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# LITHIUM DRIFTED BERYLLIUM OXIDE HIGH SENSITIVITY THERMOLUMINESCENT DOSIMETER

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A new BeO : Li detector sensitized by a novel method is described. The glow curve of the detectors shows two peaks, the ratio of peak heights depends on dose. The light output per unit dose slightly exceeds that of lithium fluorides. Reproducibility is $\pm 2\%$ for doses higher than 3 mGy, detection limit is 50 $\mu$Gy, exceeding by two – three orders of magnitude the values obtained for commercial BeO detectors. Response shows less than $\pm 15\%$ change with photon energy. Fading is lower than $2\%$ per month.

Beryllium oxide (BeO) TL dosimeters were used by the author and his co-workers in the past for gamma and mixed neutron-gamma radiation dosimetry [1], [2]. In spite of several advantages (precision, low neutron response, etc.) por sensitivity restricted their field of application to nuclear accident and radiobiological dosimetry [3], [4].

The present paper deals with a new BeO:Li detector, sensitized by a novel lithium diffusion technique, developed by BOROS for TSEE detectors [5], [6]. The 8 mm dia $\times$ 0.25 mm thick BeO disks, produced by Consolidated Beryllium Co. (Milfordhaven, England) and sensitized by the BOROS method have the following TL properties.

The glow curve shows two peaks, at temperatures of approximately 250 °C and 380 °C, respectively. The ratio of peak heights depends on dose, as it can be seen from the set of glow curves of Fig. 1. The detection limit is of the order of 50 $\mu$Gy (5 mrad).

The light output per unit tissue dose slightly exceeds that of a lithium fluoride chip of 4.6 mm dia, when the dosimeters are read by a TLD-04B reader [7].

The triboluminescence of the dosimeters in question is a major effect which determines the minimum detectable dose. The reproducibility of readings of an unirradiated detector is $\sigma_0 = 2-3$ $\mu$Gy equivalent if the detector is not removed from the heater planchet between consecutive readings. Removing the detector from the heating planchet after read-out with a metal tweezer and putting it back again for the next reading, $\sigma_0$ reaches 20 $\mu$Gy equivalent, clearly showing the effect of triboluminescence. Scratching the detector surface with a steel laboratory tweezer increases the $\sigma_0$ of the triboluminescent signal to 40–80 $\mu$Gy equivalent (Table I).

Values for triboluminescent effect were obtained by measuring the TL signal between temperatures of 160 °C and 400 °C. Comparing the tribolumines-

**Table I**

Triboluminescent signal induced by handling

| Handling method | Triboluminescent signal µGy equivalent | Standard deviation of triboluminescent signal, µGy equivalent |
|---|---|---|
| untouched | ~ 60 | 2— 3 |
| grasped with steel tweezer | ~100 | 15—20 |
| scratched 5 times with a steel tweezer | ~160 | 40—80 |

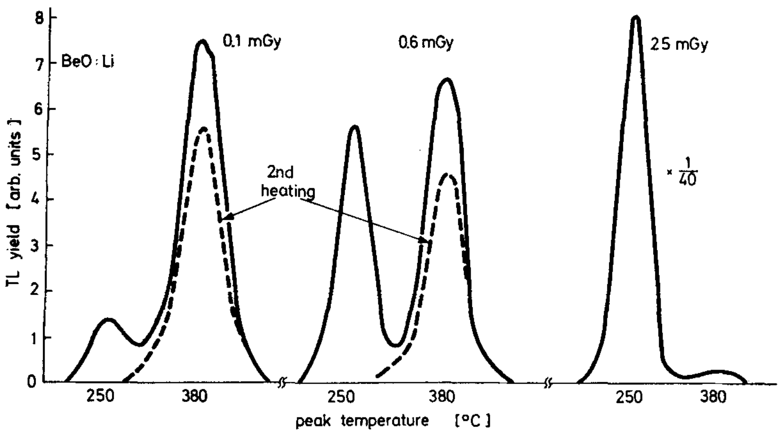


*Fig. 1.* Glow curves of BeO : Li detectors, irradiated with different doses. Heating parameters of read-out: 12 °C/s heating rate, 420 °C maximum temperature. The right hand glow curve was divided by 40.

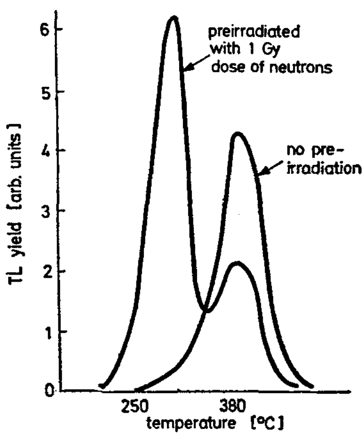


*Fig. 2.* Triboluminescent glow-curve of a virgin detector and that of a detector previously irradiated with 1 Gy tissue dose of thermal neutrons and read out several times. Triboluminescent signal was induced in both cases by tweezer handling.

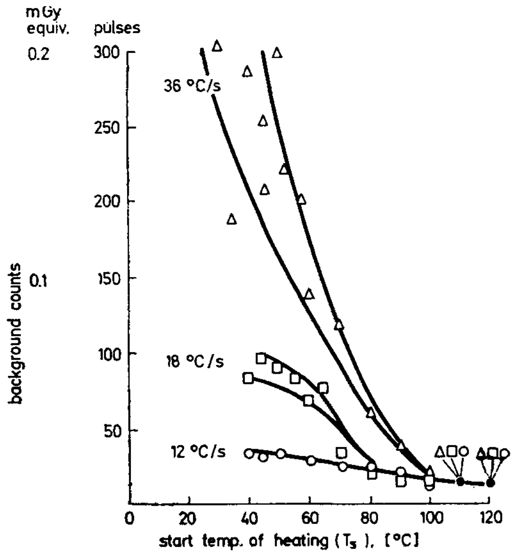


*Fig. 3.* Thermal effects on background counts of unirradiated detectors. Parameter is the heating rate. Counts were accumulated between 120 °C and 300 °C temperature.

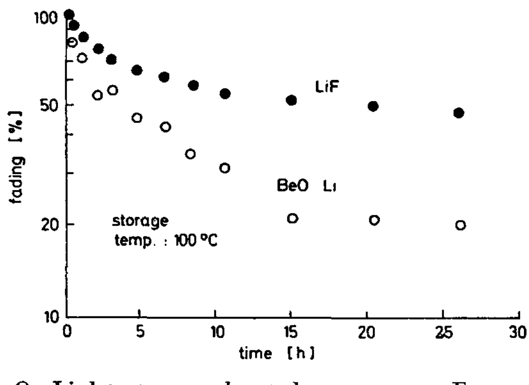


*Fig. 4.* Fading of BaO : Li detectors at elevated temperature. For comparison the fading of LiF hot pressed chips (produced at Nuclear Research Inst. Cracow, Poland) is also plotted.

cent glow-curves of no preirradiation (Fig. 2) with those of induced by gamma radiation it is evident that a large part of the triboluminescent signal can be excluded by proper detection window setting. The two-peaked glow curve in Fig. 2 shows that neutron irradiation increases triboluminescent sensitivity. Increased triboluminescent sensitivity is not reduced by repeated read-out cycles.

In order to investigate possible heating rate effects the following measurement was carried out: 1) Unirradiated detectors were read with a linearly increasing heating profile followed by constant heating at a temperature of

380 °C for 5 s, 2) a second reading cycle was started before the detector cooled down to room temperature.

Counts obtained during the 2nd read-out are plotted against start temperature of that read-out in Fig. 3. Results indicate that background counts increase, if a longer cooling time is allowed. With the increase of heating rate the background also increases. These heating rate effects are probably due to the thermal stress of the ceramic disk.

Fading of the irradiated detectors stored in darkness at room temperature was found to be less than 2% per month. Results of fading mesurements at an elevated temperature are shown in Fig. 4.

The gamma-energy dependence of the detectors is very favourable, response below 80 keV slightly decreases to a value of 0.85 at 30 keV if the response 1.25 MeV is taken to be unity [8].

Summarizing our findings it can be stated that BeO:Li detectors can be used as virtually energy-independent detectors for X and gamma radiation. The detection limit is $\sim$ 50 $\mu$Gy, if some precautions are taken: a heating rate not exceeding 10 °C/s and the use of plastic coated tweezer.

Reproducibility is excellent, $\pm$ 2% s.d. for doses higher than 3 mGy.

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