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Characterization of the first prototypes of Silicon Photomultipliers with bulk-integrated quench resistor fabricated at MPI semiconductor laboratory

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Silicon Photomultipliers (SiPMs) have the potential to replace conventional photomultiplier tubes in many applications. Thus, the improvement and full understanding of SiPM properties is of general interest. Conventional SiPM concepts use deposition of a high ohmic polysilicon layer as quench resistor. This, in turn, acts as an obstacle for light and reduces the fill factor which gives limitation to the maximum photon detection efficiency (PDE). A new detector concept in which the quench resistor is integrated to the silicon bulk was developed at Max-Planck semiconductor laboratory. Therefore, a metal and polysilicon free entrance window can be realized which offers an improvement in PDE. For electrical separation and suppression of optical cross talk (OCT) an insensitive area (gap) between neighbouring cells is required. Based on simulations a first prototype production was performed and devices with different combinations of cell size and gap were fabricated, providing the opportunity to study the influence of these parameters on the detector performance like PDE, recovery time, OCT, etc. Advantages and disadvantages of the concept will be presented. Results of the characterization of this first SiPM prototype, including the influence of geometrical variations will be presented and discussed. An outlook on possible future developments of the concept will be given.

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