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Assessment of Therapeutic Doses Using Tissue Equivalent Dosimeter

By

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SUMMARY

The measurement of radiation dose has become a science of ever increasing importance to the estimation of the risks and benefits inherent to the uses of exposure to ionizing radiation. From this point of view, a strong demand for dosimeters that can be easily hold with the persons everywhere (no need for high voltage or cables) or used in determination of therapeutic doses and have a wide useful absorbed dose range, small physical size and tissue equivalent. The thermoluminescent dosimeters TLDs can be requested for this demand.

Improper use of a thermoluminescent material in a dosimetric application may lead to numerous errors in determined doses. To assess the radiation doses precisely, the sources of dose errors should be identified and minimized. All those sources of errors can be reduced or eliminated if appropriate procedures are followed. Typically, standard practice procedures for TL dosimetry involve pre-irradiation background (also known as “zero dose”) readings of TLDs especially at low dose levels, to be subtracted from readings of irradiated dosimeters. However, some experimentalists do skip this procedure at different circumstances: (1) if dosimeters are being irradiated to high doses compared to which background values could be neglected, (2)when high level of dosimetry with minimized uncertainties is not within the scope,(3) when dealing with large number of dosimeters, it was thought to be enough to select randomly few dosimeters for pre-irradiation background measurements instead of reading all dosimeters for saving time, and (4) when the glow curves are a subject of an analytical study regardless of doses delivered.

We selected commonly used lithium fluoride (LiF) from the numerous available thermoluminescent materials. LiF as a TL dosimeter is known for its high sensitivity, stability, and approximate tissue equivalency. Since the discovery of its useful TLD properties at the University of Wisconsin, LiF was extensively studied and is now arguably the most extensively used reference thermoluminescent material in a wide spectrum of applications. Selecting specifically LiF dosimeters to evaluate the effect of pre-irradiation background measurements on the post-irradiation dosimeter readout values and the other heat treatment effect has made the results interesting to a wide audience.

For radiation dosimetry in radiotherapy, there is a need to measure the high dose/dose rate submitted to tumor volume at the same time there is a need to measure the low dose/dose rates reached the healthy tissues around the tumor. The dosimetry system used in the determination of therapeutic doses must be independent on the dose rate. The dosimetry system used in the determination of therapeutic doses must have linear dose response in wide range from few mGy or less to few Grays or more

In this thesis, the results of the dosimetric properties such as the sensitivity, dose response and linearity range and dose rate dependence are represented and discussed. The effect of annealing, heat treatment pre-irradiation (zero dose) and the readout heating rate of the dosimeters are also represented and discussed. The application of the results in vitro measurements using the Rando phantom in different levels inside the head and comparing it with that from the treatment planning system are represented discussed and compared.

The result confirm the importance of the sensitivity factor to be applied and corrected for before any comparison or even dealing with the obtained data. If there is a shift in the temperature at which the peaks, normalization of the peak positions are a must before calculating the average of different TLDs from the same type.

The results also conclude that annealing regime plays an important role on the re-use of TLDs through cancelling the residual dose and to re-arrange the crystal structures in order to have the same previous response to radiation doses. The slow cooling is the best in devolvement of the glow peak as area under the curve and the resolution of the peaks.

In the application of the TLDs in determination of the therapeutic doses, under estimated doses is achieved compared to the use of ionization chambers.

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