TCAD Simulation of X-ray irradiated n-Fz Si microstrip detector : Impact on full depletion voltage and leakage current

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**Abstract**. In the intense x-ray radiation environment at synchrotron sources, it is reported that the performance of the silicon pixel detectors degrades with an increasing x-ray dose up to 10 MGy. To study the impact of x-ray irradiation effects in the n-Fz Si microstrip detector, the microscopic radiation damage parameters of x-ray radiation were extracted from the current–voltage, and capacitance-voltage experiments on test Si microstrip detector. The damage parameters are implemented in Synopsys TCAD. In this paper, we have irradiated the test structure up to 10 MGy, and the results on full depletion voltage, and leakage current are compared with the TCAD simulation results. A very good agreement in between experimental and simulation results is observed in the leakage current for the non-irradiated, and 1 MGy irradiated detectors, where for high doses up to 10 MGy, experimental leakage current was fifty times higher than the simulated leakage current at full depletion voltage. The full depletion voltage in 0 MGy detector is also well matched with the simulation result, and further, it shows the full depletion voltage performance of x-ray irradiated detector. Finally, the new detector design specifications and process parameters are proposed for the optimum performance of the radiation hard p+n Si pixel detector equipped with guard rigs at cut edge for the next generation photon science applications.

References

[1] Rossi L, Fischer P, Rohe T, Wermes N 2006, *Pixel Detectors From Fundamentals to Applications*  (Springer Berlin, Heidelberg).

[2] Zhang J, et al. 2012, J. Synchrotron Rad. 19, 340 [arXiv:1107.5949].

[3] Hatsui T, Graafsm H 2015, IUCrJ .2, 371–383.

[4] Srivastava A K 2019, *Si Detectors and Characterization for HEP and Photon Science Experiment*, (Springer Science and Business Media LLC).

[5] Zhang J 2013, *X-ray Radiation Damage Studies and Design of a Silicon Pixel Sensor for Science at the XFEL Ph.D thesis (* Hamburg University, Hamburg, Germany).

[6] Morozzi A, Moscatelli F, Croci T, Passeri D, Frontier of Physics. 9:617322.

[7] <http://www.synopsys.com/Tools/TCAD/DeviceSimulation/>

[8] Saini N, Patyal S, Kaur B, Srivastava A K 2022, Radiation effects and defects in solids, vol.177, issue 9-10,pp 957-971.

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