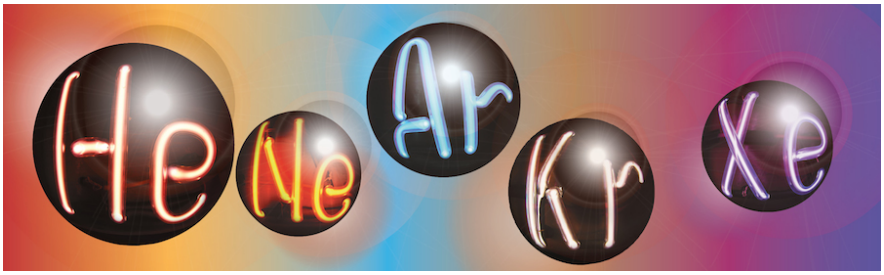

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Initial characterization of fully processed NUV Backside-Illuminated SiPMs developed by FBK in the framework of IBIS and IBIS_NEXT projects

Silicon Photomultipliers (SiPMs) are compact, high gain photon detectors widely used in particle physics and medical imaging. In conventional front side–illuminated (FSI) devices, light enters through the same surface that hosts metal routings and quenching resistors, limiting the fill factor and the photon detection efficiency. By adopting a backside illuminated (BSI) architecture, photons enter through a dedicated window on the side opposite the metallization, thereby enabling an almost 100% fill factor and allowing the implementation of a thin, uniform entrance window that could be designed to enhance photon detection efficiency down to the VUV range. In this work, we present the initial characterization of the first batch of next generation NUV BSI (Near UV Back Side Illuminated) SiPM technology devices currently being developed by FBK in collaboration with INFN within the framework of the IBIS and IBIS_NEXT projects.

The development of this new technology requires modifications to the microcell architecture with respect to standard FBK technology. The high field region is reduced and separated from the bottom surface and the charge is collected through a focusing mechanism. Deep Trench Isolation (DTI) does not reach the bottom surface in order to have a uniform surface after substrate thinning to implement the novel entrance window. The backside fabrication sequence comprises wafer thinning down to ˜10 µm, followed by plasma doping, laser annealing and the deposition of an anti reflective coating. Collectively, these steps yield a newly engineered entrance window optimized for NUV photon detection.

Preliminary measurements on both FSI only and fully BSI processed devices confirmed the correct operation of the newly implemented device architecture. FSI wafers exhibit the expected reduction in gain and recharge time associated with the small cell pitch and charge focusing design, together with controlled DCR levels and correlated noise behavior consistent with the presence of non metal filled DTIs. Fully BSI processed devices show an increase in both primary and correlated noise, with a strong dependence on the applied annealing fluence, yet they retain promising PDE and timing characteristics. PDE measurements on SPAD structures reach approximately 65% at 550 nm and 40% at 400 nm, with a pronounced sensitivity to backside window optimization. SPTR values are around 200 ps FWHM for 35 µm cells, whereas 15 µm cells display diffusion induced tails indicative of residual neutral regions. A preliminary characterization in liquid nitrogen is also reported.

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