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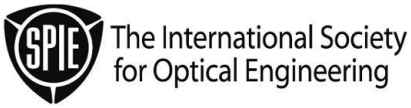

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Silicon-on-insulator microdosimeter for radiobiology

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ABSTRACT

To estimate the cancer risk when exposed to radiation fields, it is of paramount importance to measure the energy deposited by radiation on cellular and subcellular levels, using a technique known as microdosimetry. Usually, gas tissue-equivalent proportional counters (TEPC) are used which are bulky, require a high voltage bias, a gas supply system and are not effective in a confined space. Silicon-on-Insulator (SOI) microdosimeters with rectangular parallelepiped (RPP) p-n junction arrays, working in analogue mode, and modelling of 2D biological cell distribution was previously proposed and investigated[1]. Taking into account the shortcomings of these previous designs, a novel SOI radiation detector structure for microdosimetry is proposed here. We aim to improve the track structure measurement range for high and low energy ions to as low as 0.06 keV/μm. The new SOI microdosimeters are fabricated by using convenient microfabrication process. The 3D silicon sensitive volume (SV) is well defined, with chord distribution similar to the cylindrical TEPC at an average chord length of about 1-5 microns. The major advantage of the cylindrical SV is that 100% of charge collection can be achieved in contrast to 80% for planar RRP SV in previous designs. 3D SVs of the detectors are connected in a way that the signal-to-noise ratio is improved and the capacitance effect is reduced, while keeping the detection area large. Instead of using a polyethylene converter mechanically attached to the detector array, the new microdosimeter has polymethyl methacrylate (PMMA) coated on the 3D SVs without air gaps to mimick the sensitive site of biological cells. 3D ISE-TCAD modelling of SVs along with Ion Beam Induced Charge (IBIC) analysis of charge collection in SVs using a heavy ions microprobe will also be presented.

Keywords: Microdosimeter, silicon-on-insulator, radiation detector

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