'I-V Characteristic and Crystal Structural Of a-As/c-Si Heterojunctions

Jenan H. Al.Haidery* ***Ramaz A. Al.Ansari*****
Hussien K.Al.Lamy** ***Hanaa I.Mohammed******

Received 20, December, 2012
Accepted 11, March, 2014

Abstract:

In this research the a-As flims have been prepared by thermal evaporation with thickness 250 nm and rata of deposition r_d(1.04nm/sec) as function to annealing temperature (373 and 473K), from XRD analysis we can see that the degree of crystalline increase with T_a, and I-V characteristic for dark and illumination shows that forward bias current varieties approximately exponentially with voltage bias. Also we found that the quality factor and saturation current dependence on annealing temperatures.

Key words:Amorphous Arsenic ,Heterojunction and Annealing temperature

Introduction:

The heterojunction device of the amorphous- crystalline semiconductor type have been much attention considerable interest from researchers both from a fundamental physics and technological field ,for example Mimer and Hatenaka 1987 [1] showed that a-Si:H/c-Si has application to imaging devices,Kentaro and Nakazawa 1988;Lovejoy 1992 have also studied amorphous-polycrystalline of silicon films have possible application in a photoelectonics [2,3] Amorphous arsenic generally, were among the first and most widely investigated amorphous semiconductors[4] , The understanding of the behavior of arsenic in highly doped near surface silicon layers is of crucial importance for the formation of *n* -type ultrashallow junctions in current and future very large scale integrated technology.[5] This is of particular relevance when studying recently developed implantation and annealing methods, The use of arsenic as *n*-type dopant silicon has beenExtensively Investigated and applied for the past and present semiconductor technology.

Compared to other *n*-type dopants, arsenic offers a relatively high solid solubility and a high mass that gives low penetration depth when the dopant atoms are introduced by ion implantation [6].

According to Kazerski [7] amorphous thin films posses a large density of dangling bands which difficult doping attempts because dopants attach for possible device application.

The purpose of this study is to measure the structural characteristica-As/c-Siheterojunction as a function to annealing temperature and attempt fabricate the a-As/c-Si heterojunction as a function to annealing temperature

Experimental details:

p-type silicon wafers of (111) were etched in a chemical solution consists of 3ml HNO_3 1ml H_2O for 1-3 minutes and they where dried by using blower and wiped with soft paper before arsenic deposition . High purity of arsenic thin film (250nm thick) was deposition on the glass surface by thermal evaporation technique in unit vacuum type Edwared 306A .Ohmic

*Department of physics, college of Science ,University of Nihreen
** Department of physics, college of Science for women ,university of Baghdad .
*** Department of physics, college of Science, university of Baghdad.
****Collage of Education, Ibn Al-Haitham, university of Baghdad.

contacts were made by evaporating of a thick film of high purity Al at back of the wafer. The evaporation was achieved under vacuum pressure down 10^{-5} Torr .Substrate temperature was kept close to room temperature, The annealing has been done with temperatures of 373K and 473K and annealing time around 60 minutes[8].

Results and Discussion:

1- XRD analysis:

X-ray diffraction(XRD) diffraction of arsenic films at various T_a were carried out in order to get an information about the structure changes produced by heat treatment at various T_a obviously.

The structure of the as deposition As film at room temperature and the annealing at 373 and 473 K are crystalline phase as show in fig (1) and the degree of crystalline phase increase with increasing Ta ,similar result have been pointed by ref [9].

Table (1) the comparison between observed and standard peeks at XRD patterns for 250 nm a-As thin films for different T_a.

T_a (K)	2ø (degree)	d_{hkl} Exp. (nm)	Int. Exp. (arb. u.)	d_{hkl} Std. (nm)	Int. Std. %	hkl	FWHM (degree)	G. S. (nm)
373	32.6	2.745	60	2.738	100	(111)	0.45	173
473	32.7	2.736	95	2.738	100	(111)	0.40	195

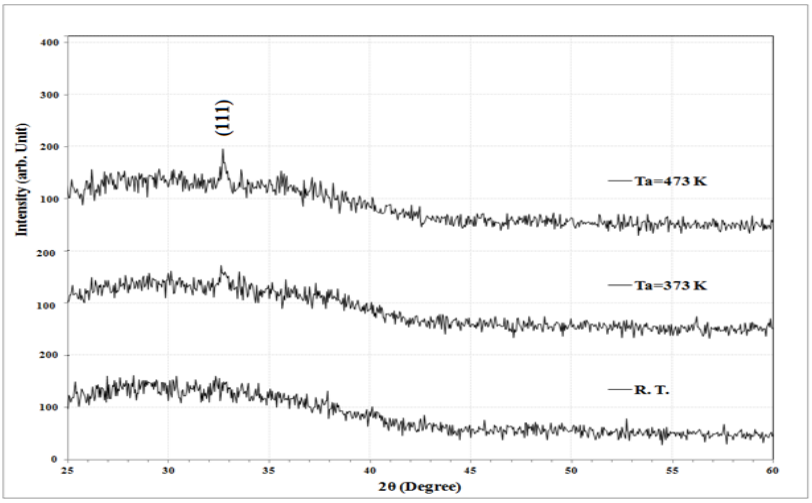


Fig (1) XRD of Arsenic with different annealing temperature

2- I-V characteristic of a-As /c-Si under dark

The I-V characteristic of a-As/c-Si as show the forward I-V characteristic for a junction is described by the thermionic emission relation :

$J_F = J_S \exp qV_F/nK_BT$

A sime –log J-V plot under forward bias for annealed and unannealed for a-As/c-Si hetrojunction at forward and

reverse bias voltage is presented in fig (2) . the ideality factor of the diodes is in value (1.5-2) for sample prepared at RT and annealing with 473K . This values reflected that the carriers transport is taken place by tunneling and recombination mechanisms associated with the thermionic emission mechanism.

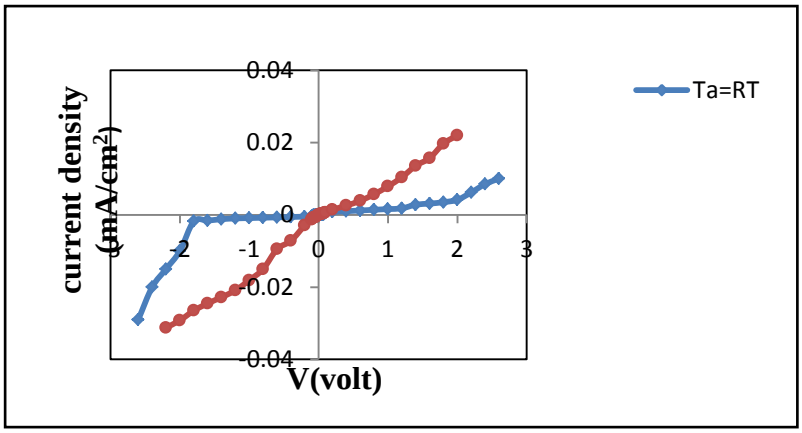
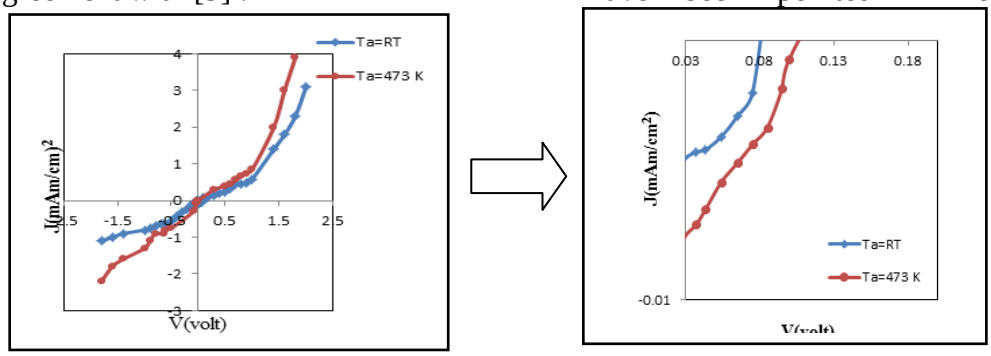


Fig (2) Forward J-Vcharacteristic for a-As/c-Si annealed and unannealedhetrojunction

In general the forward dark current is generated due to the flow of majority carriers and the applied voltage injects majority carriers which lead to the decrease of the built-in potential ,as well as the width of the depletion layer. We also observed that the current increases slightly with increasing of annealing temperature because the increasing of temperature causes as rearrangement of the interface atoms and reduce the dangling bond , surface state and dislocation at interface layer between a-As and c-Si which leads to improvement of the junction characteristics this behavior are agreement with [9] .

(b) I-V characteristic of a-As /c-Si under under illumination

The (I-V) for a-As/c-Si characteristic under illumination shown in figure (3) , in the forward bias the current increased exponentially with voltage as expected, but in reverse bias the current was found to be increasing slowly with voltage (soft break down) and did not show any trend of saturation or sharp breakdown ,From this figure we can see that the V_{oc} increase with T_a, this may be associated with reduction the recombination center in term important the crystal structure similar variation have been pointed in ref [10].



Fig(3) I-V characteristic under illumination for a-As/c-Si heterojunction solar cell at forward and reverse bias voltage at 300K and 473K

We observe the photocurrent density increases with increasing of the bias voltage

Table (2) value of V_{OC},$J_{Sh.C}$, J_{sh},V_{max},$I_{s\ max}$and idealtyfacter for a-As/c-Si hetrojunction

Th .µm	T_a K	n	$J_s \times 10^{-7}$ (Am)	V_{oc} (Volt)	I_{sc} (mA/cm)	V_{max} (Volt)	$I_{s\ max}$ (mA/cm^2)
0.25	R.T	1.87	16	0.08	0.004	0.05	0.003
	473	1.76	10	0.1	0.007	0.005	0.005

Conclusions:

The structure nature of the As is amorphous but after the annealing process changes to partial single crystalline.

The current-voltage measurement of a-As/c-Si in the dark case to deduce that the value of ideality factor increases with increasing of annealing temperatures ,also theJ_{sc}andV_{oc}increase with the increasing of annealing temperature.

References:

[1] H.Mimura, Y.Hatanaka, J.Appla. phys.61:2955 (1987).

[2] I.Kentaro,I.Nakzawa, Japanese ,journal of Applied physics 27:2094 (1988).

[3] D.Lovjoy, Renewable energy – technology and environmeat, Exeter, pergamon press, pag. 12 4-132 (1992)

[4] N. Mott, and E. davis" Electronic Processes in Non-Crystalline Materials" second edition(Oxford , Clarendon press) (1979).

[5] D. Giubertoni , P. Pepponi, S. Gennaro, "journal of applied physics 104, 103716 (2008).

[6] R.duffy,T.Dao, Tamminga, K.Vandertak, F.Roozebom and E.Augendre, appl. Physs. Let 89,71915(2006)

[7] Sze,S.M. Semiconductor Devices: physics and Technology. 2nded. New York: John Wiley and Sons,(2001)

[8] M. Hammam, G.Adriaenssens and J.Grevendonk, " Solid State Phys. "2151-2160(1985) .

[9] Fatin .K.H "optoelectronic properties of a-Sb/c-Si hetrojunction" M.Sc thesis

[10] A.H.Sabbar and H.Kh.Al.Lamy " the third scientific conference of Wassit University "(2009).

الخصائص الكهروبصرية والتركيبيه للمفرق المتباين a-As/c-Si

جنان حسين الحيدري* ***رامز احمد الانصاري**** ***حسين خزعل اللامي*****

حنان محمد **

*جامعة النهرين – كلية العلوم- قسم الفيزياء.

**جامعة بغداد كلية العلوم للبنات-قسم الفيزياء.

***جامعة بغداد كلية العلوم -قسم الفيزياء .

****جامعة بغداد –كلية التربية ابن الهيثم- قسم الفيزياء.

الخلاصة:

حضرت أغشية a-As بطريقة التبخير الحراري بسمك250 nmمعدل الترسيب (1.04nm/sec) كدالة لدرجات الحرارة التلدين K (373473and) بينت فحوصات XRD وجود التركيب العشوائي مع تبلور جزئي لأغشية a-As المحضرة عند RT ولوحظ زيادة درجة التبلور مع زيادة درجة حرارة التلدين درست خصائص التيار- فولتية في الظلام والإنارة حيث لوحظ زيادة التيار الأمامي مع درجة حرارة التلدين وأن تيار الانحياز الامامي يتغير أسيا مع فولتية الأنحياز,كذلك وجد اعتماد عامل المثالية وتيار الاشباع على درجة حرارةالتلدين.