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Design and TCAD simulation of planar p-on-n active-edge pixel sensors for the next generation of FELs

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Future experiments at the European X-Ray Free Electron Laser (XFEL) will require silicon pixel sensors with demanding performance: a wide dynamic range from 1 up to 10^4 12-keV photons per pixel, a small pixel pitch (~100 μm), minimum dead area and a radiation tolerance of 1GGy per 3 years of operation. Therefore, the development of four-side buttable tile detectors that meet such requirements is challenging. Through this work, carried out in the framework of the PixFEL project, design and TCAD simulations of planar p-on-n sensors with an active edge approach are performed with the aim of minimizing the dead area at the edge. The improvement of the breakdown characteristics in order to reach at least the minimum bias voltage required to avoid plasma effects at high charge concentration is achieved using different edge borders or layouts with the incorporation of multiple guard rings at the edge. The methodology of the sensor design, the optimization of the most relevant parameters, and the optimized layout are described. Finally, the simulated performance, in particular the breakdown voltage and the charge collection properties are presented.

Collaboration

On behalf of the PixFEL Collaboration. The PixFEL project is funded by INFN. The members of the PixFEL Collaboration are affiliated with Università di Bergamo, Università di Pavia, Università di Pisa, Università di Trento and INFN, Italy.

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