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New developments in high-density SiPM technology at FBK

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The recently proposed (2013) high-density SiPM technology (HD-SiPM) is based on a redesigned border region of the microcells, allowing a small cell size with high fill factor. The separation between microcells is obtained with trenches, which provide electrical isolation and optical attenuation of the photons emitted during the avalanche. These features translate into high photo detection efficiency, low correlated noise, fast cell recovery time and a very high number of cells per unit area, improving the linearity of the detector. New developments and refinements in the fabrication technology provide a reduced dark count rate and further increased fill factor. We present the full characterization of new RGB-HD SiPM prototypes, featuring peak sensitivity around 550 nm. We produced a set of devices with cell sizes of 12×12, 15×15, 20×20, 25×25 and 30×30 μm^2. For the smallest cell, we measured a photo-detection efficiency close to 30% around the green region of the light spectrum whereas for the larger ones it reached 50%. Setting a limit of 10% to the optical cross-talk, the PDE reaches a remarkable value of 40% in the last three structures. We coupled 4×4 mm^2 SiPMs to a 3×3×5 mm^3 CsI(Tl) scintillator and we measured an energy resolution at 122 keV of 8.4% FWHM using the 25×25 μm^2 cell size. We also measured the performance of the same devices coupled to 3×3×5 mm^3 LYSO crystal at 511 keV. For both the 20×20 μm^2 and 25×25 μm^2 cell sizes, the energy resolution is better than 10% FWHM and the coincidence resolving time is close to 130 ps FWHM at 20℃.

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