NEUTRON TRANSMUTATION DOPING OF SILICON

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The method nuclear doping by an irradiation by thermal neutrons of nuclear reactors has found wide application in a modern semi-conductor industry, which is special for silicon [1] and gallium arsenide [2]. To the present time a lot of works on neutron transmutation doping of other semi-conductor connections such as AIII BV - InAs is issued [3], InSb [4], InP [4], including a cycle of works on neutron transmutation doping at action of the charged particles [5].

It is known, that neutral particles-the neutrons find wide application for homogeneous doping of semi-conductor plates and ingots [1].The interest to NTD is caused by two its basic advantages before usual metallurgical methods of representation doping. First, high doping of accuracy, as the concentration of the entered impurity in a constant neutron flow is proportional to time of an irradiation, this can be controlled by large accuracy. Secondly, high uniformity of distribution of an impurity, which is determined distribution of isotopes, small cross sections of capture.

In the survey report is discussed results and prospects of use NTD of semiconductors for the decision of tasks to radiating physics.

It is a lot of semi-conductor devices require extremely homogeneous doping and exact control, and concerning the majority and concentration of an impurity of minority (N_{max} and N_{min}) to achieve optimum and consecutive operational parameters. The concentration of the entered impurity at neutron transmutation doping of a method is determined as follows:

$$_zN^{A+1} = {_zN^A} F \sigma$$

Here F (neutron sm^{-2}) a flow (doze) of thermal neutrons, σ -is the thermal neutron capture cross-section of the given isotope, zNA, z N^{A+1} (cm^{-3})-concentration of initial and final products of reaction accordingly, Z- charge of a nucleus, A- mass number of a nucleus.

In [6] works the first time was observed the donors of phosphorus in crystals of silicon enriched with an isotope Si^{30}, which was generated by neutron transmutation doping, which testifies to achievement of high concentration of the perfect donors of phosphorus to many concentration of excess achieved at nuclear doping of silicon with the natural contents of isotopes. In results were shown, that the neutron irradiation with flow 10^{19} and 10^{20} $см^{-2}$ comes to an end by concentration of the perfect donors P approximately $5*10^{16}$ and $7*10^{17}sm^{-3}$ accordingly. It opens opportunities also for research of superficial effects, using easy excitation with high energy penetrating only in narrow about a superficial layer of silicon. The analysis, made by us, of the data has shown, that concentration of the donors at an irradiation Si grows not linearly, and proportionally integrated flow of neutrons in a degree 1.5. The change different of concentration find acceptors and donors also occurred to a proportionally integrated flow of neutrons in a degree 1.5 and is described by the formula: N_a -N_d = (Na -Nd)o -10^{-5} $F^{1.5}$. The superlinear dependence of concentration of the donors on a flow of neutrons specifies that alongside with formation of the donors by means of nuclear reactions occurs also any other processes, in which the defects of structure are generated. Is established, that during a long irradiation of concentration RD and atoms of phosphorus are great, probability therefore is great also, that that they form complexes. At small dozes of an irradiation the complex of formation is possible to neglect, as RD and the atoms P are far apart, which are complicated with monitoring introduction of an impurity in Si at nuclear doping.

Thus, the results show the complex analysis of experimental and theoretical works, that close prospects of works this direction, which from our point of view, will help us to create wafer of structures based on alternation of isotopes.