Dosimetry with diamond detectors

G. Gervino[1], C. Marino[1], F. Silvestri[1], A. Lavagno[2] and F. Truc[1]
1.- Dipartimento di Fisica Sperimentale di Torino, via p. Giuria 1, 10127 Torino, Italy
2.- Dipartimento di Fisica, Politecnico di Torino

The dosimetry analysis in term of stability and linearity of the signal and dose rate dependence of a synthetic single crystal diamond grows by Chemical Vapour Deposition (CVD) technique is presented. The measurements carried out by 5 MeV X-ray photons beam show very promising results, even if the dose rate detector response points out that the charge trapping centres distribution is not uniform inside the crystal volume and this handicap, that affects the detectors performances, must be ascribed to the growing process. Synthetic single crystal diamonds could be a valuable alternative to air ionisation chambers for quality beam control and for intensity modulated radiation therapy beams dosimetry

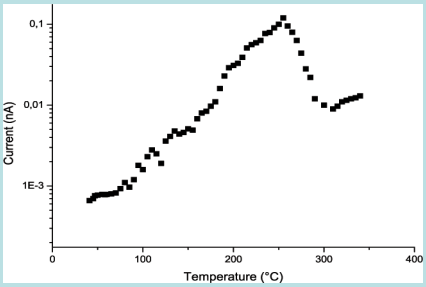
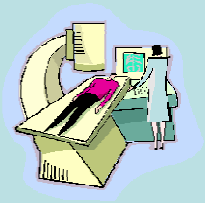


Fig. 1: Thermo-stimulated current measurements done after 50 keV X-ray irradiations.



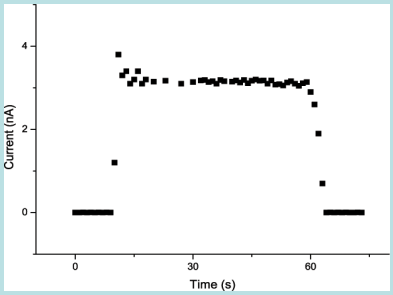


Fig. 2: Signal shape of the single crystal synthetic diamond under 5 MeV photons beam irradiation with a dose of 2 Sv/min.

The goal of this research project was to investigate the performance of CVD synthetic single crystal diamond detectors built optimising an already available industrial process devoted at present to the fabrication of heat spreader for electronics and infra-red transparent windows for defence applications. In this way we think it would be possible to produce synthetic diamond detectors at a lower price and so more accessible for many useful dosimetry applications. In particular, single crystals of synthetic diamond of small size and high sensitivity are very promising for intensity modulated radiation therapy beams dosimetry. The thermo-stimulated current measurements reveal that a satisfactory low level amount of defects has been reached in the growing process, but on the other side, as the D value points out, trapping charge centres are distributed in a non-homogeneous way inside the crystal, much likely affecting its detector performances.
The stability results can be thought as an encouraging starting point that should be increased with further work as ref.[1] has demonstrated, the repeatability is acceptable and linearity of the detector response at the dose rate dependence is good.

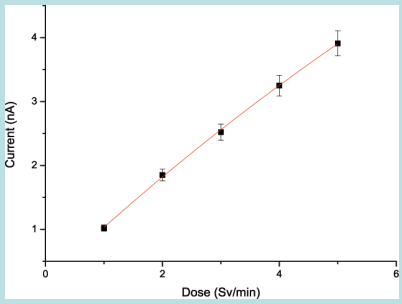
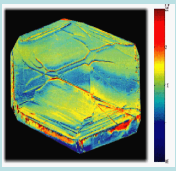
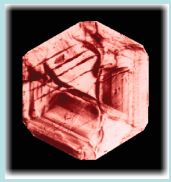
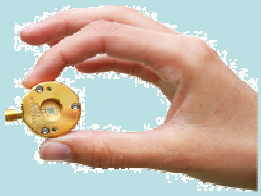


Fig. 3: Induced current on the synthetic diamond vs dose rate.





Single crystal CVD synthetic diamond



CVD diamond detector mounted

References.
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[3]: Fowler J.F. Radiation Dosimetry, in E.H. Attix & W.C. Roesch (eds), Academic Press, New York, 1966.
[4]: De Angelis C. et al. Med. Phys. 29(2), 2002, 248-254)