48

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Performance of a MOSFET Microdosimeter

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Traditional applications of a MOSFET dosimeter are based on charge build up in the oxide layer. Measuring a change in MOSFET electrical characteristics which is proportional to the built up charge provides an information on the total absorbed radiation dose. However the knowledge of the total absorbed dose is not enough for estimation of the biological effect of mixed radiation fields used in modern cancer treatment modalities. High linear energy transfer (LET) particles have a high biological efficiency then low LET radiation. By measuring a LET spectrum with a microdosimeter a valuable information for calculation of the biological efficiency of a medical radiation beam can be obtained.

An optimal microdosimeter should have the sensitive volume of a cellular size and even represent a biological cell on a subcellar level for understanding deposited energy pattern in nuclear and cytoplasmic cell structures. An approach to microdosimetry, which satisfies the above criteria, models a biological cell with a silicon micro size cell. The quantitative measurement of deposited energy pattern by charge spectroscopy in a p-n junction with the size of a typical biological cell is a further step in characterisation of a mixed radiation environment. Such a dosimeter incorporates integral MOSFET dosimetry and charge collection spectroscopy in practically the same geometric volume. The integral dose has been measured using threshold voltage shift and the spectrum of deposited charge has been measured using the drain n^+-p junction as a *dE/dx* detector. These measurements were performed simultaneously on the same MOSFET detector chip.

Integral response of a MOSFET dosimeter was measured for ^{210}Po and ^{241}Am alpha particles at a range of bias voltages. It was shown that contribution of a ^{241}Am 59.9 keV x-ray to the MOSFET threshold voltage change was insignificant and decreases with the bias voltage.

The pulse height spectra were measured for ^{210}Po and ^{241}Am alpha particles, photons emitted by a ^{60}Co source and beta particles from a ^{90}Sr. For alpha particles spectra were measured for two different connection modes at different bias voltages. The changes in the spectra are discussed. It is necessary to point out that the change in threshold voltage did not affect the pulse height spectra. Low LET particles (gamma and electrons) did not contribute to a pulse height spectrum except for the few first channels while giving contribution to the threshold voltage change. This allows separation of low and high LET radiation in the medical applications. Using a MOSFET dosimeter in the single integral mode does not allow such separation.

Practical application of the MOSFET microdosimeters for separation of high and low LET radiation were done at radiation oncology facility at Brookhaven Medical Research Reactor. Some results of this study are to be discussed.