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Preparation of Mn_2 Si_3 and ni Si_2 silicides on silicon substrates using secondary ion mass spectrometry method: formation and mechanism study

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ABSTRACT: The technology of silicides formation structures is developed on the basis of alloyed silicon monocrystal Mn and Ni dynamics of element change and a chemical compound, electronic and crystal structure of a silicon monocrystal superficial layers is in details investigated during implantation of Mn and Ni ions with a various doze of an irradiation $10^{15}\div10^{17}$ sm^2. The basic laws silicides of formation are established during thermal heating. Are determined optimum structure and conditions of silicides thin cover monocrystals formation (d>500-1000Ǻ).

KEYWORDS silicon, epitaxial, structure, electron, zone, temperature, spectroscopy.

I. INTRODUCTION

Nowadays it is very difficult to imagine the further progress in the following spheres of science: micro- and nanoelectronics, thin films optics, technology of homo and heteroepitaxial growth of films, molecular and beam epitaxial, solid phase epitaxial, ion doping, ion stimuli synthesis of chemical compounds and etc. without the success in the comprehension of microscopic nature of surface and various phenomena, taking place in the sub-surface layers of solid bodies under the impact of ion and molecular beam, the new direction development in the solid body physics, dealt with the study of presses of crystallic grow thing of ultra-thin epitaxial films and the study of physical effects in the multi-layered hetero-structures, epitaxially, in quantum holes and ultra-lattices. Such systems shows absolutely new physical (electrical, optical, heat and other) properties, which are not presented in the bulky crystals. The significant achievement obtained in the field of epitaxial-planar technology and ion implantation using the modem methods of sub micronic lithography, ion-beam doping, ion-beam etching, local epitaxial gave the possibility to manufacture the commercial ever-large integral schemes on the base of silicon.

However, the great interest of scientists to the purposeful change and study of physical and chemical properties of solid bodies surface, firstly, is caused by a large practical significance of obtained results for the different spheres of modem science and technology.

Silicides based on the metals of transitive groups possess the unique physical and chemical properties allowing to implement the development of nano-sized semiconductor devices: transistors with penetrated base, transistors with the Shottky barrier, as well as a new generation of photo-receivers.

II. RELATED WORK

However the physics of growth of silicides nanolayers is weakly studied, and the thermal technology of their obtaining is not stable, that's why the study of the process of silicides nanolayers obtaining by the method of ion doping and study of their structural and electronic properties is a very actual scientific and technical task. The purpose of the recent research is the revealing of silicides strutures formation mechanism at ion doping the development of an optimized technology of silicides formation and the finding of origin and typical peculiarities, dealt with the

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type of valency of interaction of charged particles with a solid body, as well as the evalution of the informative capacity of the SIMS (Secondary ion mass spectrometry), AES(Auger electron spectroscopy), RHEED(Retlection height energy electron diffraction), RBS(Rutherford backscatterihg spectrometry) methods.

III. RESULTS AND DISCUSSION

As a initial material was used in silicon, growing method Chahralskova, with concentration of boron 2-10^{15} Cm^{-3} and 10^{14} Cm^{-3} , Implanter manganese and nickel in silicon at ions energy 40 keV, density of a current 50 μA/cm^2, By dozes 10^{14} to 10^{17} Cm^{-2}. During implantation, temperature of a sample remained room. It permits to consider, that participating in experiment of defects are basically radiations, saved after natural ageing target, that is their distribution is defined(determined) implantation. The experience were conducted on SIMS to installation LAS-2000 of the firm "RIBBER" and on installation described [1]. The technique of receipted structures of distribution on a depth of a sample consists of definition (determination) as the change *of* peak intensity the ion current of a researched element on a time, under condition of not a change of peak is carried out (conducted) on a total secondary current For arrival from temporary coordinate a depth have taken advantage of known expression[2].

$$v_s = \frac{jsAm}{e\rho}$$

Where; j - density of a current of primary ions; S - factor of spray of the sample; A - nuclear weight of the target; m - nuclear unit for weight; ρ -density of target; e - charge in electrons.

The density of a current in our measurements was equaled 6,4 • 10^{-6} A/Cm^2 . Factor of spray for a silicon at bombardment by the ions Ar with energy 5 kev and comer of fall According to [3] makes ≈2,5. From here easily to calculate speed Spray Vs = 0.2 $\overset{0}{A}$/C. As known, at measurement of identical sizes for the same object the results can differ. In particular at SIMS the analysis exists so the named device factor [4], determined as throughput of a analytical part, that is attitude (relation) of total quantity of registered ions to quantity of ions formed at a spray. On the other hand, the process of selection of secondary ions for various devices can some(Sa little) differ, that can render influence to received results. In particular, so named effect, determined as distortion as a result of additional spray from walls of crater. With the purposes of the account (record-keeping) of these effects, as well as with the purposes of additional check of received results, we received structures of distribution on the depth's B and Mn in silicon of implanted ion at identical energy and doze. And these structures for the same sample were received on two different installations. In fig.1 results the measurement of structures of distribution of concentration on a depth of ions B and Mn of a implanted in a silicon are indicated.

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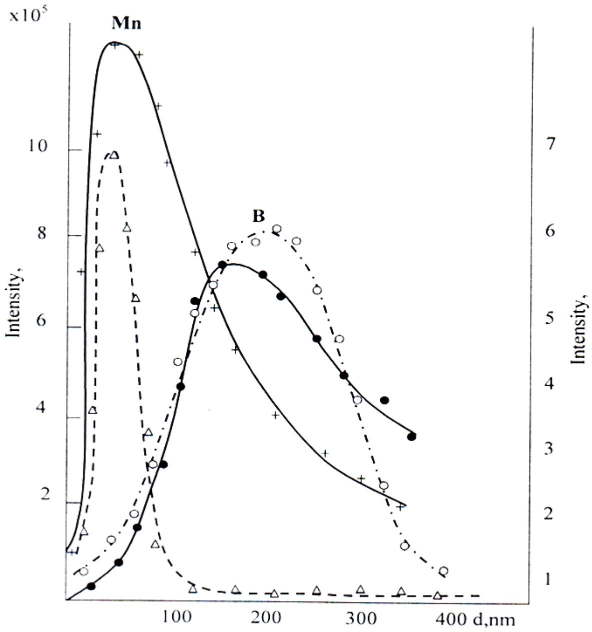

Figure I. Structures and distribution of B(o, ●) and Mn (Δ, X) in Si - ion micro exploring of a analyzer, (firm "Cameca" SIMS -installation on base MI-1201)

Maximum significance of concentration of impurity B and Mn the implanted is visible, in Si at a doze of doping equal 1. 10^{16} ion/Cm^2 lie in depth's of the order 45,0 - 50,0 nm and 180-200 nm for Mn and B of a correspondent Such distinction of depth's occurrence of maxim B and Mn is explained by a large difference of their weights and electronic configuration. From drawings, that experiments conducted on two various installations completely confirm one another. As it is visible, from a course of curve distributions of a impurity on a depth, distribution of coincidence Rp for both results, appreciable deviation(ΔR_P rejection) in the party of expansion, on shown is explained higher(above) by the described instrumental factors and crater effect From received result it is possible to resume, that the chosen technique is quite concentrated techniques for study of structures and impurity of implanted ion On a given technique, distribution structure of manganese in silicon, irradiation implantation at dozes. These structures are received in SIMS by installation 1-10^{14} , 2-10^{15}, 1-10^{16}, 1 - 10^{17} ion/cm^2 fig.2 on base weight-spectrometer MI-1201 and device IAS-2200 of the firm "RIBER".

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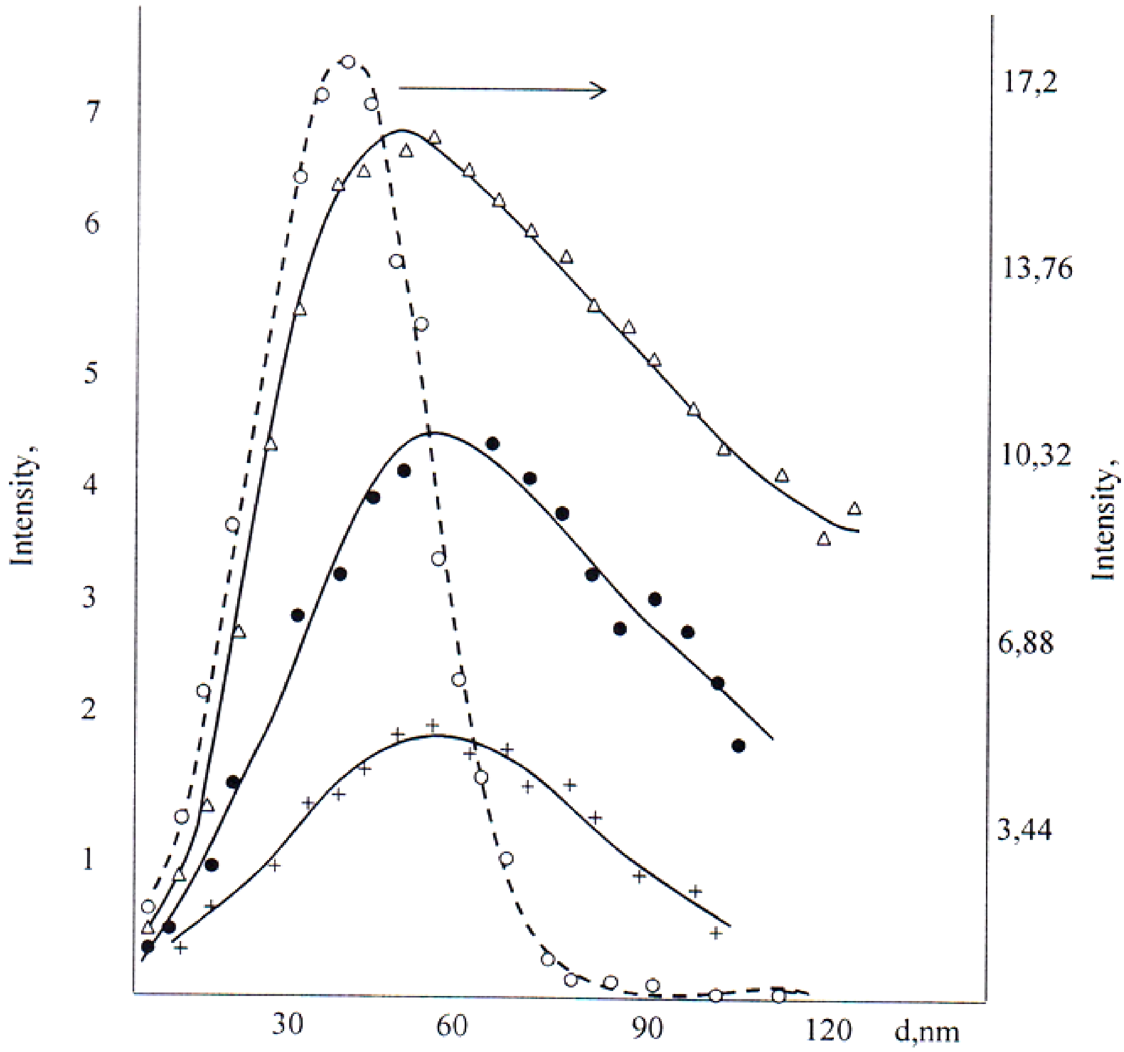

Figure 2. Structures and distribution of Mn in Si: x-l-10^{14}, ●-1,2-10^{15}, Δ-1-10^{16}, 0-1,2-10^{17} ion/Cm2 (SIMS - installation LAS - 2200firm RIBER).

As it is visible from a drawing 2, the maxima of curve distributions of manganese lie in a interval 38,5-54 nm and with the increase of doze of irradiation, this maximum will be gradually mixed in the party of smaller depthes. On all visibility, such displacement is connected to growth process of spraying at a increase of a doze, the irradiation of implanted ions. Analogue results are received for a nickel (fig 3) with unique difference in a insensitive of peaks Ni. As it is visible from fig. 3 follows, that is not dependent on doze, implantation distribution is described as Gaoovosky function.

Thus the depth of projected run Rp not unequivocally depends From a doze implantation. If at a doze 1 . 10^{16} ion/Cm^2.

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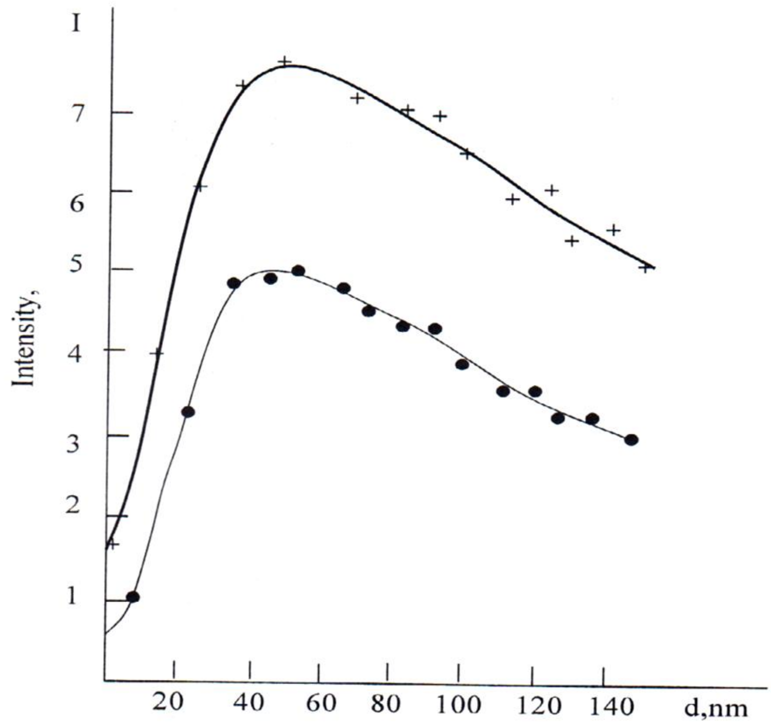

Figure 3. Structures and distribution of Ni in Si, At ● – $1\cdot10^{16}$, x-$1{,}2\cdot10^{17}$ ion/Cm2

The depth of $1{,}2\text{-}10^{17}$ ion|Cm^2 projected run made 45,6 nm, at a doze the implantation size it(him) made 42,8 nm. It is from here visible that with a increase of a doze of irradiation, this maximum gradually displaces in the party of smaller depthes. On all visibility, such mixture is connected to growth of process of spray at a doze increase of irradiation in implanted ions. Thus, at reception, the ion-implanted of structures with given redundant concentration of impurity Mn and Ni in narrow at the surface area without fail should be accepted in attention of a atomization sample.

In samples, a implantation ions go(pass) in a electro neutral condition and are basically inactive. For their dopes and the decrease(reduction) of concentration of radiations defects resort to thermo processing samples.

IV. CONCLUSIONS

The special interest presents research of influence of thermo processing on a structure of distribution of manganese. Results of research structures, the spray of Mn on a depth up to and after heat treatment at T = 800°C in current 2 hours, show that in difference from the elements in and V of groups [5] after heat treatment the surface concentration is not increased, and on the contrary, sharply decreases. It on visible, is connected to a 7-considerably smaller solubility manganese in a silicon in comparison with elements III and V groups.

There, of during heat treatment at T - 800 ^{0}C the restoration of a crystal lattice is accompanied by replacement of atoms of manganese in volume of crystal. At heat treatment in vacuum partial evaporation of manganese from the surface of crystals takes place. It hi turn results in migration of a implanted of atoms in surface of the crystal and some quantity of concentration of manganese at a surface. Besides after a annealing increase of concentration of deep maxima hi a depth 1 Micron observable for a number of samples are observed.

Results of these researches give main to consider, that the change of specific resistance is connected not only to activation of impurity, as a solubility manganese In a silicon at T = 800°C with considerably less than 10^{15} Cm^{-3} . And can activate being in between a units crystal lattice. Thus can also show that the electro neutral complexes Mn and Ni with separate dot defects, formed

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during ion bombardment Thus, it is possible to note that in process to heat treatment samples of silicon, implantation nickel and manganese complex (difficult) process of activation the latter goes. Thus, on all probability, the activation goes at the expense of formation (training) of various silicides as on a surface site, as in volume of a crystal.

REFERENCES

[1]Маллаев А.С.Исследование механизмов образования силицидов Mn_2Si_3,$FeSi_2$,$CoSi_2$,$NiSi_2$ на кремнии полученных ионным легированием.Автореферат канд. диссертации,Ташкент 2009,с.20.
[2] Bahaderkhanov M.K., Egamberdiev B,A, Abdugabbarov M.C.,
Haidarov K. " Research of properties surface and at surface layers ofsilicon, implantation elements of transitive group of manganese "Inorganic materials. RAN. 1995, N2, p. 1-3.
[3]Chipakin S.P." Research of thin layers by a method of weights Spectrometers of secondary ions " -. Kiev, science 1980.
[4]A. Morgan, N. A M. Dc Grefte, N. Warmolts and H.W. Warner. " The influence of bombordment conditions upon the sputtering and scandary ion yield of Silicon. - Appl. Surface ScL, 7 (1981), p372-392.
[5]Russel H., Kuge. L ," ions implantation " - M, Science. 19