56

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THE RADIATION DAMAGE IN SILICON DIODES INDUCED BY STRAY FAST NEUTRONS FROM THE ANSTO CYCLOTRON

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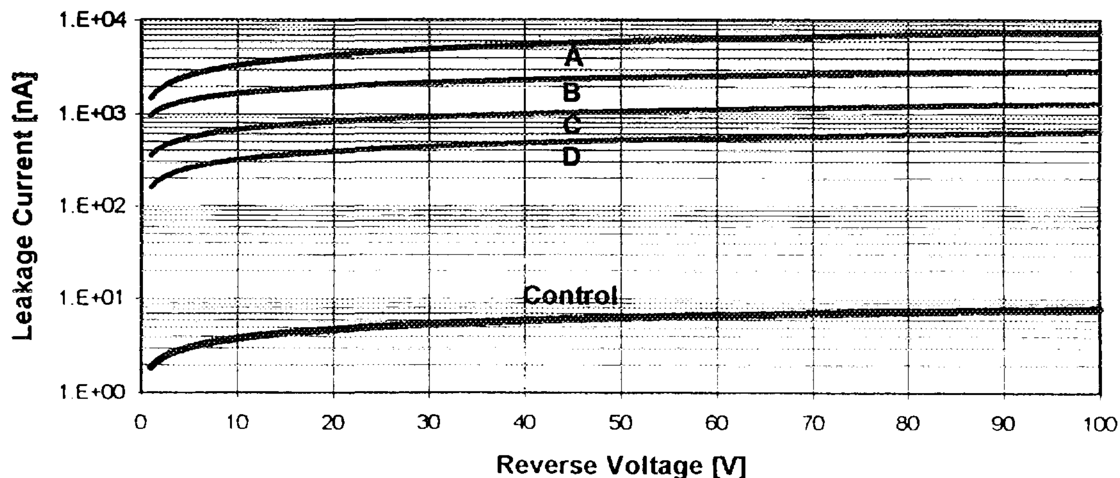
Introduction: Intense flux of fast neutrons are produced during routine isotope production runs at the National Medical Cyclotron. These stray neutrons induce irreversible displacement damage in the semiconductor devices, the vital building blocks of the various electronic instruments used in the facility. This poster highlights the results of the radiation hardness investigation study of commercial silicon diodes undertaken at the Health Physics laboratory of the National Medical Cyclotron.

Material and Methods: Four batches of small signal silicon diodes (IN 4007) with 5 diodes per batch were exposed to fast neutrons to a neutron flux of 2.03×10^{14} n.cm^{-2}, 3.18×10^{14} n.cm^{-2}, 5.50×10^{14} n.cm^{-2} and 2.89×10^{15} n.cm^{-2} in the radiation hardness testing device developed by the author (**B Mukherjee et al.** Development of a radiation hardness testing facility for semiconductor devices at a medical cyclotron. Nucl. Instr. Meth. (in print), October 1996. and **B Mukherjee et al.** Development of a simple neutron irradiation facility utilising the stray neutron field of a medical cyclotron. Appl. Radiat. Isot. 46(1995)1333).

Results and Discussion: The leakage currents (nA) of the diodes were measured at room temperature (22 °C) with reverse biased condition at 5 V, 10 V, 20 V, 50 V and 100 V using a Kiethley Model 617 Pico-Amperemeter and a Hewlett Packard Model HP 34401A Digital-Voltmeter. The hardness parameter (HP), spectral index (SI) and the displacement KERMA of the neutron flux were calculated from the neutron energy distribution. The average leakage current of the diode batches irradiated at various neutron flux levels as well as the un-irradiated control batch are shown as function of the reverse bias voltage in Figure 1. The results of this experiment were used to predict the "remaining life" of the detector electronics of the radiation monitoring instruments and the semiconductor temperature monitors for the cryogenic pumps located in the cyclotron vault and the beam room of the NMC. They also validate the feasibility of the commercial usage of this neutron irradiation facility for the hardness testing of semiconductor materials used in High Energy Physics (HEP) experiments (**M Edwards et al.** Neutron radiation damage studies of silicon detectors. Nucl Instr. Meth. A310(1991)283).

Figure 1: Leakage currents of silicon diodes irradiated with stray fast neutrons and the control batch are shown as functions of the reverse voltage. The average neutron flux for batch A, B, C and D was adjusted to 2.89×10^{15} n.cm^{-2}, 5.50×10^{14} n.cm^{-2}, 3.18×10^{14} n.cm^{-2} and 2.03×10^{14} n.cm^{-2} respectively.



Acknowledgments: Author wishes to thank Mr K Butterfield and Mr G Carter of the Physics Division of ANSTO for technical assistance and Mr C Jamieson, Manager RO for his support.