

PROCEEDINGS OF SPIE

Micro- and Nanotechnology: Materials, Processes, Packaging, and Systems III

**Jung-Chih Chiao
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**11–13 December 2006
Adelaide, Australia**

Sponsored and Published by
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Volume 6415



**The International Society
for Optical Engineering**

Proceedings of SPIE—The International Society for Optical Engineering
9780819465238, v. 6415

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Author(s), "Title of Paper," in *Micro- and Nanotechnology: Materials, Processes, Packaging, and Systems III*, edited by Jung-Chih Chiao, Andrew S. Dzurak, Chennupati Jagadish, David Victor Thiel, Proceedings of SPIE Vol. 6415 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X
ISBN 9780819465238

Published by
SPIE—The International Society for Optical Engineering
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone 1 360/676-3290 (Pacific Time) · Fax 1 360/647-1445
<http://www.spie.org>

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Printed in the United States of America.

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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 investigated¹. 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 RPP 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 mimic 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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1. P.D. Bradley, A.B. Rosenfeld, M. Zaider, "Solid state microdosimetry", *Nucl. Instr. and Meth. in Phys. Res. B* **184** (2001) 135-157

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