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Alpha irradiation induced stability studies in single crystal diamond radiation detectors

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The time stability of a single crystal diamond radiation detector in response to alpha particle irradiation is studied in this work. A diamond detector is fabricated from a free-standing single crystal diamond plate and is packaged for the alpha irradiation studies. The detector under the bias voltage of +70 V is kept under constant alpha irradiation from a mixed α -source having major activity from 239Pu and minor activity from 238Pu. The diamond detector is found to be stable for the tested period of 4 hours, in consistent with the work carried out by Girolami et al. [1]. To further test the stability of the detector against alpha irradiation for increasing time duration and at the same time avoiding any avalanche related multiplication effects, the irradiation is again carried out for nearly 12 hours without the application of the bias voltage. It is found that the performance of the detector is degraded severely after the irradiation and this can be attributed to the alpha irradiation induced polarization effects in the diamond detector [1,2]. This phenomenon is found to be reversible and after subsequent room temperature annealing with and without bias, the detectors are functioning as expected.

References:

[1] M. Girolami, A. Bellucci, P. Calvani, C. Cazzaniga, M. Rebai, D. Rigamonti, M. Tardocchi, M. Pillon, D.M. Trucchi, Mosaic diamond detectors for fast neutrons and large ionizing radiation fields, Phys. Status Solidi. 212 (2015) 2424–2430.

[2] M. Rebai, A. Fazzi, C. Cazzaniga, G. Croci, M. Tardocchi, E.P. Cippo, C.D. Frost, D. Zaccagnino, V. Varoli, G. Gorini, Time-stability of a Single-crystal Diamond Detector for fast neutron beam diagnostic under alpha and neutron irradiation, Diam. Relat. Mater. 61 (2016) 1–6.

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