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THE PTTL IN LiF:Mg,Ti FOR GAMMA AND NEUTRON RADIATIONS

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Introduction.

The LiF:Mg,Ti is widely used in personal dosimetry due to its properties which are a good compromise between various desired characteristics of thermoluminescent materials: almost tissue equivalent, low thermal and optical fading and allows doses of 0.1 mGy to be measured with high performance equipment (1). One of the main shortcomings of the TLD method is the exposure information deletion during readout. PTTL (photo-transferred thermoluminescence) is thermoluminescence after u.v. light exposure in a phosphor (2) which had been earlier exposed to ionizing radiation and then read, leaving some TL as a residual (RTL). The LiF has deep traps that can be significantly populated when exposed to high doses of ionizing radiation. Because normal readout procedures (heating to about 300°C) usually do not depopulate these traps, a second u.v. irradiation followed by the conventional readout produces a response which is proportional to the original high dose. These "memory effects" in the TL materials can be employed for the re-estimation of doses and have been reported in several papers (3,4).

The PITL (photo-induced thermoluminescence) is the thermoluminescence obtained when the phosphor is exposed to u.v. light, whithout being earlier exposed to an ionizing radiation. This phenomena is very low for the most thermoluminescence phosphors (5),and is the background in the measurements of the PTTL.

The PTTL effect in LiF:Mg,Ti TLD-100 cards for high doses of gamma rays was presented in the past (5 ,6). In the present work we are presenting evaluations of the PTTL effects for gamma and neutron irradiations, for several exposures. We have checked the PTTL values in LiF:Mg,Ti chips for gamma and neutron radiations, and found significant differences. We have also measured the PITL of several phosphors, in order to evaluate the background of the measurements. The glow curve of the PTTL compared with the glow curve of the PITL is presented and the glow curve of the LiF:Mg,Ti phosphor, irradiated by thermal neutrons and gamma rays are given, too.

Materials and methods.

The measurements were performed using standard Harshaw/Bicron manufactured G-1 cards, each of them containing two TLD-100 chips (3mm X 3mm X 0.9mm). The u.v. irradiation was performed by a 15 w u.v. lamp (λ=254nm). Gamma irradiations were carried out using a Cs-137 source. The neutron irradiations were carried out at the KANDI-II neutron diffractometer facility at the IRR-2 (Israel Research Reactor-2) and the energy of the neutrons employed was 0.018 eV. The neutron fluence was monitored by a U-235 fission chamber. The heating profile was a preheat to 50°C and heating rate of 25°C up to 300°C, for a total time of 13.3 seconds. The TLD cards were read by an automatic 6600 Bicron/Harshaw reader.

Experimental results.

PITL

Three G-1 cards which have not been irradiated before, were irradiated by the u.v. lamp for 15 minutes and then evaluated immediately. The glow curve of the PITL of one of the phosphors is presented together with the glow curves of the PTTL obtained after irradiation to thermal neutrons and gamma (fig 1). The average obtained after integration over the glow curve area was 0.3 mGy.

PTTL after gamma irradiation

Three G-1 cards were irradiated by gamma rays (Cs-137) to three doses between 26 mGy and 180 mGy. The reading of the first dose for each phosphor was performed after 48 hours. After the evaluation of the second reading, the phosphors were irradiated by the u.v. lamp for 15 minutes and evaluated immediately (PTTL). In table 1 the results of the exposures, first reading, PTTL and the percentage of the PTTL from the original dose are presented. The PTTL value is the net value, after subtracting the PITL.

Table 1: The dose and the PTTL of LiF:Mg,Ti irradiated by gamma rays.

Exposure (mGy)	First reading (mGy)	PTTL (mGy)	Percent of (3) from (2) (%)
26	26.44	0.39	1.48
100	104.16	1.80	1.73
180	187.0	3.26	1.74

The results obtained for the percentage of the PTTL from the first dose are similar to those described in an earlier publication (6) .

PTTL after thermal neutron irradiation

Five G-1 cards were irradiated by thermal neutrons, as described previously, to different doses equivalent to 30 - 400 mGy. The reading of the first dose for each phosphor was performed after 48 hours. After the evaluation of the second reading, the phosphors were irradiated by the u.v. lamp for 15 minutes and evaluated immediately (PTTL). In table 2 the results of the exposures, first reading (equivalent to the gamma dose), PTTL and the percentage of the PTTL from the original dose are presented. The PTTL value is the net value, after subtracting the PITL.

Table 2: The dose and PTTL of LiF:Mg,Ti irradiated by thermal neutrons.

Exposure (mGy)	First reading (mGy)	PTTL (mGy)	Percent of (3) from (2) (%)
30	29.6	2.79	9.42
60	59.6	5.87	9.83
193	197.8	18.30	9.25
324	334.1	29.35	8.78
402	382.6	34.32	8.97

It can be seen that there is a significant difference between the PTTL values for neutrons and gamma rays.

In figure 1 the glow curves of the PTTL after irradiation to thermal neutrons and gamma, compared with the glow curve of the PITL are given. The glow curve of the PTTL after irradiation to gamma rays and thermal neutrons have the same shape. This is in contrast to the different glow curves from the first reading (see fig.2)

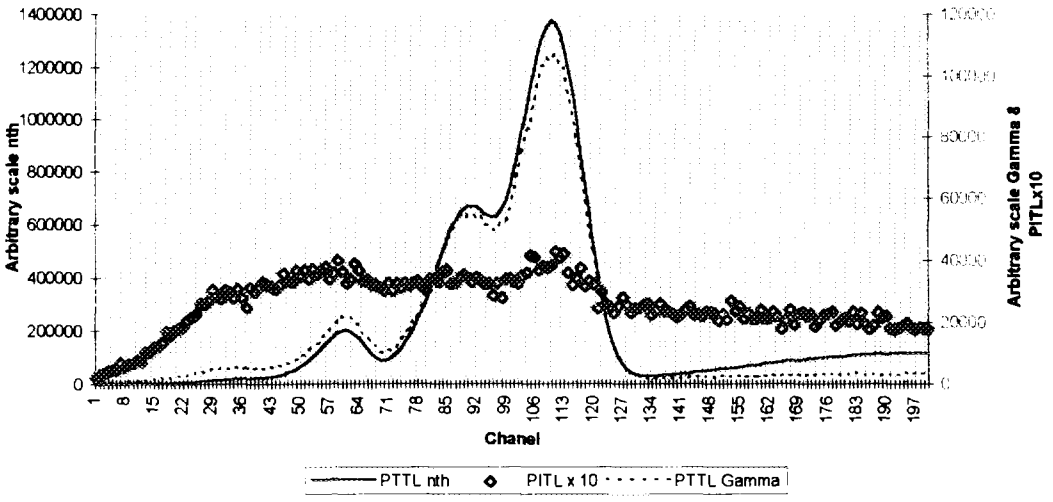

Fig 1 Gamma and thermal neutron PTTL glow curves and the PITL.

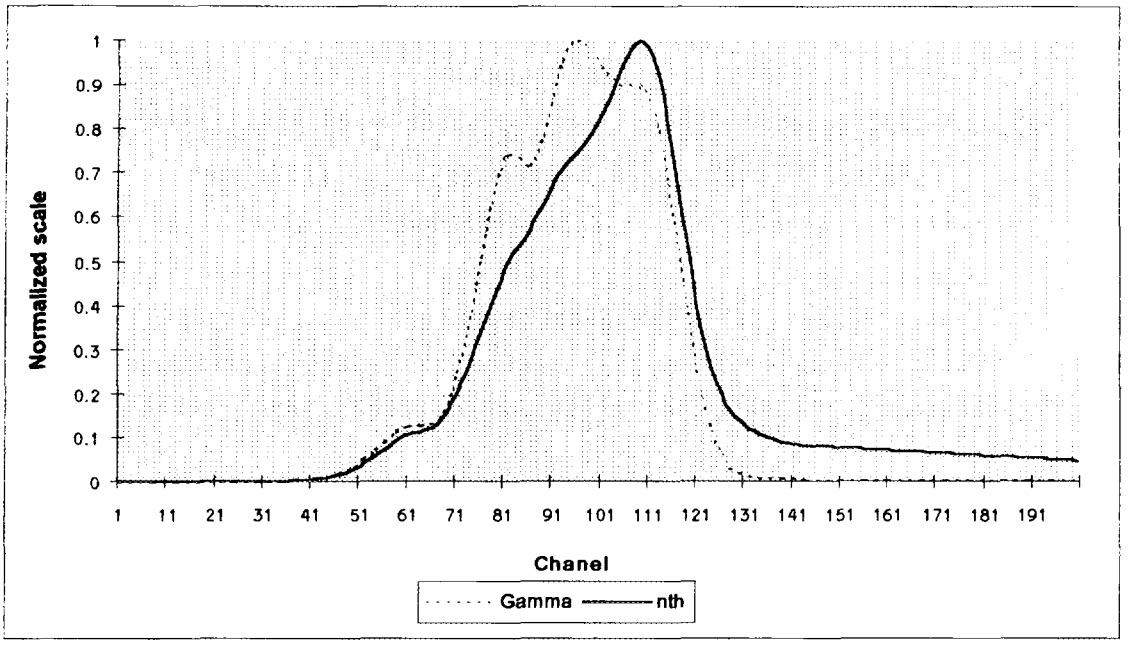

Fig 2 Gamma and thermal neutron glow curves (first reading)

CONCLUSIONS

1. The PTTL curves obtained after neutron irradiation and gamma irradiation have similar shapes.
2. The PTTL obtained after irradiation by thermal neutrons is much higher than the PTTL after gamma irradiation, and seems to be not dependent on the dose.
3. Intermediate and high doses of gamma rays and neutrons can be reassessed by u.v. irradiation (PTTL). Our evaluation indicate that the percentage of the PTTL from the absorbed dose (first reading) is 9.25 ± 0.40 for thermal neutrons and 1.65 ± 0.15 for gamma rays.

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