

## 2nd generation microdosimeter with guard ring: an IBIC study

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Silicon-on-insulator (SOI) microdosimeters have recently been used to successfully measure the radiobiological properties of mixed radiation fields typical of medical, space and radiation protection environments. These SOI devices consist of a 2D array of elongated parallelepiped diode structures. Charge collection studies have revealed that due to the electric field distribution within the planar SV, there are significant lateral charge diffusion effects which complicate charge collection and give rise to a less than ideal chord length variance.

To address the shortcomings of this device a second generation SOI microdosimeter was designed at the Centre for Medical Radiation Physics (CMRP), University of Wollongong. This next generation SOI design was based upon an array of 3D cylindrical p-i-n diode structures. The cylindrical geometry of each structure reduces the chord length variance throughout the SV and supports a radial electric field to facilitate the collection of all deposited charge via drift. Fig. 1 shows a schematic of the SV design and the  $1/r$  electrical field distribution.

Recently a prototype device based on this design was successfully fabricated at the University of New South Wales. An Ion Beam Induced Charge (IBIC) study of the device was performed using the Australian Nuclear Science and Technology Organisation (ANSTO) heavy ion microprobe. This study confirmed proof-of-principle operation of the device. The study also revealed that: 1. There exists a small amount of low energy charge collected outside of the expected cylindrical SV, and 2. difficulties with laying Al tracks onto a raised mesa structure design resulted in a low yield of readable diode structures.

In response to these issues an updated concept for the second generation SOI microdosimeter has been designed and manufactured. The design is still based on an array of concentric p-i-n diode structures, however, instead of the Si substrate around each SV being etched away to form a raised mesa, each SV now has a highly doped  $n^+$  guard ring associated with it to prevent any unwanted lateral charge collection effects. The topology of the two GR designs can be seen in Fig. 2.

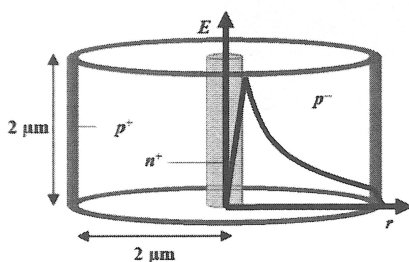


Fig. 1. A schematic showing the design of a 3D cylindrical SOI microdosimeter diode. The design overcomes the shortcomings of the previous 2D planar SOI microdosimeter.

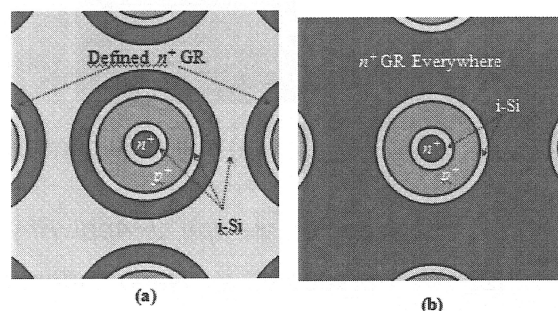


Fig. 2. Top view of a) version 2 and b) version 3 of the updated 2<sup>nd</sup> Generation SOI microdosimeter. Version 1 has a GR of finite width that is concentric to each SV. Outside of this GR is undoped i-Si. Version 2 has a GR that is continuous everywhere outside of the SV. Both GRs are created via  $n^+$  doping of the Si.

Presented is an IBIC study on the new version of second generation SOI array.