JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS
VOLUME 04, ISSUE 11
MOPNTHLY JOURNALS
GERMAN INTERNATIONAL JOURNALS
ISSN NUMBER: 2751-4390
IMPACT FACTOR: 9,08

MATHEMATICAL MODELING OF ION IMPLANTATION PROCESSES INTO A GaAs(001) SINGLE CRYSTAL TO INCREASE THE EFFICIENCY OF SOLAR CELLS

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Abstract: On purpose increase efficiency of solar elements it has been investigated process of ionic implantation influencing the big number of the interconnected coefficients, most important of which is target orientation, a grade, initial energy and a corner of falling of primary particles.

Keywords: p-n transition, light losses, reflex ion coefficient, an electron-hole, diffusions length, ionic implantation, target orientation, introduction coefficient, the semi channel, focusing.

Introduction

On a boundary of the XXI-st century the mankind has faced the serious problem concerning not only manufacture of energy from not renewed sources (coal, oil, gas, etc.) from the point of view of economy, but also with the serious ecological difficulties breaking dynamic balance in the nature. Already clearly that wide application of not renewed energy sources conducts to negative processes: to growth of thermal, chemical and radioactive environmental contamination that breaks a native habitat of the person [1, 2].

Certainly, there is still a hope of manufacture of energy by means of thermonuclear reactors. But now this possibility still practically cannot be realised because of absence even demonstration thermonuclear reactors. While experts only discuss the international project of thermonuclear reactor ITER. Besides, thermonuclear reactors completely are not deprived a radioactive waste. And the problem of processing and a burial place of such waste definitively is not solved. Therefore the mankind has forcedly addressed to renewed and a resource to saving up technologies of reception of the electric power. It is solar, water-power engineering, a wind power and some other kinds. Even active supporters of advancing development of nuclear power in the forecasts for the XXI-st century middle assume that by means of renewed sources 18-20 % of energy, and on some estimations [3] even to 40 % will be made.

Literature riview

It is known that, the solar element is made on the basis of a plate of a semi-conductor material. The solar element consists of two silicon plates connected among themselves. Light, falling on the top plate, beats out from it electronics, sending them on the bottom plate. So it is created electric a motive power an element. Consistently connected elements are a direct current source. Some incorporated photo-electric converters represent the solar battery. Efficiency of transformation of radiant energy in electric in modern installations reaches 13-17 %, in vitro on some semiconductors efficiency of 40% is reached. All requirements shown to materials for solar elements, start with the following purpose: to receive such solar element which would have maximum efficiency at the minimum expenses for its manufacturing, and also differed reliability in operation. In present time of manufacturing techniques of a solar element p-n transition is on depth approximately to 2 microns from a shined surface of the semiconductor [4]. Value of efficiency of a solar element is defined by the losses of energy depending on applied materials and a design of a photo cell, and also a choice of an operating mode of a solar element. The essential role is played by the light losses defined first of all in coefficient of reflex ion [4]. Optical radiation of various lengths of waves gets on different depth and creates the spatial distribution of the pairs born by light an electron-hole. The further destiny of the born

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pairs depends on them diffusion lengths the given semi-conductor material. If it is great enough, the superfluous no basic carriers of a charge created by light will have time to reach only at the expense of diffusion process area p-n transition and will be divided by its field. To light losses carry also that part of photons which at absorption does not reach to p-n transition and does not create pairs of carriers of electric charges. The main role in efficiency of this stage of transformation of optical radiation in the semiconductor is played by a parity between diffusion in the length L and distance from p-n transition L on which are created by light of pair an electron-hole.

At manufacturing solar elements the important role is played by process of ionic implantation. Ionic implantation name introduction process the introduced atoms in firm bodies by bombardment of their surface by bunches of the accelerated ions for the purpose of change or studying of their properties. In the field of basic research of effects of implantation of ions in connections $A^{III}B^{V}$ and instrument applications implantations technologies for these materials the amount of works on GaAs surpasses everything that has been made concerning other connections and alloys $A^{III}B^{V}$. So the great attention to implantation of ions in GaAs is connected mainly with high mobility electrons in this material and with possibility of reception of semi isolating substrates GaAs. Process of ionic implantation influences a great number of the interconnected coefficients most important of which is target orientation, a grade, initial energy and a hade of primary particles.

Research methadology

Theoretically efficiency of photo cells on the basis of GaAs can reach almost 25 %, real devices have efficiency about 16 %. Rather high indicator of absorption demands careful control of depth of layers, besides, there can be high a speed of a superficial recombination. These elements represent set of p-n-transitions with consistently decreasing width of the forbidden zone, connected so that light comes to a material with the greatest width of the forbidden zone. Photons with энергиями, there is less width of the first forbidden zone, pass before following p-n-transition etc. Light gets through lateral surfaces of transitions, so a potential difference on an exit (nearby 50 represents the sum of consecutive potentials p-n- transitions. The current is defined only by the radiating stream absorbed by a lateral surface, therefore it is small.

Important feature of a good photo cell is its surface. For the purpose of increase in efficiency apply reflecting and chemical etching surfaces. The obverse surface of such solar elements can be designed so that the radiation reflected from a surface came back to it back. Some systems can be made mechanically, others - chemical etching.

We was calculations on research of process of the ionic introduction occurring at bombardment along directions <110> and are carried out $<\bar{1}10>$ ions Se^{+} and Be^{+} with E_0=1 keV under sliding corners.

Analysis and results

On fig. 1 are resulted result of calculation of dependence of coefficient introduction K_{ci} of ions Se^{+} and Be^{+} with E_0=1 keV on GaAs (001) from a sliding corner of bombardment. It is visible that dependence of $K_{ci}(\psi)$ has a threshold at some value $\psi = \psi_{th}$. The size ψ_{th} depends both on weight of a bombarding ion, and from target orientation: it increases from the small semichannel by the deep. So, at bombardment in a direction of ionic introduction of <110> coefficient has a threshold at $\psi = 10^0$ and $\psi = 18^0$ for ions Se^{+} and Be^{+} accordingly (fig.1), and for a direction $<\bar{1}10>$ $\psi_{th} = 6^0$ and $\psi_{th} = 13^0$ for ions Se^{+} and Be^{+} accordingly (fig.2).

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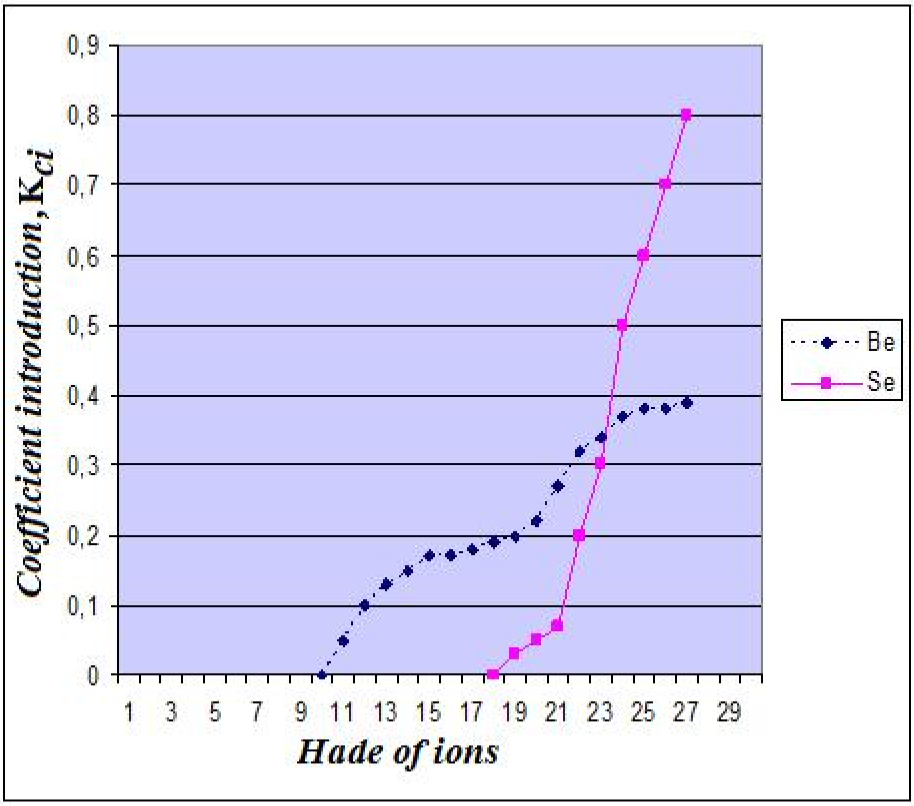

Fig. 1. Dependence of coefficient introduction of K_{ci} of ions Se^+ and Be^+ with E_0=1 keV on GaAs(001) <110> from a sliding corner of bombardment.

From fig. 1 also it is visible that at $\psi>\psi_{th}$ the increase number of the introduced ions with growth ψ is observed. Growth of dependence of $K_{ci}(\psi)$ sharper for ions Se^+ in comparison with ions Be^+. In area $\psi>22^0$ coefficient of introduction for ions Be^+ poorly depends on a sliding corner. At bombardment in a direction <$\bar{1}$10> (ψ) the minimum has dependences of K_{ci} at some value ψ. The carried out analysis has shown that minimum occurrence on dependence of $K_{ci}(\psi)$ it is connected with effect of ionic focusing. The effect to ionic focusing is shown sharp growth of intensity of a stream of absent-minded particles at certain orientations of a target in relation to a falling bunch. At this orientation the ions which are passing between two nuclear numbers of a surface, it is focused on a semichannel bottom: the density of the particles getting on a ground chain of the semichannel appears maximum and strongly the stream of the ions disseminated in a plane of falling increases what to lead to reduction number of the introduced particles.
Value of a corner of sliding, where the minimum on dependence of $K_{ci}(\psi)$ is observed (fig. 2), well coincide with values ψ =15^0 for ions Be^+ and ψ =21^0 for ions Se^+, corresponding to a condition of ionic focusing.

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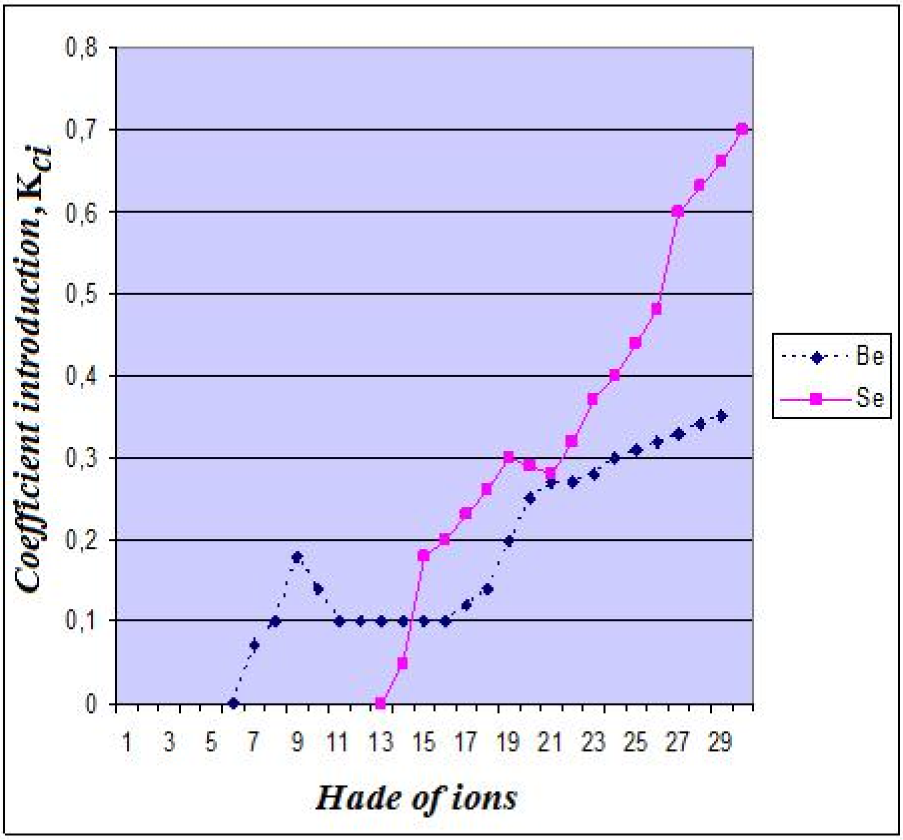

Fig. 2. Dependence of coefficient introduction of K_{ci} of ions Se^+ and Be^+ with E_0=1 keV on GaAs(001) <$\bar{1}$10> from a sliding corner of bombardment.

We also calculate profiles of introduction of implanted ions Se^+ and Be^+ on depth in GaAs (001)<110> at different values of a corner of bombardment.

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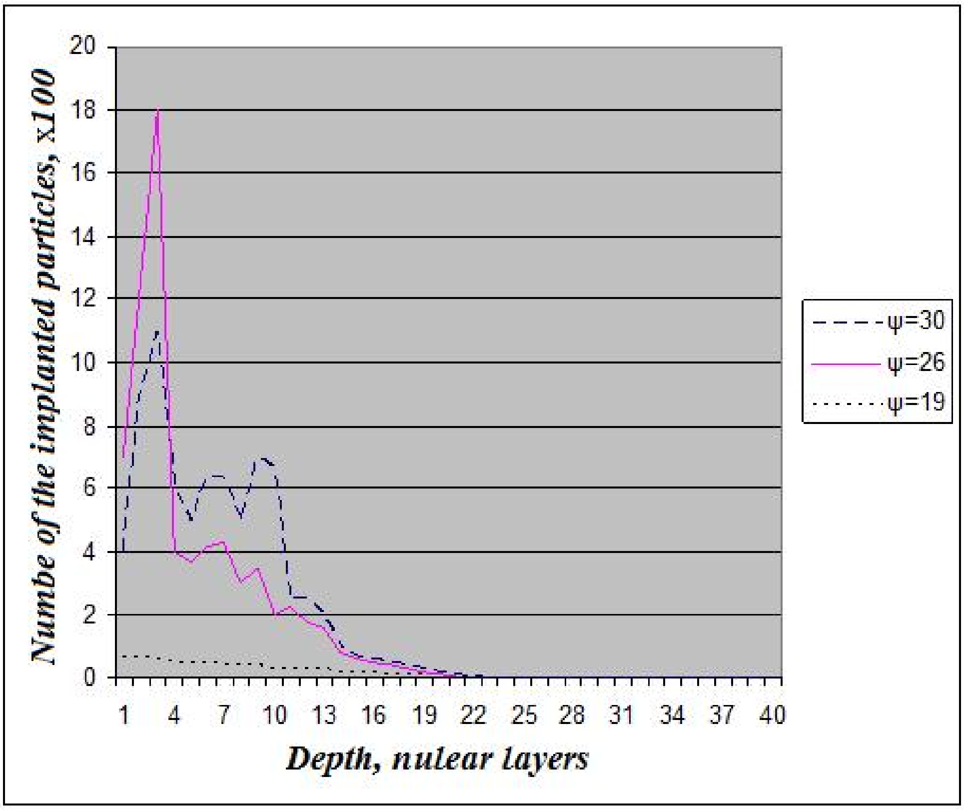
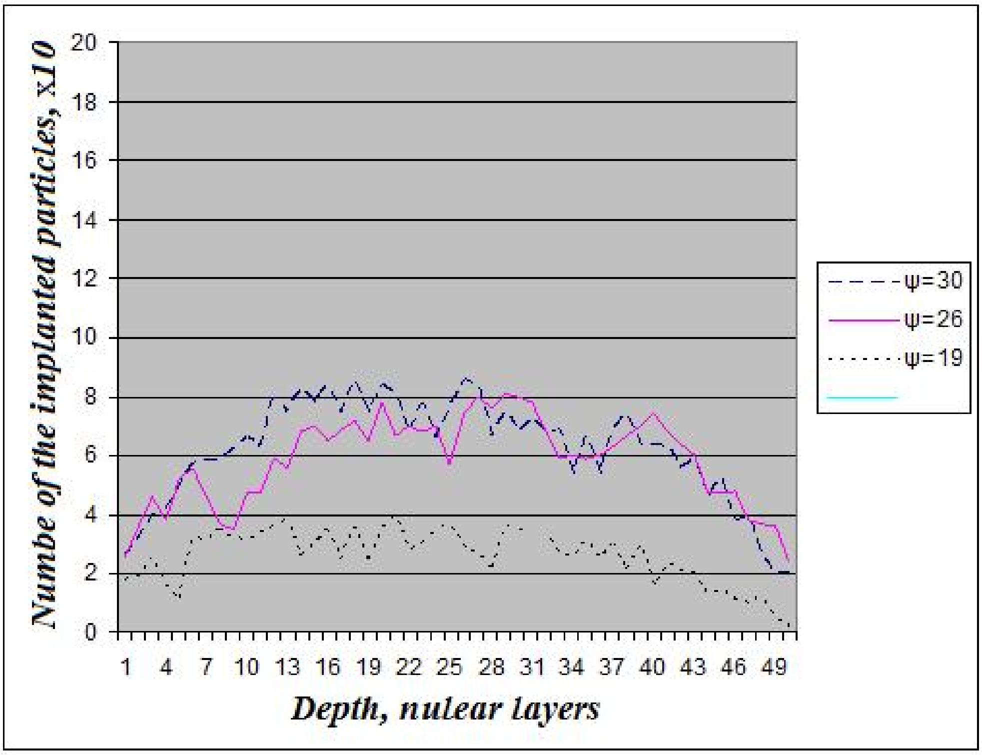


a)



b)

Fig. 3. Profiles of introduction of implanted ions Se^{+} (a) and Be^{+} (b) on depth in GaAs(001)<110> at different values of a corner of bombardment.

Results of calculation are resulted on fig. 3. It is visible that in case of ions Se^+ semiwidth of distribution of the introduced particles narrow enough, thus the basic maximum is in surface layers (5-10 layers), and distribution is stretched all till 20-25 nuclear layers (fig. 3a). Observed fluctuations dependences it is caused with the form of the semichannels formed in a direction $<\bar{1}10>$. With growth ψ the increase a share of ions of the layers introduced in deeper is observed some.

In case of ions Be^+, the semiwidth of distribution of the introduced particles is much wider. In this a case, because of rather easy weight, bombarding ions Be^+, can get on a little deeper layers (fig. 3б). Introduced ions Be^+ are distributed on depth up to 50 nuclear layers in regular more intervals. We will notice that at an identical stream of bombarding particles concentration of atoms Be^+ in the given layer of a target will be smaller, than concentration of atoms Se^+.

Conclusion

These results show that in the conditions of sliding bombardment by low-voltage ionic implantation Se^+ and Be^+ on GaAs (001) it is possible to create thin layers donors and acceptors impurity on such monocrystals.

Reference:

1. Chopra K. Thin-film solar elements / K. Chopra,; Moskva, 1986.
2. Resources and efficiency of use of renewed energy sources / P.P. Bezrukix. – Sankt-Peterburg: Nauka, 2002.
3. Physics of a firm body: the Manual / I.K. Vereofgin. / Moskva, 2001.
4. Bahadyrhanov M. S, Marovtsev A.S., Tachilins S.A., Research methods of solar elements, Toshkent, 2009.