Contribution ID: **172** Type: **Poster**

Quality Control (QC) of FBK 3D Si Sensors from the ATLAS ITk Preproduction

Wednesday 29 June 2022 17:39 (1 minute)

The High Luminosity upgrade of LHC (HL-LHC) is envisioned to reach an ultimate luminosity of 7.5×10^34 cm-2s-1 (integrated luminosity up to 4000 fb-1) and an average 200 pp collision per bunch crossing [1]. Such a challenging environment in terms of high particle rate, hit occupancy, and associated radiation damage has pushed the design of a new generation of small-pitch, and thin 3D Si pixel sensors [2].
FBK has recently produced a pre-production batch of 3D sensors with 50×50 µm2 pixel geometry compatible with the full-size ITKPix1v1.1 (RD53B) readout chip. Temporary metal shorting all pixels'junction electrodes allowed to probe and electrically qualify the production yield at wafer level at FBK. Two wafers holding the temporary metal were diced at IZM, Germany. Later, a systematic QC test campaign has been carried out at the University of Trento.
As an example, Fig.1 shows the electrical behaviour of RD53B sensors from two different wafers. After dicing, the I-V of sensors (normalized to 20 °C) shows a very good agreement with FBK data. C-V plot (Fig.1(b)) confirms the expected inter-electrode lateral depletion just in a few volts (~2V). 48 hr. long stability test (Fig.1(c)) near room temperature for a recommended operating bias, -30V, presents a stable leakage (fluctuation well below 10%). This study also comprises the additional parametric analysis, i.e., oxide charge density, oxide thickness, inter-pixel resistance, inter-pixel capacitance, etc., with the aid of Process Control Monitor (PCM) structures.

[1] C. Gemme et al., The ATLAS Tracker Detector for HL-LHC, JPS Conf. Proc., 010007 (2021).
[2] G.-F. Dalla Betta et al., Development of a new generation of 3D pixel sensors for HL-LHC, DOI: 10.1016/j.nima.2015.08.032

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Session Classification: Poster