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EVALUATION OF A DIFFUSED OXYGENATED FLOAT ZONE (DOFZ) DIODE RESPONSE AS A HIGH-DOSE DOSIMETER

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Introduction: The well-known damage produced by gamma radiation on Si diodes, responsible for a significant current sensitivity decay with accumulated dose, is the main restriction on their use in high-dose radiation processing dosimetry. However, the development of diodes more resistant to radiation damage has allowed them to be used in a harsh environment, such as those found in industrial gamma irradiators. A diffused oxygenated float zone diode (DOFZ) with enhanced tolerance to radiation has been investigated as online dosimeters in radiation processing dosimetry [1]. The main focus is on the current response stability and the experimental approaches to improve it, such as pre-irradiation and annealing of the samples [2]. A standard float zone (STFZ) is also used as a reference.

Materials and methods: The DOFZ and STFZ diodes are $p^+/n/n^+$ junction devices manufactured from n-type wafers (300 µm; 1.4 kΩcm) in the framework of the CERN RD50 collaboration. Each sample with a square-shaped sensitive area of 25 mm^2 is assembled into a light-tight holder and operated in a short-circuit mode without an externally applied voltage. The backplane (n+) is grounded, whereas the readout (p^+) electrode is directly connected to a Fluke 189 multimeter to record the induced current delivered by the diode under irradiation. It is accomplished in consecutive steps from 5 kGy to 275 kGy using a ^{60}Co Gammacell 220 - Nordion, at a dose rate of ≈ 2.4 kGy/h. The current response stability as a function of the accumulated dose is investigated for pristine diodes and after being preirradiated. The dependence of the dose-response, assessed by the integration of the current signals, on both the current sensitivity decay and the annealing (80ºC, 60 min) of the preirradiated diodes, is also evaluated in this work.

Results: The current response of pristine diodes, regardless of the type, is characterized by a fast sensitivity decay for doses up to 30 kGy followed by a slower decrease at high accumulated doses. Conversely, radiation conditioned diodes exhibit very stable and reproducible current signals over the whole accumulated dose range. This fact can be attributed to the saturation of the traps generated in the sensitive volume of the devices by the radiation. However, even less sensitive, the current to noise ratio of the preirradiated diodes is higher than 10^3, showing that the dark current contribution to the current readings is negligible. Concerning the annealing, no beneficial effect has been observed on their dose responses, shown in Fig.1.

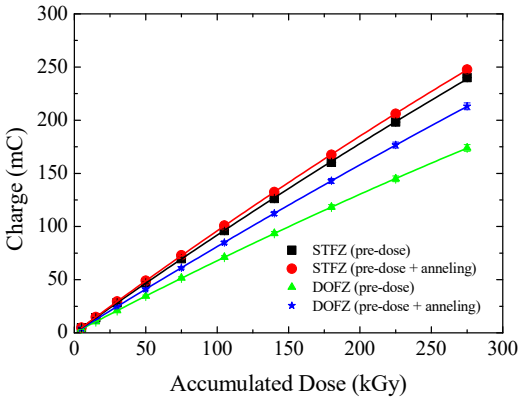

Figure 1: Charge response of preirradiated STFZ and DOFZ diodes prior and after thermal treatment (80 ºC, 60 min).

Conclusions: The results presented in this work validate the pre-irradiation approach to mitigate the sensitivity decay of both devices with increasing absorbed doses. Furthermore, the response stability of the DOFZ diode compares favorably to the standard FZ one and seems to be related to its greater tolerance to radiation damage effects.

References:

1. F. Camargo, J. A. C. Gonçalves and C. C. Bueno, *Braz. J. Rad. Sci.* **07-02A**, 1-13 (2019).
2. A. G. Bates and M. Moll, *Nucl. Instr. and Meth. A* **555**, 113-124 (2005).