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Simulation of polarization effect and charge collection in pixelated CdTe sensors

Recent progress in the fabrication of fine-pitch CdTe sensors and the development of bonding technology makes this material a good candidate for hybrid pixel detector systems, in particular for imaging experiments at synchrotrons (or free-electron lasers) with X-ray energy up to a few hundred keV. The main drawbacks of CdTe sensors in terms of their electrical performance are the high leakage current for pixel electrodes fabricated by ohmic contact, and the time dependence of charge collection caused by biasing and flux for electrodes fabricated by Schottky contact. The latter is also known as the polarization effect. To properly simulate and understand both effects, and to optimize the sensor layout in the future, the knowledge and implementation of traps into simulation is essential. In this work, the Cd vacancies (Vcd), Vcd-donor complexes, deep traps as well as residual impurities have been considered. The concentration of deep traps is calibrated by comparing the material resistivity of simulation and measurement on a Cl-doped CdTe pad sensor produced by Acrorad. Based on this result, the polarization effect has been simulated and explained. In addition, the charge collected by edge pixels and their non-uniformity compared to central pixels, which is caused by the change in resistivity at the edge of the sensor, has been studied and compared to measurements. Finally, the validation and limit of the trap model and its influence on sensor-layout optimization are discussed.

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