Fabrication and Characterization of Graphite Electrodes for Diamond X-ray Dosimeters

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Abstract

Diamond possesses outstanding properties such as high mobility, radiation hardness, low intrinsic carrier concentration and tissue equivalence. These properties make diamond a very attractive material for radiotherapy dosimetry and wider radiation detection applications. Despite improvement in CVD diamond crystal quality in the last two decades, fabrication of metal contacts on diamond needs more understanding and further improvements.

The aim of this study is to fabricate and examine diamond radiation detectors with graphite contacts. High dose ion implantation is used to fabricate the graphite contacts on diamond. The ion implantation causes damage to the diamond, and when this damage exceeds a certain level, the defected diamond turns to graphite after annealing.

Boron ion implantation was used to fabricate graphite contacts to one polycrystalline and one single crystal diamond samples. Also, one single crystal diamond sample was fabricated using carbon ion implantation. For comparison, similar samples were fabricated using conventional metallization. The electron and hole charge transport was characterized using alpha spectroscopy. 50 kVp X-ray, 10 MV photon, 20 MeV electron beams were used to study the dosimetric response of the detectors.

The graphite contacts have proven to be very stable mechanically and electronically. The sensitivity of the PC samples was found to be independent of the contact type. On the contrary, the SC samples with graphite contacts have higher sensitivity than the sample with metallic contacts especially the carbon implanted sample. The optimal operating Voltage for the SC sample is about 4.3×10^3 V/cm, where maximum charge collection can be obtained. Beyond this bias, the noise increase and the linearity between the photocurrent and the dose rate is degraded without increase in the sensitivity. The downside of boron implantation is that it causes slow response, which requires more priming than the samples with metallic contacts. However, this problem was overtaken by using carbon ion implantation, because the carbon implanted sample is free of boron impurities. Also, the samples with graphite contacts show more linearity between the photocurrent and the dose rate than the similar metallic samples