Development of microstrip detectors for the CBM Silicon Tracking System

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The second prototype of a full-size microstrip detector for the CBM Silicon Tracking Detector System was developed in cooperation with CiS [1]. It will be used for the construction of a demonstrator ladder, the building block of the silicon tracking stations. A batch of 24 wafers was produced in July 2010, and first detectors were characterized at GSI. A further achievement in the cooperation with CiS was the design and fabrication of double-sided test detectors with novel radiation tolerant structures.

The design CBM03 [2] was realized on 4" masks and was produced on high-resistivity n-type float-zone wafers of 300 μm thickness. It includes one large double-sided microstrip detector, several small double-sided detectors and other test structures. The large-area detector has outer dimensions of 6.2×6.2 cm^2 and comprises 1024 AC-coupled strips per side forming a stereo angle of 15° between the front and back side strips. Short strips in the detector corners are interconnected to a strip in the opposite corner via a second metallization layer. The strips are biased with both poly-silicon resistors and punch-through structures. Both detector sides have the same segmentation and contact pattern, which limits the complexity of the microcables for their connection to the readout electronics.

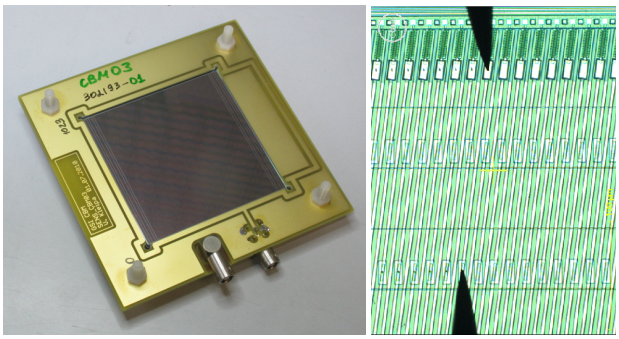

Figure 1: (Left) A CBM03 microstrip detector mounted on a test board for characterization under bias voltage. (Right) Microscope photograph of a CBM03 detector on a probe station for testing individual strips.

For the characterization of the detectors, new infrastructure was developed and set up at GSI. This includes a program-controlled voltage-scan test station and a wafer prober Süss-PA300. The bulk current-voltage (I-V) and capacitance-voltage (C-V) behaviour can serve as primary acceptance criteria. For this test, every detector is installed in a simple fixture, shown in Fig. 1-left. The sandwich of two identical printed circuit boards has a square opening with a thin balcony structure milled in that accepts the detector. Bias is provided to the detector through two wire bonds. The scan is then run with a program-controlled precision source-measure unit and a LCR meter. Results of the characterization are shown in Fig. 2. Individual strips are characterized on the probe station. Fine needles can be brought into contact with the readout or bias pads as shown in Fig. 1-right. One important inspection concerns the insulation between the implanted strip and the metal electrode. It is formed by an about 0.2 μm thin SiO_2 layer. This layer is prone to defects that short the capacitor. A strip-by-strip investigation showed that the current CBM03 detectors exhibit such defects. The reason for the shorts is being investigated. Further characterization of the sensor will involve measurement of interstrip parameters, e.g. resistance and capacitance, and their alteration after exposure to radiation.

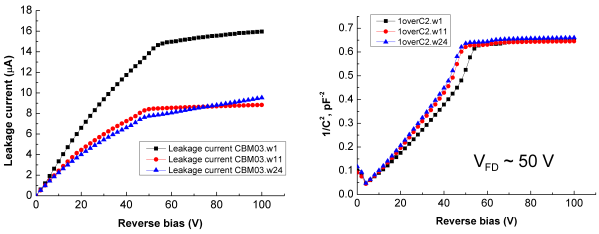

Figure 2: Characterization of CBM03 detectors. Plots of I vs. V (left) and $1/C^2$ vs. V (right) allow extracting the full depletion point, here around 50 V.

Prototypes of double-sided microstrip detectors with new radiation-tolerant structures were designed and manufactured by CiS. The test detectors comprise Shottky barriers between the strips to increase their charge collection after irradiation. GSI is research partner for the evaluation of these detectors before and after irradiation, to be performed in 2011.

References

[1] http://www.cismst.de

[2] J. M. Heuser *et al.*, *CBM Progress Report 2009*, Darmstadt 2010, p. 10