2007 International Nuclear Atlantic Conference - INAC 2007
Santos, SP, Brazil, September 30 to October 5, 2007
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
ISBN: 978-85-99141-02-1

USE OF A PIN PHOTODIODE FOR DOSIMETRIC PURPOSES IN RADIATION PROCESSING

Danilo C. Ferreira [1], Fábio de Camargo[1], Célia M. Napolitano[1] , Josemary A. C. Gonçalves[1,2], Helen J. Khoury[3] and Carmen C. Bueno[1,2]

[1] Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP
ccbueno@ipen.br
cmnapoli@ipen.br

[2] Pontifícia Universidade Católica de São Paulo (PUC - SP)
Rua. Marquês de Paranaguá, 111
01303-050 São Paulo, SP

[3] Depto. de Energia Nuclear – Universidade Federal de Pernambuco (UFPE - PE)
Av. Prof. Luiz Freire, 1000
50740-540 Recife, PE

ABSTRACT

This work examines the possibility of using a silicon PIN photodiode (SFH 00206) as a rotine dosimeter for irradiation processes that have been performed with a Gamma Cell facility in the Centro de Tecnologia das Radiações (CTR) at IPEN/CNEN-SP. The diode is encapsulated in a polymer plastic of 1.2 mm thickness and it was connected in the photovoltaic mode to the input of a Keithley 617 electrometer. The current response of the device was performed using a ^{60}Co-gamma source, with a dose rate of about 2.94 kGy/h. The diode's response as a function of the gamma-ray doses in the interval of 5 Gy to 100 Gy has been investigated and the results have demonstrated a linear behavior in the whole range.

1. INTRODUCTION

The application of silicon devices for dosimetric purposes is very attractive due to their high sensitivity, small dimensions and ability to operate passively. However, while they are well established for low photon dose measurements [1], there is only a small literature on their utilization in radiation processing dosimetry. Since quality assurance in any radiation processing is primarily based on dose measurements, there has been a huge interest to improve the response of existing dosimeters and several promising innovations for high dose dosimetry. With this aim, this work examines the possibility of using a silicon PIN photodiode (SFH 00206) as a rotine dosimeter for irradiation processes that have been performed with a Gamma Cell facility in the Centro de Tecnologia das Radiações (CTR) at IPEN/CNEN-SP.

2. EXPERIMENTAL APPARATUS

The device under investigation is a PIN photodiode type SFH 00206 (Siemens), especially suitable for applications from 400 nm to 1100 nm. The dynamic current and capacitance

measurements of the device were performed at a voltage range between 0 and 30 V and published elsewhere [2]. For the application envisaged in this work, the diode operates in photovoltaic mode and, at this experimental condition, bears 0.02 nA/mm^2 of dark current and capacity of 72 pF. The diode, which active area is 7.3 mm^2, is encapsulated in a polymer plastic of 1.2 mm thickness. To use this device as a dosimeter and also to protect it from light and moisture, the diode was recovered by a black plastic foil and its leads were soldered to a 1 m long coaxial cable of 50 Ω of impedance. The dosimetric probe, presented in Fig.1, was connected in the photovoltaic mode to the input of a Keithley 617 electrometer with adjustable time resolution. The irradiation was performed using a ^{60}Co-gamma source with a dose rate of 2.94 kGy/h. The temperature during exposure was typically 25 ºC. The diode's response as a function of the gamma-ray doses in the interval of 5 Gy to 100 Gy has been investigated and the preliminary results have demonstrated a linear behavior in the whole range.

Figure 1. Dosimetric probe.

3. RESULTS

The photocurrent generated in the sensitive volume of the diode as a function of time was measured with the Keithley 617 electrometer, which can automatically record up to 100 data. This feature was taken into account to select the time interval between two consecutive current measurements during each diode exposition. The current response of the diode was investigated for doses ranging from 5 to 100 Gy, in steps of 10 Gy.

The results obtained, presented in Fig. 2, shows that the current signal of the device, with respect to a dose rate of 2.84 kGy/h, is very stable during the gamma-irradiation. However, the effect of the transit motion of the dosimeter within the irradiation chamber, at both the beginning and the end of the irradiation process, is also observed.

The integral of the current response curves, i.e., the accumulated charge in the sensitive volume of the diode during each exposition, was related to the absorbed dose to attain the dosimetric response of this device. Fig. 3 shows the linear dependence of the generated charge on total dose within the dose range from 5 to 100 Gy.

Since these results are preliminary, it has been investigated the SFH 00206 diode response with respect to reproducibility, stability and the total dose threshold for damage effects.

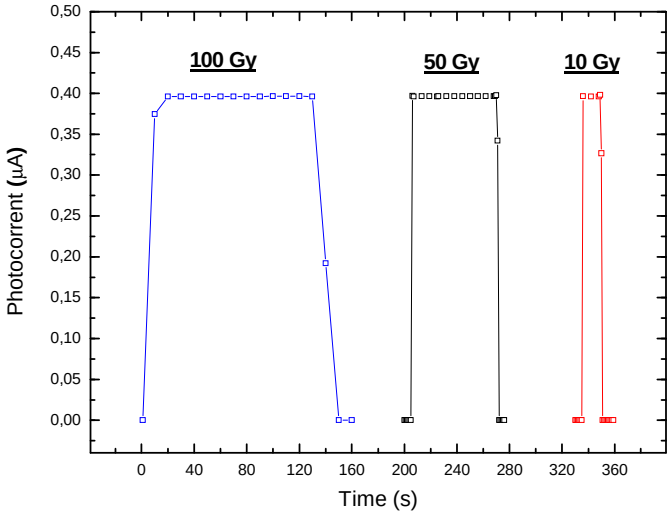

Figure 2. Current signal as a function of the dose rate.

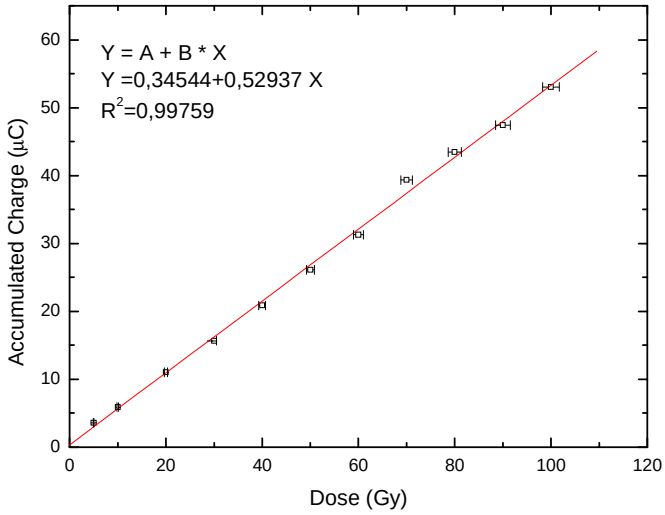

Figure 3. Accumulated charge as a function of the dose.

4. CONCLUSIONS

The data obtained in this work lead us to believe that the SFH 00206 diode is suitable to be used in radiation processing dosimetry. Furthermore, studies about the reproducibility of the device and the possible radiation damage effects are under way.

ACKNOWLEDGMENTS

The collaboration of Eng. Elizabeth S. R. Somessari and Eng. Carlos Gaia da Silveira, both from Gamma Cell staff, is highly acknowledged. One of us, D. C. Ferreira, is grateful to Comissão Nacional de Energia Nuclear (CNEN) for the award of scholarship. This work was partially supported by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

REFERENCES

1. B. McLaughlin, W.L. et al, "*Dosimetry for radiation processing"*. Taylor&Francis, New York (1989).
2. C.C Bueno, J.A.C Gonçalves, R. R. Magalhães and M. D. S. Santos, **"**Response of PIN diodes as room temperature photon detectors", ***Appl. Rad. And Isotopes*** **61(6)**, 1343-7 (2004).