INFLUENCE OF CHEMICALS ON UNIRRADIATED LIF THERMOLUMINESCENCE DOSEMETER READING

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In determining the partial body dose of a large number of persons using thermoluminescence dosemeters (TLD's), contact of the TLD with detergents or other chemicals during monitoring cannot definitely be ruled out. Studies were carried out into whether a dose can be simulated by these means in TLD evaluation and how a simulated dose can be recognized in routine evaluation (1).

Method

Unirradiated, regenerated TLD's of LiF were studied both as TLD chips (Harshaw, TLD 100, 1/8 x 1/8 x 0.035") and as small Teflon disks with embedded LiF (Teledyne Isotopes, D-LiF 7-0.4). In order to determine the influence of liquids on the TLD reading, the dosemeters were immersed in the liquid for a few minutes and subsequently kept in the dark to dry for 20 h before evaluation. In some of the tests, the TLD's were rinsed with distilled water before drying.
The TLD's were stored over concentrated solutions of HNO_3, HCl and NH_3 for one to two hours in order to study the influence of aggressive vapours.

The TLD's were evaluated in a reader of the Harshaw 2000 A/B type. During the evaluation the multiplier current in the reader was only integrated for planchet temperatures of 160 °C to 240 °C. Light emitted from the TLD at lower temperatures was not included in the evaluation. The mean background of unirradiated TLD's not influenced by chemicals is subtracted from the readings. The glow curve was recorded during evaluation. Immediately after evaluation the TLD was evaluated a second time and the glow curve recorded once again (Fig. 1). The glow curves were plotted semi-logarithmically because of the large dynamic range of the emitted light intensity. The chemical influence was generally studied on 2 TLD's. If a major influence on the TLD reading was found then the measurements were repeated with 10 TLD's.

Results and Discussion

The increases in the TLD readings caused by non-radiation-induced light emission after the influence of various chemicals are compiled in Table 1. In many cases the apparent dose induced by chemicals is smaller than the fluctuations in background of the unirradiated TLD's. The influence of the chemicals is larger with TLD's of LiF in Teflon than with TLD chips. Non-radiation-induced light emission is particularly large after treatment with $NaPO_3$, NaOCl, NaOH and certain detergents. The fluctuations of the measured values about the mean are unusually large. Lingertat (2) has already pointed out this property of non-radiation-induced light emission. With the aid of the glow curve from the first or second TLD evaluation it can always be recognized whether an apparent dose generated by chemical influence is being measured during TLD evaluation. A comparison of the curves in Figs. 2-4 with those in Fig. 1 shows this for several examples. Whereas after treatment with water, NaOCl and the detergents Sunil and Fakt a clear difference in the glow curves from those of the irradiated dosemeters is established, this is not the case after treatment with NaOH. With NaOH, however, the glow curve clearly differs from that of irradiated TLD's when repeating the evaluation.

Teflon disks without LiF treated with detergents, NaOCl or NaOH displayed similar glow curves during evaluation in the TLD reader and approximately the

same dose increases as TLD's of LiF in Teflon after chemical influence. A non-radiation-induced light emission is obtained with the detergent "Sunil" if a few grains of this substance are heated in the TLD reader. If the TLD's of LiF in Teflon are rinsed with water after being kept in the Sunil solution then the value of the non-radiation-induced light emission drops by more than one order of magnitude.

Summary

The influence of chemicals on TLD's can bring about readings during evaluation which correspond to doses of less than 1 mSv in the case of LiF chips and to doses of less than approx. 20 mSv with TLD's of LiF in Teflon. The chemical influence in the tests described here is many times larger than could unintentionally occur in radiation monitoring with TLD's. Apparent doses caused by chemical influence can be recognized in TLD evaluation and corresponding errors can be excluded.

References

1. Schumacher, R.
Untersuchungen zur Fehlererkennung bei der Routineauswertung von Thermolumineszenzdosimetern
Internal Report: ASS-No. 0366, Jülich 1982

2. Lingertat, J.
Untersuchungen zur Personendosimetrie mit Lithiumfluorid
Dissertation, Dresden 1967

Table 1: Apparent Dose after Influence of Chemicals on Unirradiated TLD's

Group	Chemical	Concentration**	Exposition time	apparent dose ***	
				LiF chips	LiF in Teflon
		%	min	mSv	mSv
	H_2O	-	30	0.03	0.36
acids	CH_3COOH	10	5	0.02	0.07
	H_2SO_4	10	5	0.03	0.06
	HCl	10	5	0.02	0.00
	HNO_3	10	5	-	-0.02
	H_3PO_4	10	5	0.03	0.22
lye	NaOH	10	5	0.58	7.6 ± 6.5
dissolved salts	NaCl	10	5	0.03	0.15
	NaI	10	5	0.04	0.12
	Na_2SO_3	10	5	0.03	0.29
	Na_3PO_4	10	5	0.21	0.79 ± 0.32
oxidizing agents	$KMnO_4$*	5	5	-	0.77 ± 0.51
	$KMnO_4$*	5	30	0.02	-
	H_2O_2	10	5	0.05	0.70 ± 0.39
	NaOCl	10	5	0.22	2.7 ± 2.4
aggressive vapours	NH_3	-	120	0.01	0.22
	HCl	-	120	0.02	0.04
	HNO_3	-	60	0.02	0.05
organic substances	methanol	-	5	0.03	0.55
	ethanol	-	5	0.04	0.30
	acetone	-	5	0.03	0.49
	methyl-acetate	-	5	0.03	0.73
detergents and washing agents (trade names)	soap solution	0.1	30	0.03	1.4 ± 0.2
	Risol	10	30	0.02	0.33
	Decopan 85	-	30	0.10	0.75
	Decopan 85*	-	30	0.01	-
	RBS 50	10	30	0.18	1.1
	RBS 50	-	30	0.20	1.8 ± 0.7
	RBS 50*	-	30	-	2.5 ± 1.2
	Sanso	1	30	-	0.84 ± 0.40
	Calgon	1	30	-	1.7 ± 0.6
	Fakt	1	30	0.07	1.2 ± 0.8
	Mustang	1	30	0.04	1.1 ± 0.2
	Dash	1	30	0.11	1.6 ± 0.3
	Persil	1	30	0.05	5.0 ± 2.5
	Sunil	1	30	0.22	5.3 ± 2.6
	Quanto	1	30	-	7.5

* After chemical treatment the TLD's were rinsed with distilled water before drying.

** If no concentration is given the substances were used in the initial concentration.

*** If measurments with 10 TLD's were carried out then the standard deviation is given in addition to the mean.

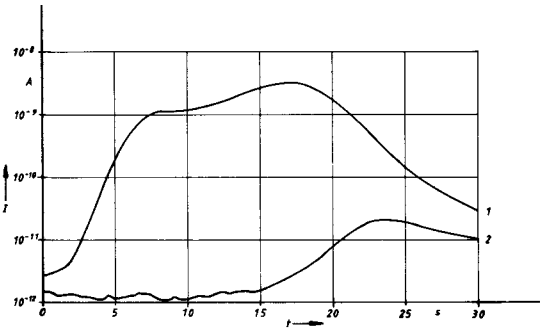

Fig. 1: Glow curve of TLD's of LiF in Teflon irradiated at a dose of 0.03 Sv (1) and glow curve of the subsequent repetition of the TLD evaluation (2)

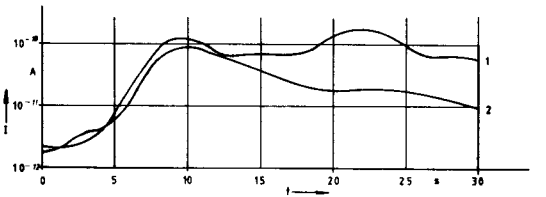

Fig. 2: Glow curve of TLD's of LiF in Teflon after influence of NaOCl solution (1) and distilled water (2)

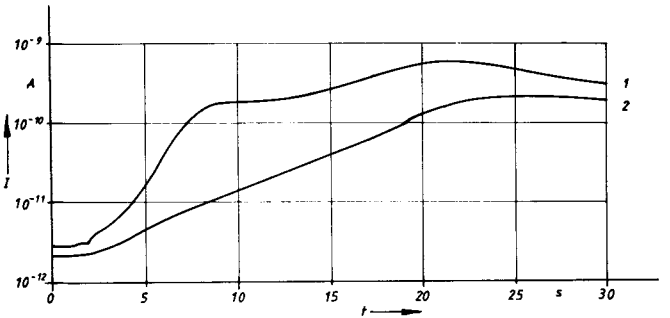

Fig. 3: Glow curve of TLD's of LiF in Teflon after influence of 10 % NaOH solution (1) and glow curve of the subsequent repetition of TLD evaluation (2)

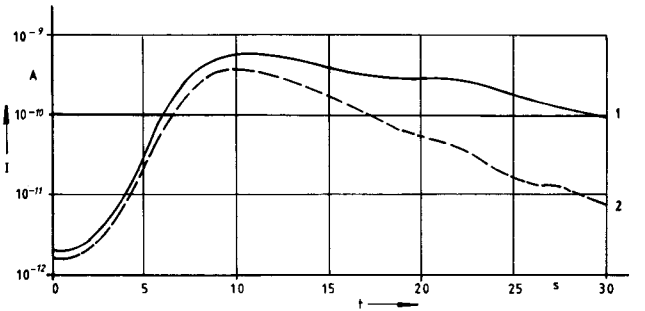

Fig. 4: Glow curve of TLD's of LiF in Teflon after influence of 1 % solutions of the detergents Sunil (1) and Fakt (2)