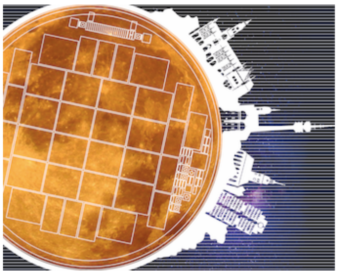

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Characterization and simulation of small-pitch 3D diodes after irradiation up to 3.5×10^16 neq cm^-2

Using 3D diodes, we have investigated the radiation tolerance of 3D sensors from the first batch fabricated at FBK on Si-Si DWB 6”substrates with a single-sided technology. The active layer thickness is 130 μm. Diodes reproducing the same layout details of their parent, small-pitch pixel sensors were irradiated with neutrons at the TRIGA Mark II reactor at JSI (Ljubljana, Slovenia) up to a fluence of 3.5×1016 neq cm-2. After irradiation, the breakdown voltage is higher than 200 V, so that sensors have a wide operational margin.
For functional tests, we used a vacuum chamber allowing to operate the samples at around -15C without any humidity problem. The samples are biased from the back side by placing the silicon dice on a metallic thermal finger covered with a conductive paste. The signals are read-out from the front side by contacting the probing pads by microneedles. The read-out chain includes a charge amplifier and a shaper.
By using a position resolved pulsed laser (wavelength 1055 nm, nominal pulse width 40 ps), we have collected 2-d maps of the relative signal intensity across a 3D basic cell at different bias voltages. Data were then normalized to the signals acquired on non-irradiated samples. The relative efficiency reaches up to 75%(55%) for sensors irradiated to 1×1016 neq cm-2 (3.5×1016 neq cm-2). The 2-d signal maps were compared to those calculated according to Ramo's theorem with input data obtained from TCAD simulations incorporating the new Perugia model for radiation damage, and the agreement was satisfactory.

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