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Dosimetric evaluation of an epitaxial silicon diode as an online dosimeter for orthovoltage photon beam radiotherapy

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Abstract

The response of a dosimetry system based on an epitaxial silicon diode as an online dosimeter for orthovoltage photon beam radiotherapy has been investigated in this work. To be used as a dosimeter, each diode is housed in a light-tight probe, and its readout electrode is directly connected to the Keithley 6517B electrometer. All current measurements are carried out in short-circuit mode with the diode unbiased and its backplane grounded. The data acquired by the electrometer are directly sent to a personal computer via a GBIP interface controlled by software developed in LabView to analyze the current signals. A Pantak/Seifert X-ray tube is used to irradiate the diode, placed 50.0 cm away in a radiation field of 8 cm, with 10, 25, 30, and 50 kV photons. The dose rate response is investigated for the 50 kV beam by varying the current tube from 2 to 20 mA. As expected, the induced current is linearly dependent on the dose rate within the range of 0.8 and 8.05 mGy/s. The current signals are quite stable, with a repeatability parameter of less than 0.2%. The dose-responses assessed offline by integrating the current signals are linear between 0.5 and 3.0 Gy despite being slightly dependent on the photon energy. However, in this dose range, no dose rate dependence is observed. These results are theoretically supported by dose and dose rate calculations performed assuming the diode is thin compared with the standard values of the minority carrier diffusion lengths in the epitaxial layer. Good agreement is found between calculations and experimental data. Investigations of possible radiation damage produced in the diode through dynamic measurements of dark current and capacitance as a function of the accumulated dose are currently in progress.