First Russian double-sided Silicon strip sensors for CBM

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In July 2010, the first pilot batch of Russian silicon double-sided sensors with double metallization was produced at RIMST by the topology especially developed for the CBM experiment. Of the 20 wafers manufactured, 14 were made on Wacker Siltronic HighReflection (HiRef) wafers, and 6 on double-sided, polished FZ wafers.

The sensors were tested and certified at SINP MSU. The yield of the sensors made on the HiRef material as estimated from the total leakage currents was around 20%. Further measurements of these sensors revealed numerous other faults such as broken-through coupling capacitors (on both p- and n-sides) caused by surface scratches on the wafers, from which it became clear that using the HiRef wafers for production of double-sided detectors is not practical. The yield of the sensors produced from the FZ material was about 50%; their quality significantly surpassed that of the sensors made on the HiRef wafers. Fig. 1 shows the $1/C^2$-V dependencies for the sensors made on the FZ wafers. From these curves, the depletion voltage can be estimated as the voltage at which the measured capacitance becomes nearly constant. Determined this way, depletion voltages for the sensors made on the FZ wafers turn out to be lower than those of the HiRef sensors.

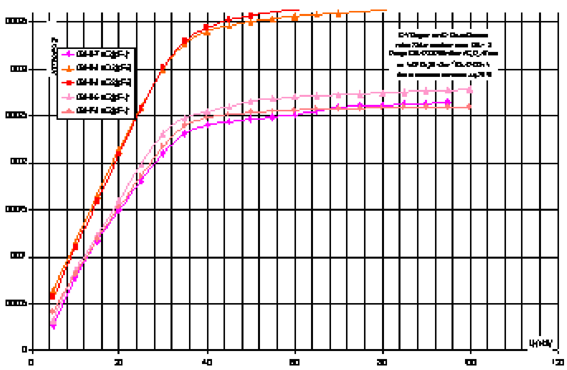

Figure 1: Total bulk capacitance of sensors on FZ wafers

To characterize the sensors more precisely and for a probable correction of the detector topology, we measured the capacitances and quality of coupling capacitors on the n- and p-sides of the sensors. The results obtained for the p-side are shown in Fig. 2.

The proportion of short-circuit capacitors for the p-side is less than 0.5%, but there exist a few short-circuit ones with twofold and threefold capacitances. The total proportion of broken-through and short-circuit capacitors is less than 1%. The results obtained for the n-side of the sensors suggest high enough etching quality of aluminium: no short-circuit strips were observed. The proportion of broken-through capacitors (with capacitances below 20pF) is less than 1%.

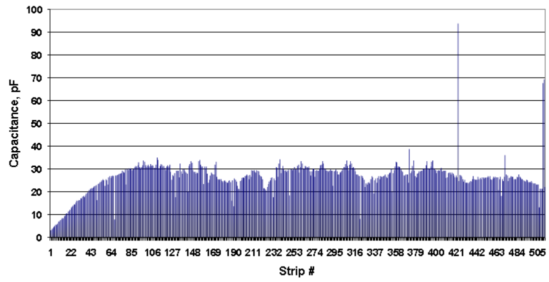

Figure 2: Capacitances of coupling capacitors at the p-side

Among the most important characteristics of double-sided sensors is the quality of the n-strip isolation. This characteristic was selectively investigated on the sensors made on the FZ wafers. Figure 3-left shows the strip current as a function of bias voltage. The sharp drop of strip current at 34-35 V is an evidence of the separation of strips by p-stops. This value of separation voltage agrees well with the measurements of the full depletion voltage.

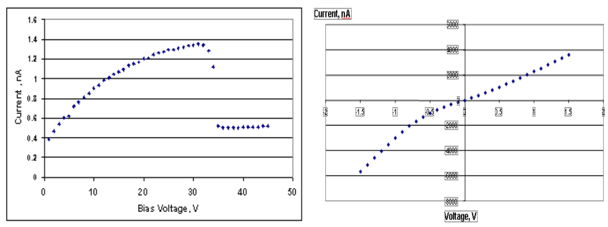

Figure 3: (left) Strip current on the n-side of a sensor as a function of bias voltage; (right) measurement of a bias resistor on the p-side of the sensor (right)

Figure 3-right shows the values of polysilicon biasing resistors measured on the p-sides of the sensor. The resistance falls within the tolerable range and is fairly linear. The measured values of the resistors are 0.5 MΩ and 2.5 MΩ for p- and n-sides, respectively.

The topology and production technology developed and used for manufacturing the first Russian double-sided Silicon strip detectors may be considered as well suited for further use.