Abstract

THERMOLUMINESCENT RESPONSE OF LITHIUM FLUORIDE TO RADIATIONS WITH DIFFERENT LET

by

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Lithium fluoride (TLD-100) irradiated to X- or gamma radiation exhibits a non-linear thermoluminescent (TL) response with dose. This supralinearity is directly due to an increase in sensitivity resulting from the irradiation.

Monoenergetic electron beams, compared to X- or gamma photon beams, have a relatively well defined specific ionization or linear energy transfer (LET) in different materials. The supralinear TL response of LiF (TLD-100) has been investigated in detail using monoenergetic electrons over a wide range of energies. In the low energy region, electrons from 50 to 400 keV were used. This energy range covers essentially the entire spectrum of secondary electrons encountered in the previous X- and gamma ray studies. Experiments were also performed using high energy electrons from 6 to 33 MeV.

The results of the dose response studies indicated the higher LET radiations as causing less supralinearity. Also, the high energy electron irradiations showed a

response identical to the Cesium-137 gamma radiation. These two types of radiations have almost equal values for the LET or mean stopping power in lithium fluoride.

More evidence for the LET dependence has been obtained from studies on the increase in sensitivity as a function of previous dose. Measurements of the sensitivity factor, a measure of the increase in sensitivity, showed a pronounced dependence on the quality or LET of both the sensitizing and the test radiations. Low LET radiations gave a high sensitivity factor at doses greater than 10^4 rads and as the LET increased this sensitivity factor decreased.

The LET dependence of the TL response was further verified using high LET 4.4 MeV deuterons. No supra-linearity was seen from these irradiations, the response remaining linear to 10^5 rads.

From the studies reported in this thesis it is concluded that there are now four different radiation quality dependent effects in the thermoluminescence of lithium fluoride: 1) the usual low energy increase in photoelectric cross-section, 2) the decrease in supra-linearity with increase in LET, 3) the decrease in the response of sensitized phosphor with increase in LET and 4) increase in efficiency at low doses with increase in LET. The LET dependence of both the supralinearity and

increase in sensitivity suggest the possibility that a TL phosphor with large supralinearity might serve as a "LET meter".

A physical model for the supralinearity is proposed. The changes in sensitivity are accounted for by the elimination of competing mechanisms during irradiation.

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