

TCAD simulation of p-MCz Si LGAD equipped with MGR irradiated up to a mixed fluence of $1 \times 10^{17} \text{ n}_{\text{eq}}/\text{cm}^2$

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Abstract

Radiation-hard LGAD as MTD detectors is required for the 4D tracking with the process of assigning a space and a time coordinate to a hit ($\sim 10\text{-}30 \mu\text{m}$ position and $\sim 10\text{-}30 \text{ ps}$ time resolution) in the CMS phase 2 of the experiment for the HL-LHC upgrade and FCC colliders. To improve the performance of the heavily irradiated LGAD detectors up to the mixed fluence of $1 \times 10^{17} \text{ n}_{\text{eq}}/\text{cm}^2$ in terms of high fill factor with the reduced dead space without any avalanche breakdown, and full depletion voltage $< 800\text{V}$ is the crucial requirement for the detector to achieve the aforesaid criteria. In this contribution, TCAD simulation has been used to perform the full device optimisation using the surface and four-level deep trap p-MCz mixed radiation damage model for the experiments and extrapolate the data, taking into account the PerguiaModDoping acceptor removal model in the SRH and CCE modelling of the irradiated detectors for the data as per the experiment up to -40°C . The electric field, electron concentration in the EAL layer and space charge distributions are shown inside the detectors around the trench and JTE extension to illustrate the reasons for the possible innovations and technological improvement in the gain of the irradiated LGAD devices.

Keywords: p-MCz Si; LGAD; SRH; Leakage current ; Gain; E-field; V_{BD} ; V_{fd} ; CCE.

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