration on the quality of Nano-multilayers of a-Si:H/a-Ge:H were investigated.

II. Experimental

The Nano-multilayers(NMLs) of a-Si:H/a-Ge:H were prepared by alternating deposition from SiH4 and GeH4 plasmas in a computer-controlled four chamber glow-discharge depositionsystem with capacitively coupled diode reactors. At a substrate temperature of

200°C, a RF of 13.6 MHz, aRF power of 10 W, a pressure of about 0.18 mbar and a gas flow of 5 sccm in the SiH4 chamber and 0.32 mbar and a gas flow of 0.25-2 sccm of H_2–GeH_4 in the GeH4, (NMLs) of a-Si:H/a-Ge:H films were grown on quartz substrates for optoelectronic characterization and on crystalline Si for composition analysis. The (NMLs) of a-Si:H/a-Ge:H structures with well layer thickness of 1.6–8 nm and a barrier layer thickness of 3nm and the other set with barrier layerthickness of 1.6–9 nm and well layer thickness of 1.2and 2 nm were prepared for the measurements. The individual thickness of a-Si:H barrier layer dSi was varied bychanging the deposition time, while the well layer thickness d_{Ge} of a-Ge:H was controlled by changing the hydrogen dilution ratio [H_2]/[GeH_4] as well as by changing the deposition time. The growth rate was kept near 0.1 nm/s for a-Si:H and ranged from 0.1 to 0.4 nm/s for a-Ge:H layers. The total film thickness measured by the Dectak surface profiler was in the range of 300 to 550 nm and the total number of periods was controlled between 60 and 100.The X-ray diffraction (XRD) of the prepared samples has shown that the interface between a a-Ge:H well layer and a a-Si:H barrier layer is atomically abrupt. The period thickness measured by XRD was in good agreement with the period calculated from the total film thickness measured with a Dectak surface profiler and the growth rates of the individual layers in the bulk. Infrared absorption spectra were measured in the range between 400 and 2200 cm^{-1} using a Nicolet Fourier transform infrared spectrometer (model 740). After base line correction, the IR absorption peaks were fitted by Gaussian to obtain the integrated absorption intensity I*. As the film thickness was usually below1 μm, the correction proposed by Langford et al. was employed to obtain the integrated absorption I. The optical bandgap E_g was deduced from transmission and reflection measurements using JASCO V-570 UV - vis Spectrophotometer–Instructions. The samples were characterized by the scanning electron microscopy (SEM) after annealing at 300°C for 8 h. For electrical measurements, a co-planer method was used for the dark and photo-conductivity in vacuum. The light source of a tungsten lamp of intensity 100mW/cm^2 was employed.

III. Results and discussion

3.1. Infrared absorption spectra

Typical infrared (IR) absorption spectra for a-Si:H(3 nm)/a-Ge:H multilayers of thickness d_{Ge}=1.2 nm (HD = 20) and d_{Ge}= 2 nm (HD =10) are shown in figure (1). For the a-Si:H/a-Ge:H multilayers, major absorption peaks between 500 and 800cm^{-1} are attributed to Si-H and Ge-H wagging modes and between 1800 and 2200cm^{-1} due to Si-H and Ge-H stretching modes. The absorption peak near 1880 cm^{-1} is attributed to the stretching vibration of Ge-H groups incorporated into bulk material, while the absorption near 2100cm^{-1} is associated with the vibration of Si-H and/or Si-H_2 groups located at internal surfaces of voids. The absorption peak near 2000 cm^{-1} was attributed to Ge-H or Ge-H_2 groups at void surface and Si-H groups in compact material [3,10,11].

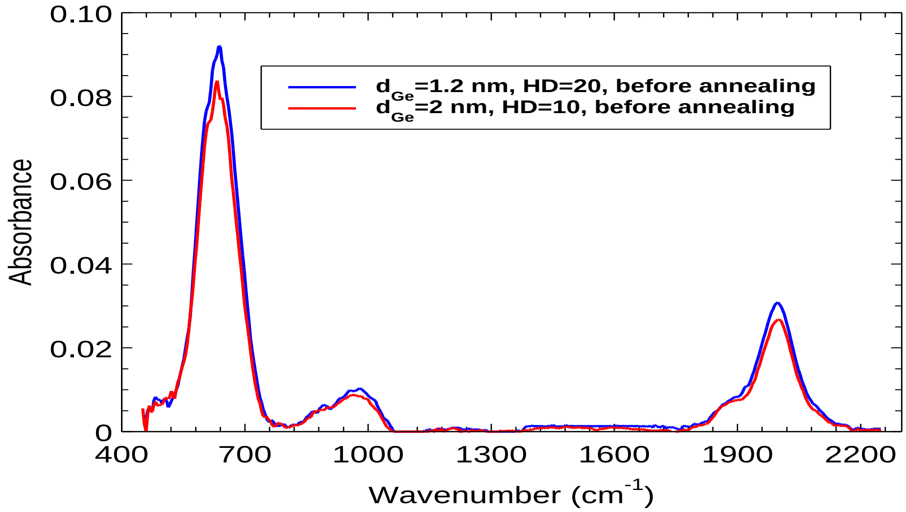

Figure (1): The IR- spectra of untreated a-Si:H(3 nm)/a-Ge:H multilayers of d_{Ge}=1.2 and 2 nm.

It seen that the absorbance of the wagging, bending and stretching modes decreases by increasing the well width due to reduction in the total hydrogen content N_H arising from decreasing of the hydrogen dilution during deposition which leads to a decrease of the hydrogen content [12].

The hydrogen evolution from the multilayers of a-Si:H/aGe:H during annealing plays an important role for changes of structure and properties. It is seen that after annealing for 8 h at 300^{o}C and 450°C, the integrated intensity of the waging, bending and stretching bond decreases for the two samples. In the stretching mode range of the wave number, the spectra show that the integrated absorption intensity of Ge-H and Si-H stretching bonds is decreasing after annealing at 300^{o}C and 450°C, indicating that hydrogen moves around in Ge and Si layers and is partially evolved, thus causing a change in the atomic density of the Ge and Si network and also a change in the ratio of $\mathbf{d_{Ge}/(d_{Si}+ d_{Ge})}$ which is correlated with the form factor. The hydrogen evolved from Ge and Si layers leads to structural relaxation caused by the annealing preferentially takes place [8,13].

The hydrogen content (N_H) calculated by fitting the stretching mode of a-Si:H(3 nm)/a-Ge:H multilayers of d_{Ge}=1.2 nm and d_{Ge}= 2 nm before and after annealing (See figures (2) and (3)) is given in table (1). The fitting was done by using Gaussian distribution for calculating the hydrogen content. For brevity see figure (4) for untreated a-Si:H(3nm)/a-Ge:H multilayers of thickness d_{Ge}=1.2 nm (HD =20).

It is seen that the total hydrogen content (N_H) is decreasing after annealing at 300 and 450°C due to the evolution of hydrogen from the network during the annealing process.

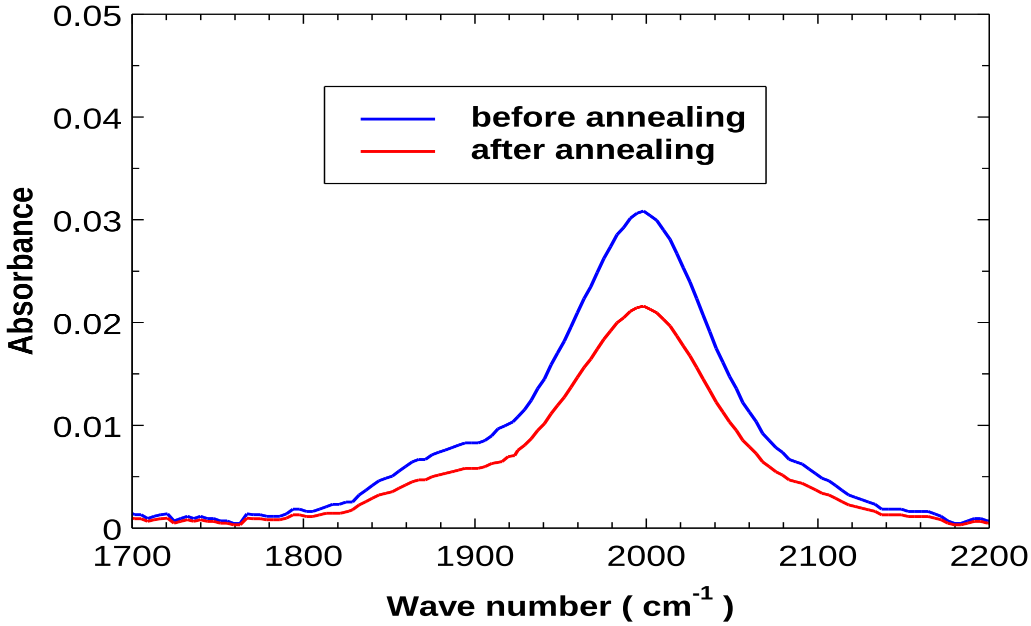

Figure (2): IR- spectra of the stretching mode of a-Si:H (3 nm)/a-Ge:H multilayers of d_{Ge}=1.2 nm before and after annealing at 300°C for 8 h.

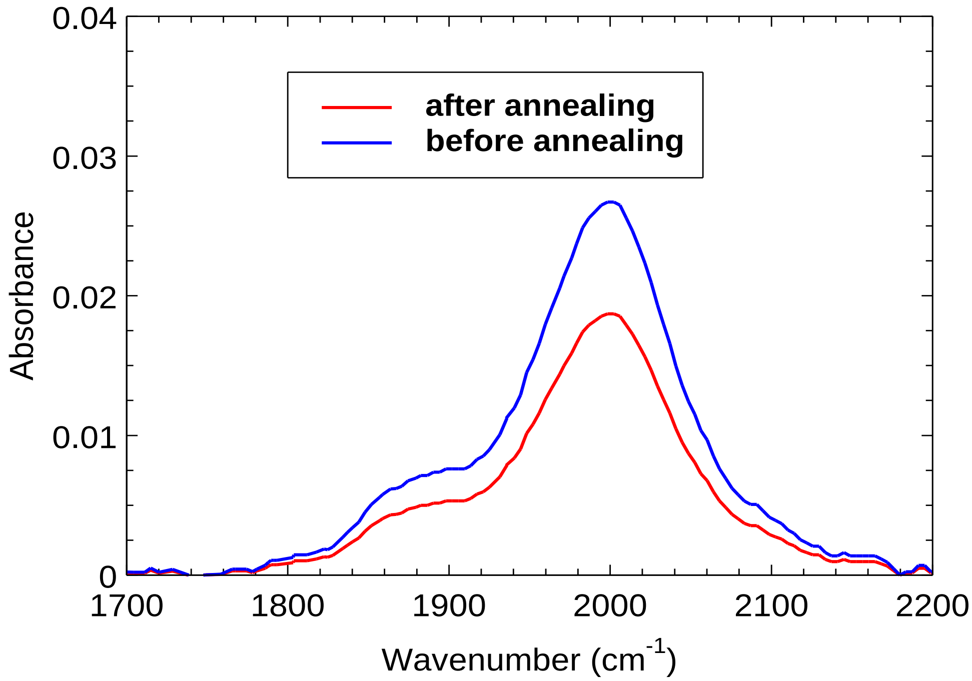

Figure (3): IR- spectra of the stretching mode for a-Si:H (3 nm)/a-Ge:H multilayers of d_{Ge}=2 nm before and after annealing at 450°C for 8 h.

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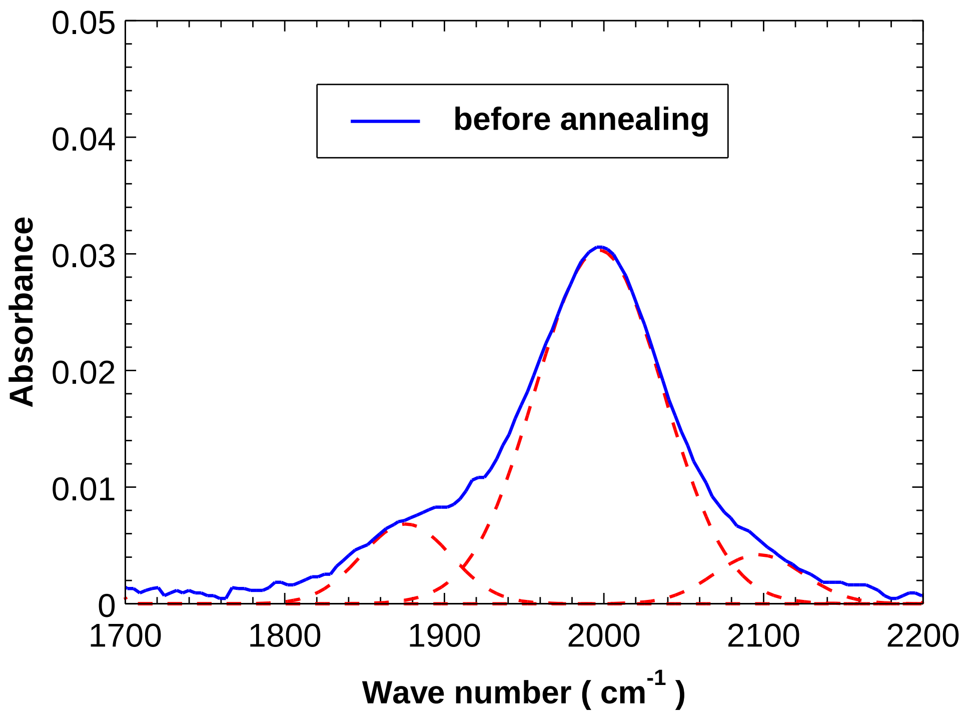

Figure (4): Fitting of IR- spectra in the stretching mode range for a-Si:H (3 nm)/a-Ge:H multilayers of d_{Ge}=1.2 nm before annealing.

Table (1): The hydrogen content for the two samples before and after annealing.

Samples	d_{Ge} (nm)	HD	annealing temperature (°C)	Hydrogen content before annealing (N_H) cm^{-3}	Hydrogen content after annealing (N_H) cm^{-3}
a-Si:H(3 nm)/a-Ge:H	1.2	20	300	2.85 $x10^{21}$	2.03 $x10^{21}$
a-Si:H(3nm)/a-Ge:H	2	10	450	2.64 $x10^{21}$	1.84 $x10^{21}$

3.2 Scanning Electron Microscopy (SEM)

Multilayers of a-Si:H (3 nm)/a-Ge:H were investigated by the scanning electron microscopy (SEM) after annealing at 300 and 450°C for 8 h. Figures (5) and (6) show the SEM images of a-Si:H (3 nm)/a-Ge:H multilayers of d_{Ge}= 1.2 and 2 nm and annealed at 300°C and 450°C for 8 h, respectively. It is seen from the images that bumps appear on the surface of the films annealed at 300°C for 8 h{see figure (5)} while craters are

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formed on the surface of films annealed at 450°C as shown in figure (6). The hydrogen forming the bubbles arises from the rupture of the Si-H and Ge-H bonds activated by the thermal energy of the annealing temperature [15] and by the energy released from the recombination of thermally generated electron hole pairs. It has been reported that if the initial H content is very high and /or the annealing conditions are very severe creation of craters occurs [16,18]. Thus, craters appeared on the surface of films annealed at 450°C as shown in figure (6).

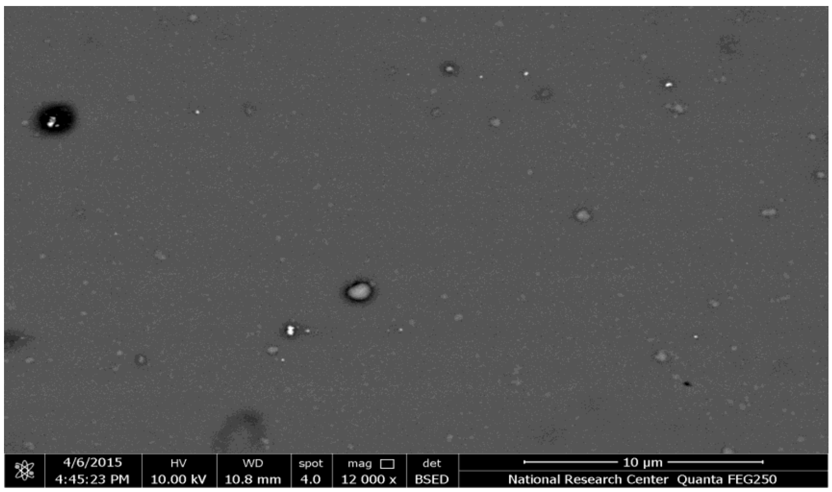

Figure (5): The SEM image for a-Si:H(3nm)/a-Ge:H multilayers of thickness of d_{Ge}= 1.2 nm and annealed at 300°C for 8 h.

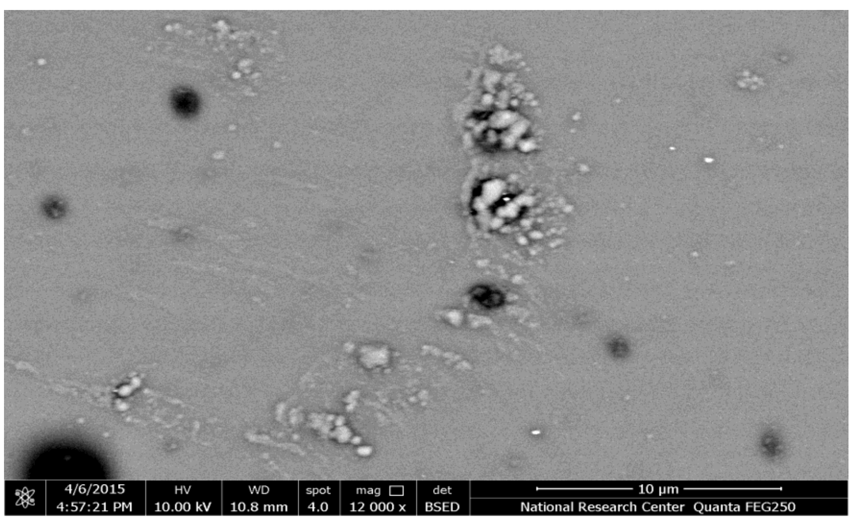

Figure (6): The SEM image for a-Si:H(3nm)/a-Ge:H multilayers of d_{Ge}=2nm and annealed at 450°C for 8h.

3.3. Optoelectronic data

The optical bandgap is useful material parameter that allows comparison of a-Si:H(3 nm)/a-Ge:H multilayers thin films based materials regarding their light absorption properties. Figures (7) and (8) shows the relation between $(\alpha h\nu)^{1/2}$ and $h\nu$ of a-Si:H(3 nm)/a-Ge:H multilayers of thickness d_{Ge}=1.2 and 2 nm, respectively. According to Tauc's relation, the optical energy gaps deduced from the plots are given in tables (2) for the two samples before and after annealing.

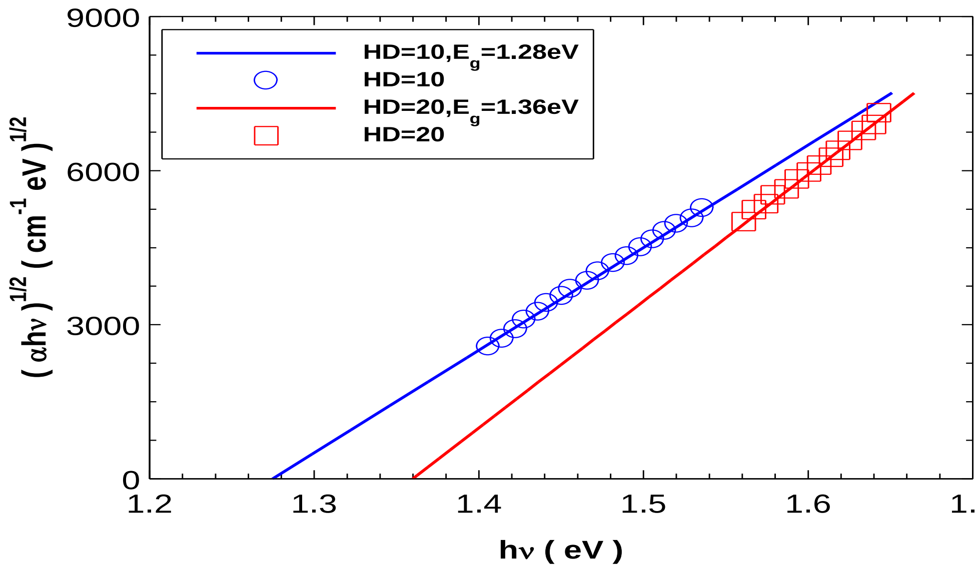

Figure (7): $(\alpha h\nu)^{1/2}$ vs. $h\nu$ for untreated a-Si:H(3nm)/a-Ge:H multilayers of d_{Ge}=1.2nm (HD=20) and d_{Ge}=2nm (HD=10).

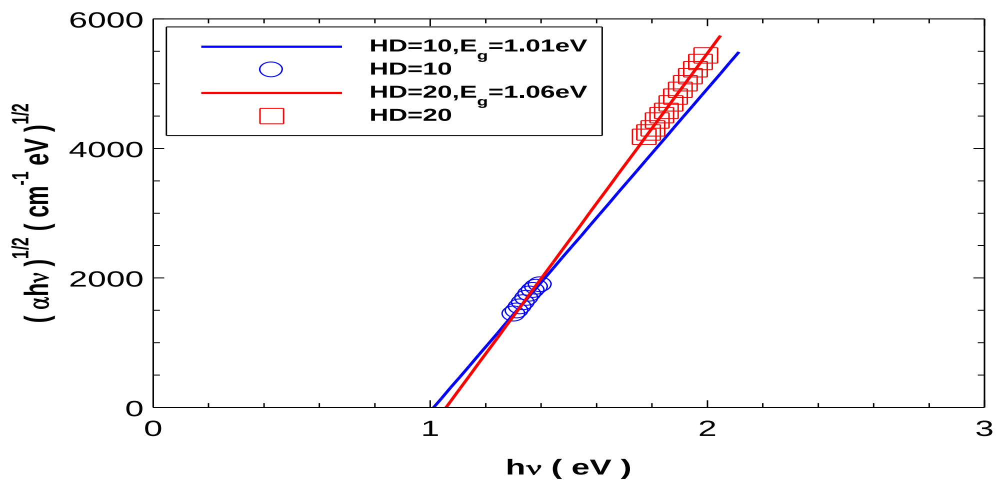

Figure (8) : $(\alpha h\nu)^{1/2}$ vs. $h\nu$ for a-Si:H(3 nm)/a-Ge:H multilayers of d_{Ge} = 1.2 nm (HD = 20) and d_{Ge} = 2 nm (HD =10) after annealing.

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It seen from table (2) that the optical gap for a-Si:H(3nm)/a-Ge:H multilayers decreases after annealing while the Urbach energy increase. This clearly confirms the very close relationship existing between these two parameters because of the presence of a more or less important density of dangling bonds in the material [9,11,17].

Table (2): The optical energy gap E_g and Urbach energy E_u for a-Si:H(3 nm)/a-Ge:H multilayers.

		before annealing			After annealing		
Sample	d_{Ge} (nm)	N_H (cm^{-3})	E_g (eV)	E_u (meV)	N_H (cm^{-3})	E_g (eV)	E_u (meV)
a-Si:H(3 nm)/a-Ge:H	1.2	2.85 $x10^{21}$	1.36	72	2.03 $x10^{21}$	1.06	79
a-Si:H(3 nm)/a-Ge:H	2	2.64 $x10^{21}$	1.28	96	1.84 $x10^{21}$	1.01	102

The dark and photo- conductivities as a function of temperature for a-Si:H(3 nm)/a-Ge:H multilayers of thickness d_{Ge}=1.2 and 2 nm in the temperature range 303- 423 K are shown in figures (9) and (10), respectively. It is seen that the relation between the electrical conductivity and the temperature obey the Arrhenius type equation:

$$\sigma=\sigma_0 \exp(-E_a/k_BT) \qquad (1)$$

where σ is electrical conductivity, E_a is the activation energy and k_B is the Boltzmann`s constant. The hydrogen content plays an important role for determining electrical conductivity of a-Si:H/a-Ge:H multilayers. The electrical conductivity measured at 300 K and the activation energy calculated from the slopes of the lines for the samples are given in table (3). It is seen that the electrical conductivity increase while activation energy decrease with increasing d_{Ge} due to a decrease in the total hydrogen content as conformed by the previous works [11,14] Also the photo conductivity increases while the photosensitivity decreases with increasing the well width thickness.

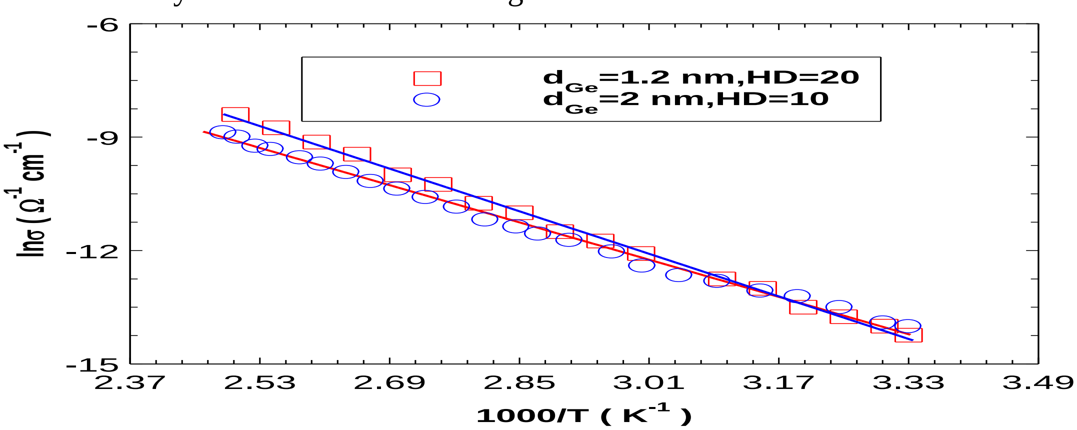

Figure (9): Dark conductivity vs. inverse of temperature for a-Si:H(3 nm)/a-Ge:H multilayers of d_{Ge} = 1.2 nm (HD = 20) and d_{Ge} = 2 nm (HD =10).

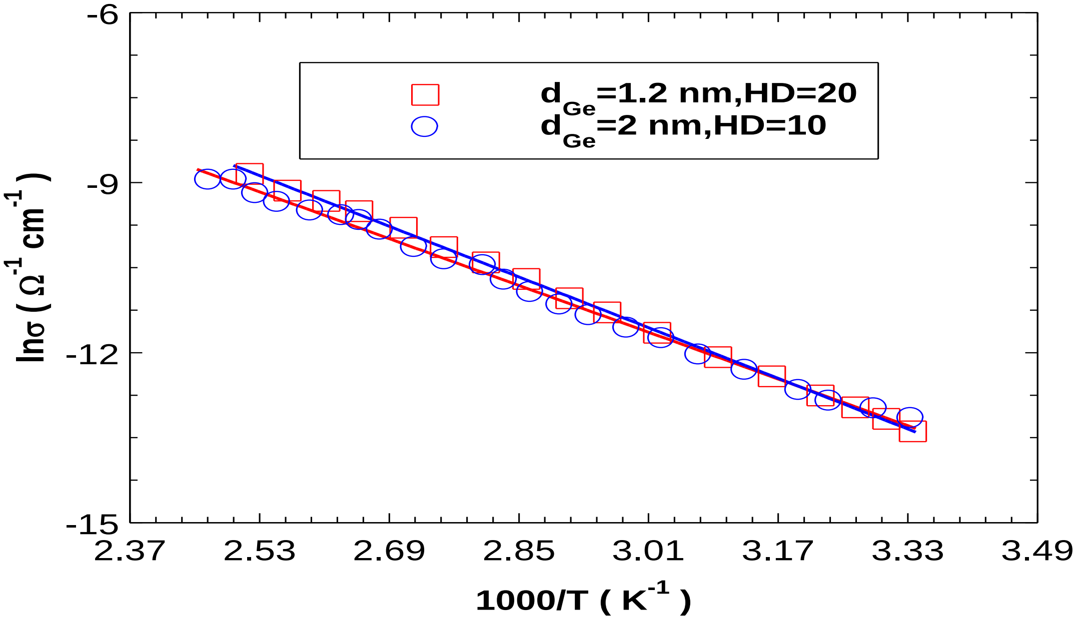

Figure (10): Photo- conductivity vs. inverse of temperature for a-Si:H(3 nm)/a-Ge:H multilayers of d_{Ge} = 1.2 nm (HD = 20) and d_{Ge} = 2 nm (HD =10).

Table (3): Dark and photo- conductivity measured at 303 K and the activation energy for untreated a-Si:H(3 nm)/a-Ge:H.

The sample	d_{Ge} (nm)	HD	σ_d ($\Omega^{-1}.cm^{-1}$)	σ_{Ph} ($\Omega^{-1}.cm^{-1}$)	σ_{Ph}/σ_d	$E_{a,d}$ (e.V)	$E_{a,Ph}$ (e.V)
a-Si:H(3 nm)/a-Ge:H	1.2	20	5.86 X 10^{-7}	1.53 X 10^{-6}	2.61	0.61	0.48
a-Si:H(3 nm)/a-Ge:H	2	10	6.67 X 10^{-7}	1.64 X 10^{-6}	2.46	0.53	0.45

The electrical conductivity of a-Si:H(3nm)/a-Ge:H multilayers of d_{Ge}= 2 nm as a function of annealing times recorded at different temperatures 493, 523, 553 and 573 K is given figure (11). All samples show the same general behavior where the electrical conductivity increases with increasing the annealing time at constant annealing temperature and becomes constant at high annealing time. This behavior is attributed partially to crystallization occurring in the multilayers and partially to the release of hydrogen from the network depending on the annealing temperature and annealing time. It is known that the conductivity of crystalline material is higher than that of amorphous one since the ordered systems exhibit lower activation energy than the amorphous one. Thus the electrical conductivity measurements as a function of annealing time at constant temperature are used to study the isothermal crystallization kinetics using Johnson-Mehl-Avermi`s (JMA) equation [20].

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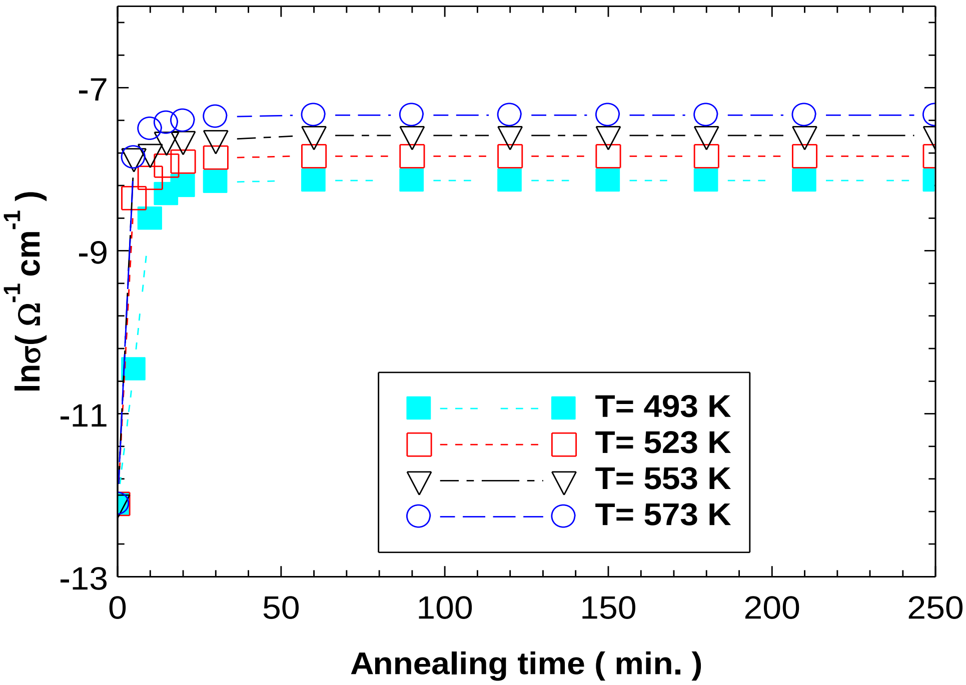

Figure (11): logarithm of the electrical conductivity versus the annealing time at constant annealing temperatures for a-Si:H(3nm)/a-Ge:H multilayers of d_{Ge}=2 nm.

It is known that the electrical conductivity of the ordered system is higher than that of amorphous one and the ordered systems exhibit lower activation energy than the amorphous one [19]. Thus the electrical conductivity measurements as a function of annealing time at constant temperature are used to study the othermal crystallization kinetics using Johnson-Mehl-Avermi`s (JMA) equation [20]. in the form:

$$\chi = 1- \exp[-(kt)^n] \qquad (2)$$

Where χ is the volume fraction of the crystalline phases transformed from the amorphous state at time t, n refers to the order of reaction and k is the effective overall reaction rate, which actually reflects the rate of crystallization [20], and it is given by:

$$k = k_0 \exp[-E_c/RT] \qquad (3)$$

Here ko indicates the number of attempts to overcome the energy barrier. From the results of the conductivity as a function of annealing time the volume fraction χ is calculated from the relation:

$$\chi = (\sigma_t - \sigma_0)/(\sigma - \sigma_0) \qquad (4)$$

where σ_0 is the electrical conductivity at zero time, σ_t the electrical conductivity at any time t and σ is the electrical conductivity at the end of saturation (full crystallization). According to JMA equation the value of n can be obtained from the slopes of the plots of Ln[-ln(1- χ)] vs. ln(t)

According to JMA equation the values of (n) are given in table (4) for the studied films measured at 493, 523, 553 and 573 K. Since the volume fraction of the crystallized phases is assumed to depend on the conductivity of the material at any annealing time, we found that the value of (n) does not depend on the annealing temperature. The values of (k) are given in table (4) for the films. According to equation (3) the values of the activation energies E_c of crystallization for the a-Si:H(3nm)/a-Ge:H multilayers of d_{Ge}=2 nm are also given in table (4).

Table (4): Values of n, k and E_c for a-Si:H(3nm)/a-Ge:H multilayers of thickness d_{Ge}= 2 nm.

	n				k				
T	493 (K)	523 (K)	553 (K)	573 (K)	493 (K)	523 (K)	553 (K)	573 (K)	E_c kJ/mol
d_{Ge}= 2nm	1.17	0. 757	0. 755	0. 771	$7.07x10^{-4}$	$3.05x10^{-2}$	$5.16x10^{-1}$	$7.8 x10^{-1}$	213.7

For a-Si:H (3nm)/a-Ge:H multilayers of d_{Ge}=1.2 nm measured at 573, 623, 673 and 723 K as a function of time, the values of n and values of (k) are given in table (5) for film. According to equation (3) the values of the activation energies E_c of crystallization are given in table (5). The results obtained show that crystallization takes place in Si and Ge layers individually since the crystallization temperature of Ge is around 573 K while that of Si is near 773 K Thus the activation energy of Si layers is higher than that of Ge layers as seen in table (5).

Table(5): Values of n, k and E_c for a-Si:H(3nm)/a-Ge:H multilayers of thickness d_{Ge}=1.2 nm.

	n				k				
T	573 (K)	623 (K)	673 (K)	723 (K)	573 (K)	623 (K)	673 (K)	723 (K)	E_c kJ/mol
Ge-Layer	1.15	0.669	0.664	0.761	$1.22x10^{-1}$	$5.13x10^{-1}$	$6.68 x10^{-1}$	$7.70x10^{-1}$	40.41
Si-Layer	0.457	0.325	0.154	0.198	$2.70 x10^{-3}$	$1.04x10^{-2}$	$3.74x10^{-2}$	$5.77x10^{-2}$	72.83

IV. Conclusion

All samples show the same general behavior where the electrical conductivity increases with increasing the annealing time at constant annealing temperature and becomes constant at high annealing time. This behavior is attributed partially to crystallization occurring in the multilayers and partially to the release of hydrogen from the network depending on the annealing temperature and annealing time. The hydrogen content plays an important role for determining the electrical conductivity and optical gap of nano-multilayers a-Si:H/a-Ge:H thin films. The reason in changing optical gap, this may be due to shifting the Fermi level, where increasing shifting the Fermi level above, with bumps large.

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References

[1] X. Sun, T. Zhang, L. Yu, L. Xu, J. Wang, Scientific Reports 9, 19752 (2019).
[2] F. T. Si, O. Isabella, M. Zeman, Solar Energy Materials and Solar Cells 163, 9-14 (2017).
[3] M. S. Abo Ghazala, Physica B 293, 132 (2000).
[4] P. Haldar, J. L. Harvey, Mater. Scie. Appi. vol. 3, pp. 67 (2012).
[5] Philips, J. I. Dijkhuis , Phys. Rev. vol. 873, pp. 155202 (2006).
[6] W.C. Sinke , W.F. van der Weg , S. Roorda , P.C. Zalm , Phys. Rev. B 53, 4415(1996).
[7] M. Daouahi, K. Zellama, H. Bouchriha, P. Elkaïm, Eur Phys J AP10,185 (2000) .
[8] Y. Bouizem , A. Belfedal, J.D. Sib , A. Kebab , L. Chahed , J Phys Condens Matter, 19,356215 (2007).
[9] A. A. Langford, M. L. Fleet, B. P. Nelson, W. A. Lanford,and N. Maley, Phys. Rev. B 45, 13367 (1992).
[10] K. W. Jobson and J.P.R. Wells,R.E. I. Schropp,N.Q. Vinh,J.I. Dijkhuis, J. Appl. Phys. 103, 13106 (2008).
[11] K. Chen, S. Huang, J. Xu, X. Huang, H. Fritzche, A. Matsuda, G. Gangul, Journal of optoelectronics and Advanced Materials, Vol.4,561(2002).
[12] M. S. Abo-Ghazala, P hys. Status Solidi C 8, 3099–3102 (2011).
[13] S. Kannan, **Master of Science ,** Department of Physics, The University of Utah (2005).
[14] R.J. Soukup, N. J. Ianno, S. A. Darveau, C. L. Exstrom, Sol. Energy Mater. Sol. Cells 87,87 (2005).
[15] W. Beyer and V. Zastrow, J. Non-Cryst. Solids 227-230, 880 (1998).
[16] W. Paul, D. K. Paul, B. Von Roe Dern, J. Blake, S. Oguz, Phys. Rev. Lett.46, 1016 (1981).
[17] J. Tauc, in Amorphous and Liquid Semiconductors, ed (J. Tauc, Plenum) 159 (1974).
[18] C. Frigeri, L. Nasi, M. Serenyi, A. Csik, Z. Erdelyi, D. L. Beke, Superlatt. Microstruct 45,475 (2009).
[19] A. A. Langford, M. L. Fleet, B. P. Nelson, W. A. Lanford and N. Maley, Phys. Rev. B 45, 13367 (1992).
[20] J. A. Augis, J. E. Bennett, J. Thermal Anal. 13, 283 (1978).

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