THE FADING OF LiF CHIPS IRRADIATED BY UV-PHOTONS

B. Ben-Shahar and Y. Laichter
Nuclear Research Centre-Negev, P.O.B. 9001, Beer-Sheva Israel.

1. INTRODUCTION

The thermoluminescent dosimeter is becoming increasingly important in all aspects of personnel and environmental monitoring. The main limiting factor that has prevented even wider usage is the inability to allow reassessment of radiation doses after the initial read-out.

The most useful dosimeter, especially in personnel monitoring, is the LiF:Mg,Ti (TLD-100). The energy, absorbed from ionizing radiation, produces mobile charge-carriers, electrons or holes, in dopped LiF. Some of the charge carriers are trapped by impurity complexes, and are released from the traps by heating the irradiated LiF. Its normal read-out is a 10-60 seconds period of heating to 250-300 °C, which is sufficient to remove the electrons (or holes) from all but the deepest traps. The thermally released carriers migrate to luminescent sites, where they recombine with (other) holes (or electrons). Light is released as this recombination occurs. The signal is recorded as a glow curve of thermoluminescence versus time or temperature.

The high, first dose can be reassessed by a second reading (residual dose) or by evaluating the dosimeter after exposing it to UV photons. In a previous work[1], we have studied the re-assessment of radiation doses measured by TLD; we have found that the dose obtained by the latter technique is greater than the residual dose, by one order of magnitude. It is known as 'UV light bleaching' or 'photo-transfered thermoluminescent' dosimetry or PTTL. It is well used for reassessing high doses in personnel and environmental dosimetry[2,3].

One of the inaccuracies of thermoluminescent dosimeters is the fading of the dose between the exposure time and the evaluation. If no annealings are performed, it can be as high as 20-30% per month for LiF chips[4,5]. The fading of LiF (TLD-100) can be decreased by different pre- and post-irradiation annealings: for a pre-irradiation annealing of 400 °C/hr or a post-irradiation annealing of 100 °C/10 min, the fading of TLD-100 is less than 4% per month[6,7].

In this work, the fading of PTTL in LiF:Mg,Ti chips during a 31-day period, was measured.

2. Experimental and results.

The measurements were performed with the standard (Harshaw) TLD-100 chips ($3x3x0.9\ mm^3$) which were all annealed for an hour at 400 °C, prior to irradiation. The samples were read-out by a manual Harshaw thermoluminescent detector, model 2000C, connected to an automatic integrating picoammeter, model 2000B and a Yokogawa recorder for glow curves.

Each chip was irradiated with a ^{60}Co source up to a dose of 80 mGy and evaluated after different periods of time, from 1 to 31 days. The dosimeters were read-out in an atmosphere of dry nitrogen to minimize the effect of tribo-thermoluminescence. The heating was about 12 °C/sec and a maximum temperature of 280 °C was reached in each cycle. Immediately after the first reading, the chips were irradiated by a 15 watt UV lamp (254 nm) at an 11 cm distance and then a second reading was performed (PTTL). In a previous work[(8)], we have concluded that the optimal irradiation-time for TLD-100 chips by a UV lamp is 15 minutes.

The ´second´ readings, which were performed after the UV-PTTL-irradiation at different times following the ^{60}Co-irradiation, were compared to those readings that were evaluated immediately. The fading of PTTL was thus calculated for different periods of time, from 1 to 31 days. The results are given in Table 1.

Table 1. The fading of PTTL.

Time (days)	Fading (in %)
1	2.6 ± 0.1
4	2.7 ± 1.5
8	2.5 ± 1.3
15	2.8 ± 0.9
22	4.7 ± 1.2
31	4.7 ± 2.6

The glow curves of PTTL after 1, 4, 15 and 31 days are shown in figure 1.

3. Conclusions

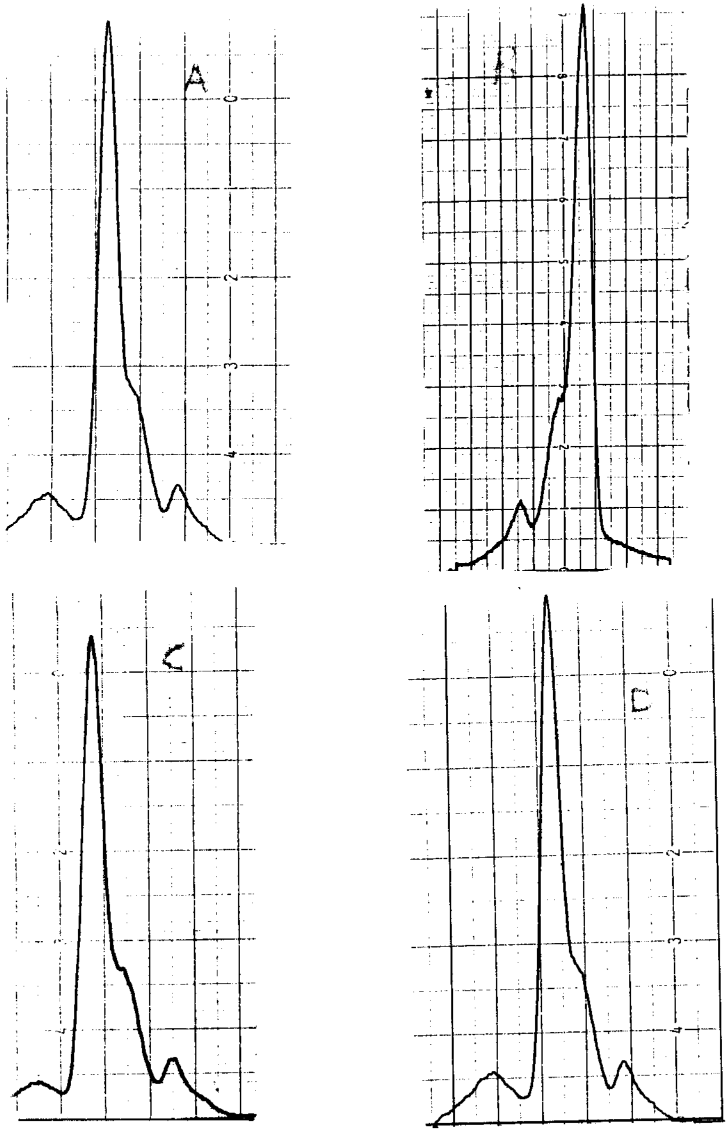
A. The fading of PTTL for TLD-100 chips is changing from 2.6% after 24 hours to 4.7% after 31 days.

B. The relatively low fading is to be expected as the second reading is due to electrons in the deep (high temperature) traps.

C. The glow curves of PTTL exhibite the same glow peaks as the curves from the γ-irradiated TLD-100; the main peaks are 4 and 5, while the lower ones are 2 and 7.

D. There is no significant difference between the glow curves of PTTL after 1 day or 31 days (see figures 1a - 1d).

Fig. 1 - The glow curve of PTTL:
a) after 1 day, b) after 4 d, c) after 15 d, d) after 31 d.



E. High doses in personnel and environmetal monitoring can be reassessed accurately, without the need for any significant fading corrections.

4. REFERENCES

1. Ben-Shahar, B., German, U. and Weiser, G.: "The reassessment of radiation doses measured by TLD", in: Trans. Israel Nuclear Soc. vol. 11, 129-132 (1983).

2. Mason, E. W., McKinley, A. F. and Saunders, D., Phys. Med. Biol. 22, 29-35 (1977).

3. Gower, R. G., Health Phys. 17, 607-611 (1969).

4. Karzmark, C. J. et al., Int. J. Appl. Radiat. Isot. 17, 161-173 (1966).

5. Ben-Shahar, B., German, U. and Weiser, G., "Fading of LiF and CaF_2:Dy", Israel AEC report NRCN-495, (1983).

6. Burkhardt, B. et al., Nucl. Instr. Meth. 155, 293-304 (1978).

7. Suntharalingam, N. et al., Phys. Meth. Biol. 13, 97-104 (1969).

8. Ben-Shahar, B. and Laichter, Y., "The intrinsic sensitivity of LiF, CaF_2:Dy and CaF_2:Tm crystals to UV-radiation and their phototransfered thermoluminescence", in: proceed. Israel Health Phys. Soc., 1987 annual meeting, pp. 28-33, (1987).