Research Journal of Nanoscience and Engineering
Volume 3, Issue 3, 2019, PP 9-13
ISSN 2637-5591

Managing Photovoltaic Properties of Formation of Radiation Defects in Double Barriers Structure with a Base of Nano structural Silicon

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ABSTRACT

Developed and analyzed double-barriers structures based silicon with high sensitivity integrated in the short range. The effect of gamma radiation on the mechanism of current transport in the structure type Schottky barrier, and in the p-n junctions. It is shown that the double-barrier structure can improve the photovoltaic parameters of conventional detectors. We studied the effect of gamma radiation on the origin of the current mechanism in the structure as a whole, and in the Schottky barrier in the p - n - transitions separately. Also studied the effect of radiation on the photoelectric and photoluminescence parameters of the two barrier structure. Shown that two barrier structures can improve the photoelectric parameters of conventional detectors. The photo detector on the basis of silicon with the increased integrated sensitivity in short-wave area of a range is developed. Influence radiation scale on the mechanism of currents of both in structure like Schottky's barrier, and in p - n - transitions is investigated. It is shown that two-barrier structures allow improving photo-electric parameters of traditional detectors. Investigated the impact of radiation on the photoelectric and photoluminescence parameters of two-barrier structures.

Keywords: *silicon photo detectors, two barrier structure, p - n – transitions and Schottky barrier, photo luminescence*

INTRODUCTION

Two barrier structures have been developed and analyzed - based on silicon photo detectors with high sensitivity shortwave spectrum. We studied the effect of gamma radiation on the origin of the existing mechanism in the structure as a whole, and in the Schottky barrier and p-n transitions separately. Also, the effect of radiation on the photoelectric and photolumine scence parameters double-barrier structure has been studied. It is shown that the two barrier structures can greatly improve the characteristics of conventional photoelectric detectors.

The effect of radiation on the photoelectric and photo luminescence parameters of the two barrier structures. Silicon photo detectors, still the most widespread type of photo converters. One of the main directions of increase of speed and increase in spectral sensitivity of modern receivers of radiation with one transition is creation of multi barrier structures, in which thanks to internal strengthening and growth of coefficient of collecting of the photo generated carriers it is possible to improve significantly key parameters which meet the requirements and needs of optoelectronics. Reliability of work of the received structures under the raised conditions of radiation, as detectors of ionizing radiation is an actual task and makes a subject of our researches.

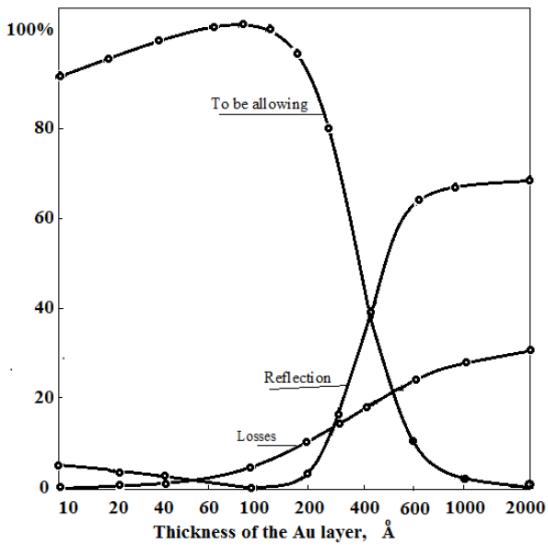

Figure1. *The dependence of reflection, absorption and conductivity of the metal (Au) thickness in the structure*

Recently for expansion of area of spectral sensitivity methods [1-4] bringing to photo current growth in short-wave area of a range are widely used. Example can is Verizon band structures; pulling fields, etc., based on reduction of speed of a superficial recombination. In our case such opportunity, but in planar execution it is possible to create at the expense of a field n-p transition included in the opposite direction. In the fig.1. Dependence of the gathering of the wavelength of incident radiation double-barrier structure, p-n- junction and Schottky barrier.

Optical Properties

An Optical property of films from the hν dependence $(\alpha h\nu)^{\frac{1}{2}}$ allows determining the width of the band gap [11, 12] for each film. In all the studied films of the coefficient of the optical absorption edge is described by the relation:

αhν=B (hν-E0)2 where, α=5·104÷105 cm-1

E0-optical band gap for each film. B Coefficient of proportionality. The value of B is determined by extrapolating depending on hν for each sample. The quadratic dependence (2) obtained theoretically for a model of Tauc [5], which describes the density of states of the mobility gap. The value of B at x = 0 ÷ 1 is from 527 to 343 eV-1, sm1/2, respectively, E0= 1, 14 ÷ 1, 86 eV for films with Au-(p-n-) Si.

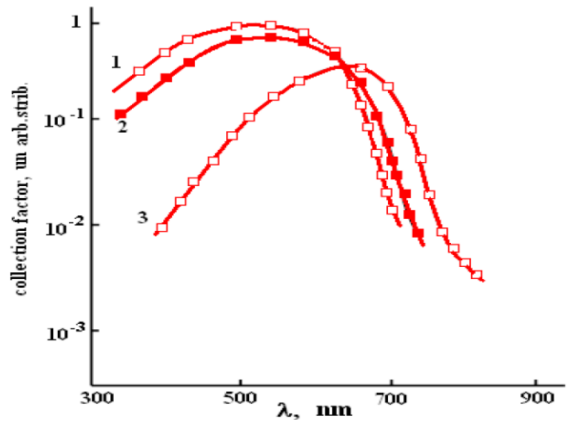

Figure2. *The dependence of the gathering of the wavelength of incident radiation: 1. double-barrier structure; 2.Schottky barrier; 3.p-n- junction.*

It is showing great interest in the study of photoluminescence features (PL) of short-wave radiation in the visible spectrum for efficiency c-Si-solar cells [6-9]. Thus, the problem improve efficiency (c-Si) photo elements consists of two parts: 1 the re-emission of short-wavelength photons in the visible spectrum edge through the mechanism of direct optical transitions zone-zone silicon mono hydrate, 2-the effective conclusion of photo generated carriers across the spectrum of solar radiation.

The spectra of the Stokes and anti-Stokes photoluminescence emissions Spectral rules of photoluminescence due to the fact that the absorption of the exciting photon with energy.

Wв = hv в, Where, h - Planck constant;

Vв - the frequency of the exciting radiation, Wl = hvl, Where, vl- fluorescent light frequency.

The energy difference W b –W l spent on various processes in the material, in addition to photoluminescence. In cases where a photon energy of the exciting radiation is added to some of the energy of the thermal motion of the phosphor particles Hvl = hvb + akT, Where, a coefficient depending on the nature of the phosphor; k-Is Boltzmann constant? T Absolute temperature of the phosphor, there is anti-Stokes photoluminescence.

Technique of Experiment And Discussion of Results

Features of two-barrier structures created on one plane are for the first time received and studied. It is shown advantages before traditional structures. For creation of photo detectors of planar execution with internal strengthening Au-Si Schottky barrier is created. As an initial material the structure p-n -type on a silicon substrate is used. The realization of management by current by means of light was enabled by selection of supply voltage of K-E in such a way that collector transition is closed, and emitter is open, at free base. Under the influence of light in it electrons and holes are generated. At collector transition there is a division electronic whole couples which have reached owing diffusions of border transition. Holes are thrown by a field of transition to a collector, increasing own current, and electrons remain in base, lowering its potential. Thus on emitter transition there is additional direct tension that strengthens injection of holes from the emitter in base. The injected holes, reaching collector transition cause additional increase in current of a collector. As total collector current is proportional to coefficient of internal strengthening, increase of spectral sensitivity - reaching 0,65A/W. The purpose of work consists in studying of influence of a charging condition of no equilibrium vacancies on processes occurring during radiation and silicon heat treatment with Nn =1016 sm3, and

also clarification of the mechanism of increase in integrated sensitivity of two-barrier structures of rather ordinary photo diodes. In fig. 2 spectral characteristics of two-barrier structure before radiation are shown, at the room temperature at the return tension of U cont. = 0B, and U cont.= 0,5B. From drawing it is visible that with growth of the enclosed return shift on r-p-transition photocurrent increases what to lead to photosensitivity growth, at an optimum choice of the return tension on r-p-structure transition. At further increase in U cont spectral sensitivity falls. Such behavior of S λ connected with growth of area of a volume charge and improvement of coefficient of collecting of photo carriers. With a further growth of cont because of overlapping of zones, photo injection of BS h is blocked and the structure works in a mode of one photo diode (fig. 3).

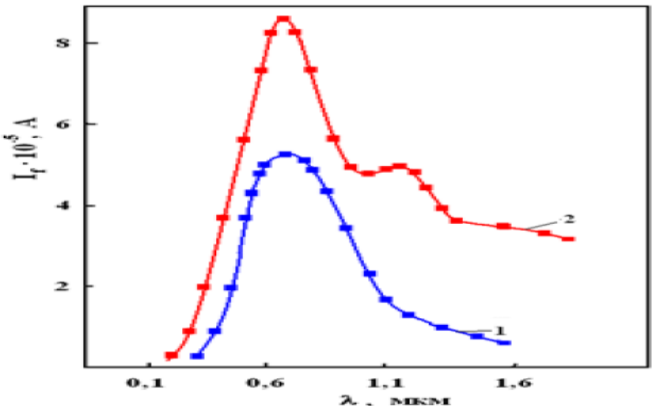

Figure3. *Spectral characteristic of the double-barrier structures to radiation 1. -Urev. =0V; 2.-Urev. =0.5 V. T = 300 K*

The structure was irradiated at T=300 K in gamma quanta of Co60. Isochronous (30 min.) annealing of radiation defects was carried out in the range of temperatures of Ta = 200-450 K.

Method of photo MF of

$$Voc=\frac{1}{1+b}\frac{kT}{q}\ln\left(\frac{\langle G\rangle^2\tau_1\tau_2}{n_i^2}\right)+\frac{b}{1+b}\frac{kT}{q}\ln\left(\frac{\langle G\rangle^2\tau_2 P_{p0}}{n_i^2}\right)=V$$

j + V B

I showed that primary radiation defects (RD) in p-Si crystals at 300 K are loaded positively.

The analysis VAC (Fig.3) and spectral characteristics showed that recombination currents increase in process of increase in a dose of radiation. Annealing of diodes leads to decrease in recombination currents. At Ta temperature ≈ 300◦C there is an annealing and reorganization of divakansion to formation of the V2 complexes + O, and at Ta = 350◦C the A-centers (V + O) and complexes (V2 + O) are actively annealed. The analysis of change of a current of through BSh and n-p- transition showed distinction of influence of annealing near a surface and in the depth of a crystal. It can be explained with growth of a photo response of BSh connected with accumulation of a charge and improvement of coefficient of collecting.

In fig. 5 curves of spectral dependence of photo current before and after radiation scale are represented at various doses and after annealing at T=400o C within 30 min. Annealing influences spectral characteristics slightly. With dose increase the radiation scale growth of photocurrent decreases.

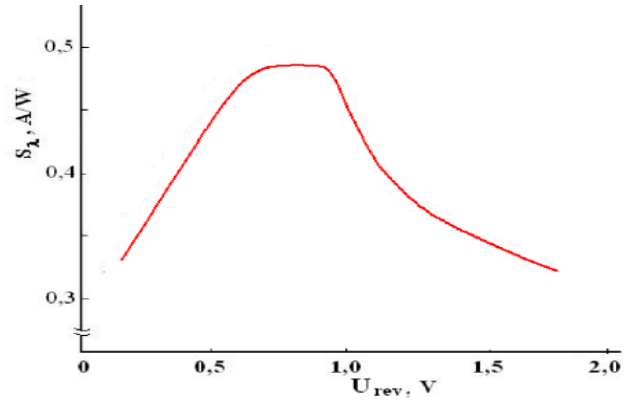

Figure4. *Dependence of the spectral sensitivity of the structure the applied reverse bias the p-n-junction.*

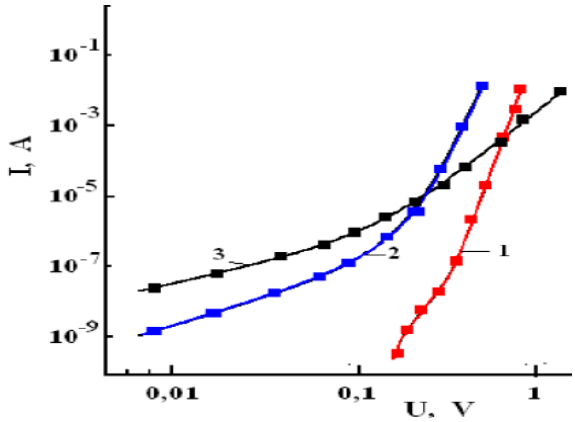

Figure5. *Volt-ampere characteristics of p-n-junction 1. Original. 2. Dγ = 100krad.3. Dγ = 200krad. Annealing results are insignificant*

In fig. 6 photo luminescence spectra of samples irradiated with gamma rays spectral rules of photoluminescence due to the fact that the absorption of the exciting photon with energy.

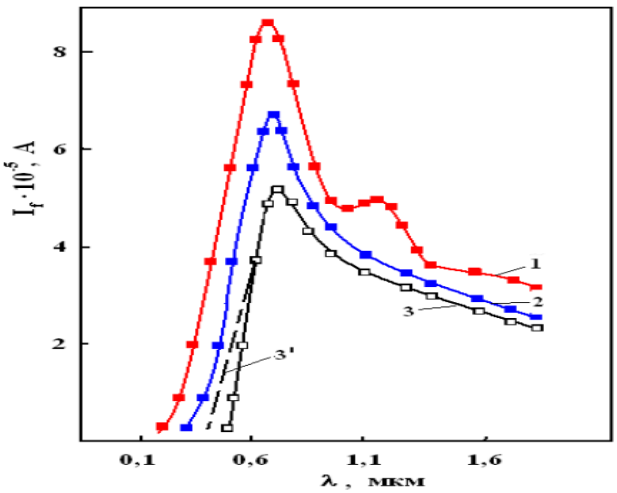

Figure6. *Spectral characteristic double-barrier structure after irradiation with gamma rays: 1-up irradiation, 2-dose 150 k rad., 3) Dose of 200krad. 3') annealed at T= 400° C for 30min*

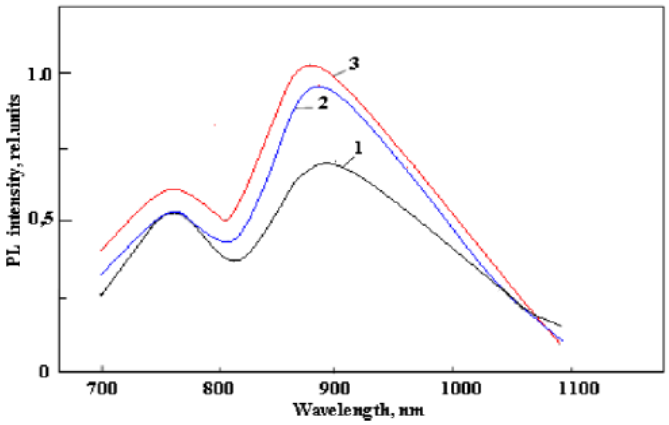

Figure7. *PL spectra of samples irradiated with gamma rays 1- prior to irradiation, 2- D $_{\gamma}$ - 150krad., 3) D $_{\gamma}$ - 200kroad.*

In fig.7 relaxation of photo conductivity when excited it rectangular pulse.

CONCLUSIONS

Thus, it is possible to claim that the main role in electric losses the studied silicon structures is played by the oxygen-containing centers (V2+O and V + O). At increase in a dose of radiation and increase in temperature of annealing, feature

VAC and spectral characteristics are caused by change of resistance of n-Si (basic area of structure), the caused accumulation (at increase in a dose) or disappearance and reorganization (when annealing) radiation defects.

It is known that the speed of capture by defect of electrons and (or) holes first of all depends on the section of capture and the provision of power level in the forbidden zone. These parameters in fact are the "individual" characteristic of defect [11, 12]. When annealing structures there is a reorganization of dot radiation defects and their disappearance.

Thus mainly there is an accumulation of the same defects. Comparison to literary data shows that the main role in photo-electric losses of the studied structures is played by the oxygen-containing centers (V2+O and V+O). At further increase in a dose of radiation there is an irreversible reduction of photo sensitivity due to significant increase in resistance of base.

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Citation: *F.P. Abasov, V.M. Safarova, “ Managing Photovoltaic Properties of Formation of Radiation Defects in Double Barriers Structure with a Base of Nano structural Silicon", Research Journal of Nanoscience and Engineering, vol 3 (3), pp.9-13, 2019.*