ABSTRACT

THERMOLUMINESCENT RESPONSE OF LiF (TLD-100)
TO 70 eV - 30 keV ELECTRONS

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Previous investigation of the thermoluminescent response of the dosimetry phosphor LiF (TLD-100) to low energy electrons have given varied estimates of its sensitivity. In addition, several investigators have noted that the glow curve shape of TLD-100 irradiated with low energy electrons differs from that obtained after irradiation with ^{137}Cs gamma rays or high energy electrons. The work reported here, for single crystal TLD-100, yields the following main conclusions:

1) If annealings are done carefully in vacuum, then the sensitivity of TLD-100 single crystals to 5-30 keV electrons and the resultant glow curve is essentially the same as when irradiations are carried out with ^{137}Cs gamma rays. The glow curve shape remains unchanged for irradiation energies as low as 100 eV; however, there is a sharp drop in the efficiency with which 5 keV - 1 keV

electrons produce TL. For energies below 1 keV the efficiency remains constant at 20% of the value measured for irradiations with ^{137}Cs gamma rays.

2) For 30 keV - 5 keV electrons all discrepancies in sensitivity can be accounted for by the higher Linear-Energy-Transfer (LET) of the electrons. At 1 keV, the sensitivity is 50% less than can be explained by the effects of the LET of these electrons.

3) A "TL effective" energy-range relationship was found which agrees with the universal curve above 2 keV and becomes nearly constant at about 300 Å for energies between 1 keV and 100 eV.

4) The commonly used "standard annealing" of 400° C for one hour produced a change in the glow curve shape and a loss in sensitivity in contrast to the vacuum anneal results. Diffusion of hydroxyl ions into the sample during air annealing was isolated as the primary cause for this change.

5) These results explain the cause for the existence of the 0.4 micron "dead layer" which previous investigators have proposed to explain the variation with particle size of the luminescent efficiency of TLD-100 powder irradiated with x-rays.

6) Irradiation with electron energies less than 1 keV result in the TL signal being emitted from the

same region from which TSEE electrons are emitted. The usual TSEE glow curve, found by other investigators, is different from the TL glow curve obtained from vacuum annealed crystals. However, if the TL sample is given the same "standard annealing" as is customary in TSEE experiments, the TL glow curve obtained after irradiation with low energy electrons is altered so that good agreement exists between this TL glow curve and the TSEE curve found by others. This implies that diffusion of hydroxyl ions into TSEE samples prior to irradiation may be the cause for the difference between the TSEE glow curve and the normal glow curve obtained from vacuum annealed TLD-100.

The shape and sensitivity of the glow curve obtained from virgin TLD-100 extruded ribbon samples varied, but in general lay between the glow curve obtained from single crystal samples annealed in vacuum and samples annealed in air.

With the use of the annealing procedure presented here TLD-100 may immediately be applied to the dosimetry of low energy electrons and other shallowly penetrating radiation. With this proposed annealing procedure the same sensitivity and reproducibility can be achieved as is currently achieved for the dosimetry of x-rays.