THE INFLUENCE OF TIME - TEMPERATURE ON THE BEHAVIOR OF TLD-100 AS PERSONAL DOSEMETERS

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INTRODUCTION

Since 1965, the survey of individual exposure for the people working in the medical field is carried out within the Institute of Hygiene and Public Health, by a central service belonging to the Romanian Ministry of Health. During this period, 6500 persons per month were monitored, using film-badges. The relative low sensitivity of film dosemeters lead to a decrease of confidence in this old system. Furthermore, the film badges do not have appropriate filters for measuring the personal equivalent doses Hp(10) and Hp(0.07), as are the new recommendations of ICRP and IAEA.

These facts made clear there is a necessity of changing this type of monitoring system with another one, having a higher sensitivity and allowing the measurement of personal equivalent doses Hp(10) and Hp(0.07).

The decision was to switch to a TL dosimetry system, namely the Harshaw 6600 System [1]. The performances of this new system have to be checked by the TL Dosimetry Group, at the Institute of Hygiene and Public Health, before being officially accepted as the new individual dosimetry system.

The paper presents the results of some of the test performed on the TLD-100 chips, concerning the influence of the heating rate and pre-heat temperature and duration (the time-temperature profiles) and the fading of the detectors.

MATERIALS AND METHOD

In order to check the performances of the TLD-100 chips, we have used the Harshaw 6600 System, which is the new system meant to be used for individual dosimetry.

The Harshaw 6600 TLD System consists of a TLD reader and a computer system. The reader uses hot nitrogen, or hot dry air to read the TLD cards. The TLD cards we are using (Fig. 1) are bar-coded cards, containing two LiF: Mg, Ti (TLD-100) included in Teflon foil.

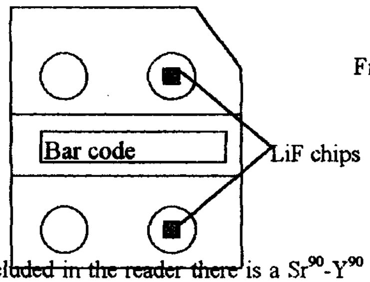

Fig. 1: Schematic of a TLD card used by the Harshaw 6600 System.

Included in the reader there is a Sr^{90}-Y^{90} irradiation source, that we used to irradiate the cards. The source was calibrated at the Secondary Standard Dosimetry Laboratory, within the IISP. A computer system, with the TLDREMS software (also provided by Harshaw) is used to control the reader. The reproducibility of the working parameters (photomultiplier noise, high voltage, reference light, etc.) is checked at least daily, in this way assuring the reproducibility of the experiment.

The software allows the selection of different time-temperature profiles for every TL chip independently. Selection can be made on the preheat temperature and duration of preheat, on the temperature rate, on the maximum temperature, on the acquire time and on the annealing temperature and duration. Using this option from TLDREMS, we have defined six time-temperature profiles for our experiment.

Table 1: TTPs used in the experiment.

TTP1	TTP2	TTP3	TTP4	TTP5	TTP6
No preheat Temperature rate: 10°C/s Maximum temperature: 300°C Acquisition time: 13 1/3 s No annealing	No preheat Temperature rate: 25°C/s Maximum temperature: 300°C Acquisition time: 36 2/3 s No annealing	No preheat Temperature rate: 30°C/s Maximum temperature: 300°C Acquisition time: 13 1/3 s No annealing	Preheat temperature: 100°C Time of preheat: 30s Temperature rate: 25°C/s Maximum temperatuire: 300°C Acquisition time: 13 1/3 s No annealing	Preheat temperature: 100°C Time of preheat: 60s Temperature rate: 25°C/s Maximum temperature: 300°C Acquisition time: 13 1/3 s No annealing	Preheat temperature: 100°C Time of preheat: 120s Temperature rate: 25°C/s Maximum temperature: 300°C Acquisition time: 13 1/3 s No annealing

RESULTS AND DISCUSSION

The first three TTPs were use to determine the influence of the temperature rate on the use of the TLD cards as personal dosemeters. In our case, the peaks of interest are peaks number 3, 4, 5. (Fig. 2), the others peaks having a too low temperature to be used in this purpose, which presumes long-term (at least one month) survey.

It is well known that the Randall - Wilkins model predicts a dependence of the peak maximum position by the heating rate given by [2]:

(1) $\beta = (sk/E)T_M^2\exp(-E/kT_M)$,

where s is the attempt to escape frequency, k is the Botzmann constant, E is the trap activation energy and T_M is the position of the peak maximum. This expression indicates that rather large changes in heating rate result in small changes in peak maximum position. The measurements we have performed indicated that the position of the peak changes with 10% +/- 3% when the heating rate changes from 10°C/s to 25°C/s, and with 5% +/- 1% when the heating rate changes from 25°C/s to 30°C/s. All measurements were performed on a batch of 50 cards.

The next three TTPs were used to determine if we can skip the period of minimum 1 week, that needs to separate the time of irradiation from the time of measurement, when the calibration of the system is performed. This time interval is needed to allow the fading of the low temperature peak, not useful for personal dosimetry, and to realize calibration conditions as close as possible to actual personal dose measurements. We have used a batch of 50 cards irradiated with the Sr^{90}-Y^{90}, and read out immediately after irradiation. The glow curves were compared with the reading of other 50 TLD cards, performed 2 weeks after irradiation.

The results indicated that, in order to obtain similar readings with the readings performed after 2 weeks, a longer annealing time is needed, than the times we have used on the reader. For example, peak number 2 had an intensity about 5 times smaller when annealed at 100°C, for 120s, than when read out immediately after irradiation. However, the same peak had an intensity about 10 times lower when read out two weeks after irradiation, which means the annealing should be done for about 1 hour, at 100°C.

A batch of 100 cards was irradiated and read out at different times after the irradiation (immediately, one day after, two days, then at two days interval until one month was achieved). The fading of the TL signal is presented in Fig. 2.

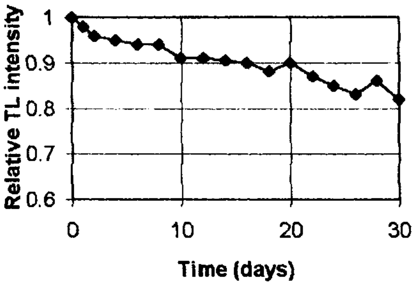

Fig. 2: Fading of TL chips used by Harshaw 6600

The relative intensity was calculated by respect to the read out immediately after the irradiation. As it can be seen, the fading is very low (less than 20% for the total area of the glow curve). Furthermore, the fading of the peaks of interest for personal dosimetry is even less important (only 3% for peaks 3, 4 and 5).

CONCLUSIONS

The measurements presented here allowed us to conclude that Harshaw 6600 is a very reliable system for personnel dosimetry.

REFERENCES

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