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Primary Design and Numerical Simulation Studies on 3D Si SOI Microdosimeter

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For evaluating and measuring the absorbed irradiation microdosimetry in radiobiology and other research areas, a primary 3D pixel structure of Si SOI microdosimeter was given in the paper. For optimizing the detector structure in order to reducing detector insensitive area and improving its charge collection efficiency, a primary optimized mircodosimeter with hexagon pixel structure was offered by numerical simulating , comparing and analyzing its electronic characteristics changed with different technology parameters, such as sensitive area, electrode doping depth, electrode width, guard ring doping profile, etc. Besides, the microdosimeter responses to different irradiation alpha particle energies(0.5MeV, 1MeV, 3MeV, 5MeV), particle incident angle, detector bias voltage, irradiation damage including surface state and displacement damage were also simulated and analyzed. The simulation results may offer some valuable reference data for optimized 3D pixel microdosimeter fabrication and applications.

Summary

The primary optimized 3D pixel Si SOI mircodosimeter designed hexagon structure profile was obtained. The thickness of buried oxide SiO2 embedded in the n-type bulk silicon substrate was 2μm. The thickness of the surface silicon bulk above the buried SiO2 layer was 10um. The doping density of the n-type bulk silicon was 7×1011cm-3. The p+ -type hexagon electrode width with constant doping density ˜1e20 cm-3 was 3˜4μm, the inner long radius of the hexagon electrode was ˜10μm. The constant doping density and doping depth of the cylinder n+-type electrode in the center hexagon pixel were the same as those of p+-type electrode. The radius of n+-type electrode was 3˜4μm. The peak doping density of the p+-type guard ring with Gauss doping profile was about 1e17cm3.The detector charge sharing, CCE, energy response ,I-V characteristics affected by the different conditions described above were compared and analyzed.

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