GRAPHITE MIXED $CaSO_4$:Dy FOR BETA DOSE MEASUREMENT

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INTRODUCTION

Dosimetry of weakly penetrating radiation, beta and photon radiation below 15 keV, has got more attention only during the last 20 years when a variety of methods for skin dosimetry were developed. One of the main difficulty in beta dosimetry is the energy independent dose determination. Dosemeters have been developed may be characterized as: mechanically thin TL detectors, surface sensitive elements, multi-element constructions and application of special evaluation regimes and/or glow curve analysis (1). Surface sensitive dosemeters include: TSEE detectors; reduction of the light transparency of thick detectors by adding graphite or other materials; creating new TL traps near the detector surface by diffusion of boron into LiF or Li_2 or $Li_2B_4O_7$. Good results have been achieved with carbon loaded LiF, $Li_2B_4O_7$ and MgB_4O_7 (2,3,4,5). Detectors loaded with carbon in a range of 11-20 % C have an effective thickness of a few $mg \cdot cm^{-2}$ therefore with an appropriate window thickness, 1-5 $mg \cdot cm^{-2}$, nearly energy independent beta dose measurement is possible even from $E_{\beta eff}$ 70 keV.

Lower sensitivity of thinner effective sensitive layer may be compensated by using high sensitivity TL material such as LiF; MCP (6) Present work presents results on graphite-mixed $CaSO_4$:Dy.

MATERIALS AND METHODS

Sintered $CaSO_4$:Dy pellets were prepared of 63-125 μm grains (7). These detectors have very good dosimetric properties: the main dosimetric peak exhibits at about 220°C, linear dose range is 10 Gy, no need for annealing at low doses, batch uniformity is letter than 2.3 %, reproducibility is better than 2 %. Environmental factors do not affect the detectors, no fading of the main dosimetric peak during a five months period is observed. The wavelengths of emission peaks are 478 nm and 550 nm, the relative TL response normalized to TLD-100 is 12-49 depending on the TL reader used for read-out. Detectors of $CaSO_4$:Dy were produced with different carbon loading, 5-10 % C. TL materials such as LiF:Mg,Cu,P IPN, Krakow, LiF (TLD-100), cold pressed LiF (0.85 % C) IKI, Budapest were used for comparison. BeO, Battelle Institute, Frankfurt and cold pressed LiF (C) were used for TSEE measurements.

Irradiations were carried out with newly designed nearly tissue equivalent beta sources. Beta dose-rates were measured with extrapolation chamber and flat ionization chambers. Irradiations were carried out at a 'contact' geometry, source to detectors distance was 7 mm, and 6.5 $mg \cdot cm^{-2}$ thick Mylar foil covered the detectors.

Irradiated TL detectors were analyzed by a Daybreak TL reader utilizing photon counting and the applied heating rate was $3°C \cdot s^{-1}$. TSEE measurements were carried out with reader developed at Fontenay-aux Roses, France having a multi needle counter.

RESULTS AND DISCUSSION

Detectors type $CaSO_4$ (C) used in measurements were selected from a larger batch and their sensitivities did not differ more than 3 % from the mean value.

Relative TL responses of pure, graphite-mixed $CaSO_4$:Dy detectors are given in Table 1 and in Fig. 1 and for the other TL detectors in Fig. 2.

Table 2. Relative TL responses of $CaSO_4$:Dy (C) detectors normalized to ^{90}Sr-^{90}Y irradiation

Detector		$CaSO_4$		
	pure	5 % C	8 % C	10 % C
^{147}Pm	10.5	36	48.5	49.7
^{204}Tl	58.3	69.6	72.5	81.1
^{90}Sr-^{90}Y	100	100	100	100
^{106}Ru-^{106}Rh	140	98	86	86

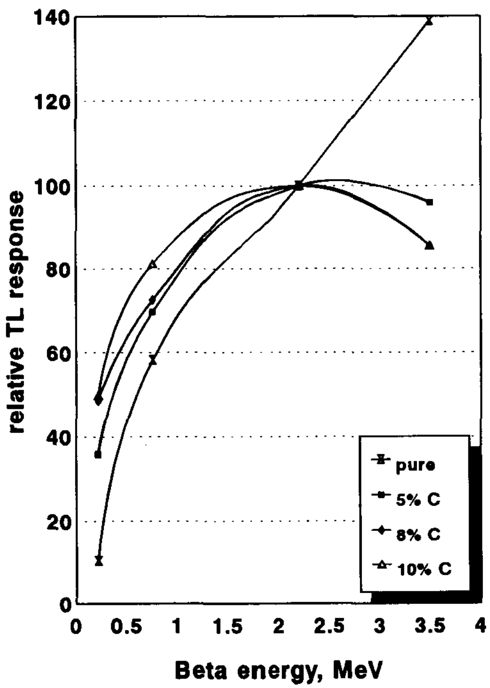

Fig. 1. Energy dependence of TL responses of $CaSO_4$:Dy (C) detectors

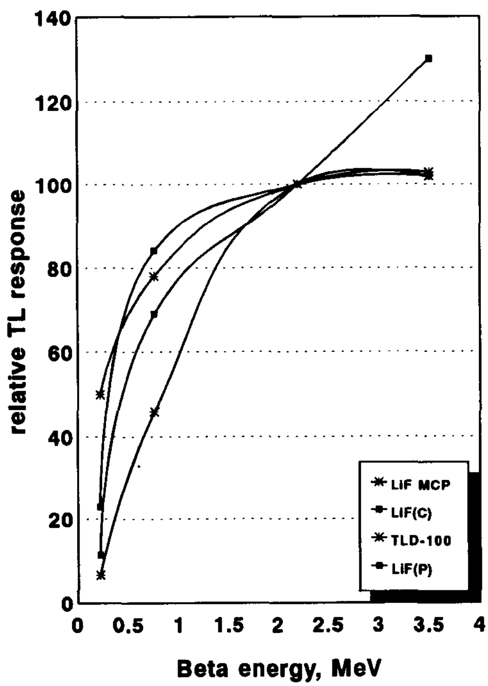

Fig. 2. Energy dependence of TL responses of different LiF detectors

Sensitivities of different dosemeters were determined, see Table 2.

Table 2. Sensitivities of TL and TSEE methods using different materials

Method	Dosemeter	Lower detection limit, μSv
TSEE	BeO	2.5
	LiF (0.85 % C)	3000
TL	LiF; Mg,Cu,P	15
	LiF (0.85 % C)	300
	LiF (p) Krakow*	80
	TLD-100*	150
	$CaSO_4$:Dy pure*	10
	$CaSO_4$:Dy (5 % C)	80
	$CaSO_4$:Dy (8 % C)	200
	$CaSO_4$:Dy (10 % C)	250

Lower detection limits is set to 3 σ of the second reading; integration: the main dosimetric peak only.
*Sensitivities are valid only for higher $E_{\beta} \geq 0.5$ MeV radiations due to strong energy dependence of TL responses.

Results of $CaSO_4$:Dy (C) detector measurements have shown: this detectors are suitable for beta dosimetry, their sensitivity is high enough, energy dependence of TL responses are nearly flat for a wide energy range if an entrance window about 3 mg·cm^{-2} thick is used. The general excellent dosimetric properties of investigated $CaSO_4$:Dy (C) detectors make them a good candidate for beta dosimetry especially for pure beta radiation field measurement where their overresponses for low gamma radiation does not appear.

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