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Design Optimization of Pixel sensors using device simulations for Phase-II CMS tracker upgrade

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In order to address the problems caused by harsh radiation environment during the high luminosity phase of the LHC (HL-LHC), all Si tracking detectors (pixels and strips) in the CMS experiment will undergo an upgrade. In order to develop radiation hard pixel sensors, simulations have been performed using 2D TCAD device simulators, SILVACO and SYNOPSYS, to obtain design parameters. Simulations are carried out on two n+p- planar pixel sensor geometries; 50 micron x 50 micron and 100 micron x 25 micron, each for two wafer thickness of 150 micron and 200 micron. Each geometry has two configurations, which are referred as “normal”and “wide”having different implant widths. To achieve the isolation between the n+ pixels, simulations are performed for both p-stop and p-spray techniques. The effect of various design parameters like pixel size, pixel depth, implant width, metal overhang, p-stop concentration, p-stop depth and bulk doping density, on leakage current and critical electric field, are carried out for both non-irradiated as well as irradiated pixel sensors. The simulation of non-irradiated pixel sensors are performed by incorporating the fixed oxide charge density (QF) of 1e11cm^(-2) and two interface traps at Si/SiO2 interface (Nit). Irradiated pixel sensors are simulated by implementing two bulk trap levels along with appropriate values of QF and Nit for different fluences considering the level of radiation damage to pixel sensors in HL-LHC scenario.
These 2D simulation results of planar pixels are useful in providing an insight of the non-irradiated and irradiated Si pixel sensors and further work on 3D simulation is underway.

Collaboration

CMS Tracker Collaboration

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