Si MICROSTRIP DETECTORS OF CHARGED PARTICLES

V.V.Kuryatkov, S.A.Khusainov, S.R.Novikov,
T.I.Prokofieva, B.D.Dvornicov*, Y.E.Kolesov*

* Scientific Research Institute "Electron", St.Petersburg

Si microstrip detectors are fabricated on monocrystalline n-type phosphorus doped wafers with resistivity varying from 3000 to 5000 $\Omega\ cm$. The polished <111> oriented wafers with diameter of 60 and 76 mm and thickness of 300, 400 or 500 μm have been used. A thorough analysis has been given to choose the initial materials with good polishing and homogeneous resistivity. We have used the wafers with variation of resistivity less than 35%. The DLTS measurements indicate that concentration of main doped impurity in the initial material is $(9—15)\cdot 10^{11}\ cm^{-3}$ and total concentration of remaining deep impurities is less than 3% relative to the main one.

Two types of microstrip detectors with different way of signal registration and topology [1,2] have been produced.

A schematic layout of the I type detectors with current coupling is shown in fig.1. The detector contains 512 sensitive elements on the area of $40\times 26\ mm^2$ with $50\ \mu m$ pitch and the bonding pads of $100\times 140\ \mu m^2$. There is another modification of such a type of the detectors containing 768 strips with $50\ \mu m$ pitch on the area of $40\times 40\ mm^2$. A cross section (relative to strips) and connection diagram of I type detectors are shown in fig.2. The p—n junction has been fabricated by boron diffusion from boron doped polysilicon layer Si* (B). The n^+-region is obtained by a phosphorus inplant. All high temperature operations (oxidation, diffusion, annealing) are made at $T\leq 1000^{o}\ C$. Our research has demonstrated that the material has a sufficient thermostability at this interval of temperatures. Metallization of the front and opposite sides is obtained by Al of (1+2) μm thickness.

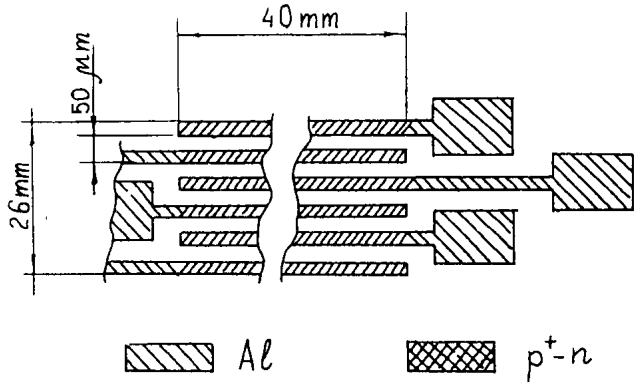

Fig.1. Layout of detector with current coupling (I type)

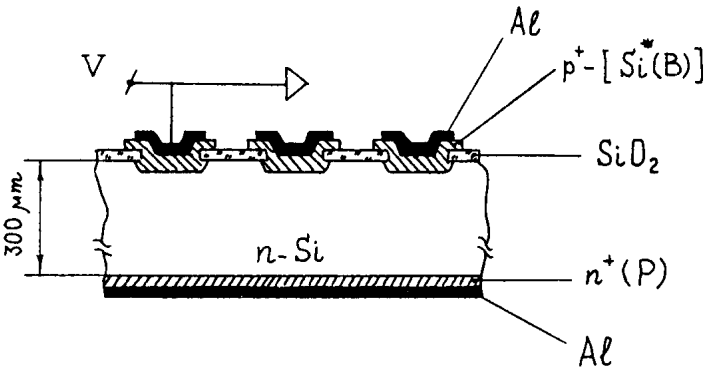

Fig.2. Cross sectional details and connection diagram of I type detector

A schematic layout of the II type detectors with capacitive coupling is shown in fig.3. The cross and transverse sections of the detectors are presented in fig. (4a,b). Detector contains 768 strips with 25 μm pitch on the area of $23\times20\ mm^2$. The strip width is 10 μm, the distance between them is equal to 15 μm, area of

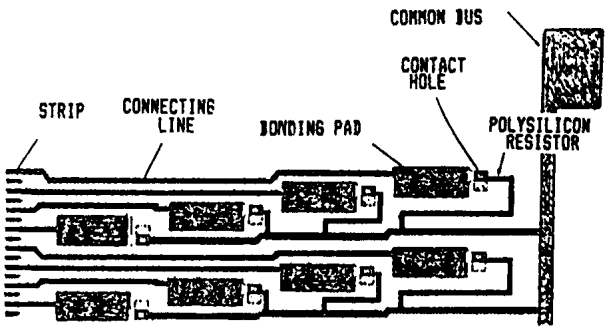

Fig.3. Layout of detector with capacitive coupling (II type)

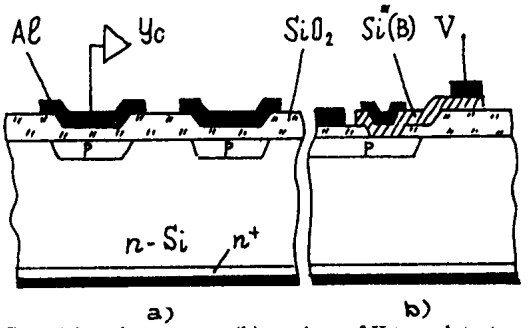

Fig.4. Cross(a) and transverse (b) sections of II type detectors

bonding pad being $80\times200\ \mu m^2$.

The main difference of the given detectors from the I type is in presence of thin SiO_2 layer of 0.2 μm thickness, coupling the strip diodes to the metallisation. Such a coupling allows an influence of strip leakage current on the preamplifier input to be excluded. The coupling capacitance of $\approx 38pF$ withstands a voltage of $\approx 170\ V$. The thicker SiO_2 layer of $\approx 0.6\ \mu m$ has been grown in the gaps between strips. All the strip diodes are connected with common bus, providing the reverse bias for diodes through polysilicon resistors of (1+3) $M\Omega$ made by boron ion doped polysilicon. Contact of polysilicon resistor with p—n junction is provided with oxide window (fig.4b), that serves simultaneously for measurement of volt-ampere characteristics (VAC) of the strip.

Check up of electric characteristics of the microstrip detectors is carried out on automatical stand permitting the measurement of an individual strip VAC and homogeneity of strip currents throughout a wafer at fixed reverse bias. Detectors are considered to be available if they have more than 97% of strips with current value less than 10 nA/strip at full depleting bias. The best samples have diode currents of (1+2) *nA/strip*. The current homogeneity of one of the I type detectors through a wafer, measured at 100 *V* reverse bias is shown in fig.5.

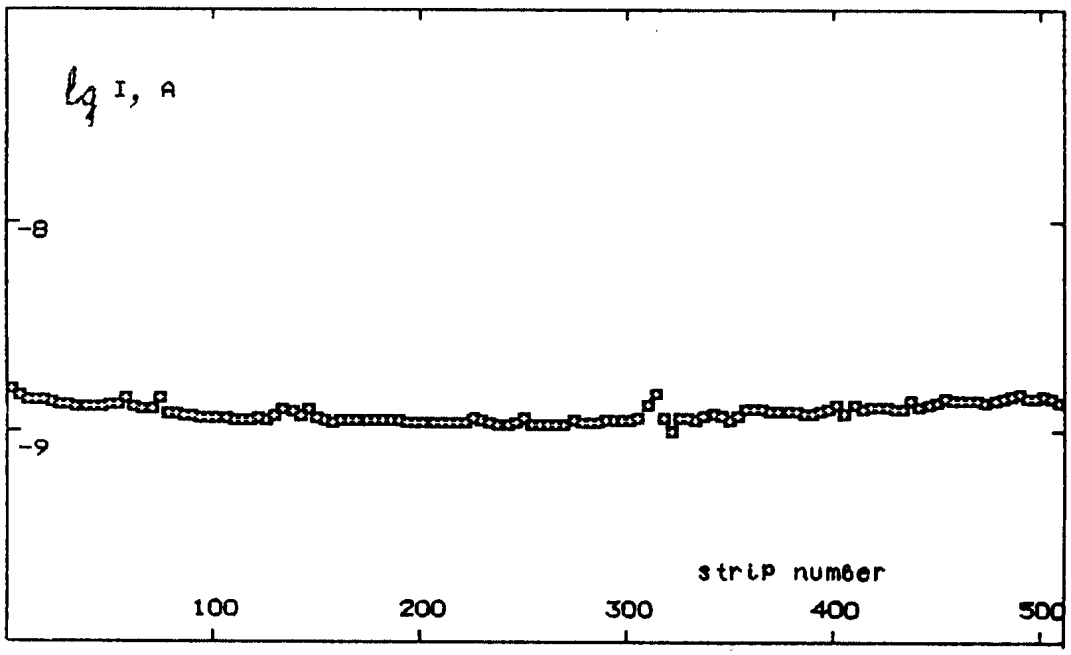

Fig.5. Current homogenity of strip diodes at 100 V reverse bias (I type)

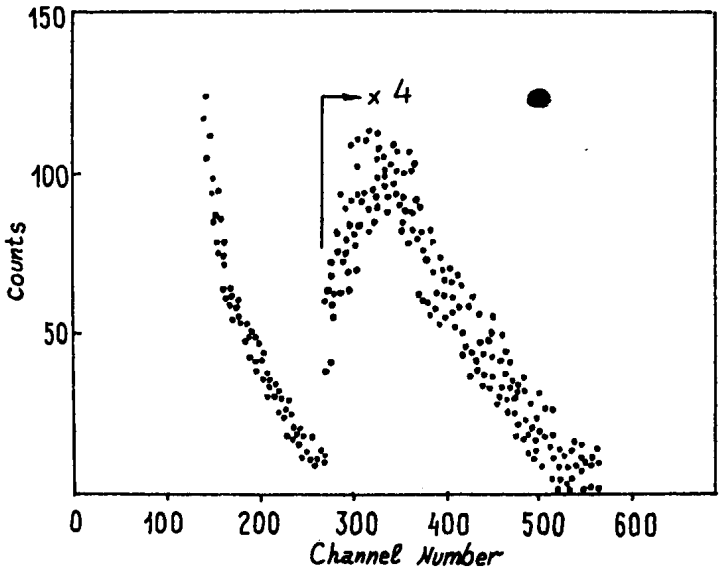

Fig.6. Amplitude spectrum of individual strip (I type)

Fig.6 presents a typical amplitude spectrum of ^{106}Ru β particles obtained from an individual I type strip, demonstrating a good performance. At present these detectors are used for the construction of two-coordinate track stations of "HYPERON" experiment on UNK which have been worked out and made in LNPI.

References

1. Dvornikov B.D. et al. //Microstrip Detector For The Trac System of "HYPERON" Experiment On UNC. Preprint LNPI-1646. 1990. 11 p.

2. Cassia M. et al. //Si Strip Detector With Intergrated Coupling Capacitors. //Nucl.Instr.& Meth.A(260). 1987. P.124—131.