Available online at www.sciencedirect.com
ScienceDirect
Nuclear Instruments and Methods in Physics Research B 266 (2008) 2915–2917
NIM B Beam Interactions with Materials & Atoms
www.elsevier.com/locate/nimb

Optical decay of OSL signal of Al_2O_3: C detectors exposed to different light sources

C.C. Gronchi [a,b], S.G.P. Cecatti [a,b], T.C.N.O. Pinto [a,b,*], L.V.E. Caldas [b]

[a] *FUNDACENTRO – Rua Capote Valente, 710 – 05409-002 – São Paulo, SP, Brazil*
[b] *Instituto de Pesquisas Energéticas e Nucleares, IPEN-CNEN/SP Av. Prof. Lineu Prestes, 2242 – 05508-000 – São Paulo, SP, Brazil*

Available online 24 March 2008

Abstract

The optically stimulated luminescence technique has been utilized as an option for personal dosimetry due to a variety of factors, as the availability of commercially personal monitoring systems based on the OSL of Al_2O_3: C. In this work, the sensitivity of OSL detectors of Al_2O_3: C, Inlight personal dosimetry system, Landauer, was verified for different light levels. The results show that the percentage fading of OSL detectors exposed to 260 lux and 26,000 lux from fluorescent light varied between 16–24% and 76–91% in the first five minutes, respectively. The data confirmed the very high sensitivity to light of these detectors.

PACS: 29.40.−n

Keywords: Optical stimulated luminescence; Al_2O_3: C; Fluorescent light; Sunlight

1. Introduction

The optically stimulated luminescence (OSL) technique has been actively utilized as a dosimetry method for archaeological and geological dating. In the present days, the OSL technique has been shown useful for personal dosimetry too [1].

The OSL phenomenon is based on the luminescence emitted from an irradiated insulator or semiconductor as a result of light stimulation.

Since the development of this technique, its use is restricted because of the lack of a good luminescent material presenting both high sensitivity to radiation and optical stimulation efficiency, a low atomic effective number and adequate fading characteristics [2]. The Al_2O_3: C detector is a very good luminescent material for OSL dosimetry, because it presents excellent dosimetric characteristics. It was the first material introduced commercially for personal monitoring based on an OSL reader system from Landauer [3].

However, there is one potential limitation of the utilization of this material due to its high sensitivity to light, and this situation is a serious problem for its application in personal dosimetry [4].

The OSL signal of an Al_2O_3: C detector is reset during light exposure of the sample. The occurrence of light induced fading in Al_2O_3: C has been previously reported by Akselrod et al. [5].

In addition, an investigation of the light induced fading of this material by sunlight was realized by West et al. [6]. A strong light induced fading of the OSL signal could be observed in Al_2O_3: C. This sensitivity to light is presented in different ways, as for instance, the generation of an OSL signal in unirradiated samples. If the light sensitivity of this dosimetric material undergoes significant changes in different ranges of time, it is very important to study this behaviour for Al_2O_3: C involving different light sources.

The purpose of this paper was to study the optical decay of the OSL signal of the dot dosimeters of

* Corresponding author. Address: FUNDACENTRO – Rua Capote Valente, 710 – 05409-002 – São Paulo, SP, Brazil. Tel.: +55 11 30666210; fax: +55 11 30666341.
E-mail address: nathan@fundacentro.gov.br (T.C.N.O. Pinto).

0168-583X/$ - see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.nimb.2008.03.139

Al_2O_3: C (Landauer) in environmental light, fluorescent light and sunlight.

2. Materials and methods

All measurements were obtained using OSL dot dosimeters of Al_2O_3: C with the Landauer microStar reader and software. This detector is a layer of Al_2O_3: C sandwiched between two layers of polyester for a total thickness of 0.3 mm and diameter of 0.7 mm [7]. The measurements were always taken immediately after irradiation. The optical treatment of OSL dot detectors was realized into the closed box (26,000 lux) during 30 min prior to each re-use [8]. A Delta OHM radiometer, model D09721, LUX LP 9021PHOT sensor, was always utilized to determine the different light levels.

The first experiment was carried out with non-irradiated detectors exposed to 260 lux of environmental light composed by 8 fluorescent lamps, Philips, model TLT 40 W/75 RS, and the OSL dot detectors were positioned on a laboratory bench during the light exposures.

In the second experiment the detectors were exposed to 17,000 lux (1 fluorescent lamp) and 26,000 lux (2 fluorescent lamps) inside a closed box. The lamp specifications are: Sylvania, model F 16 W/78, and the OSL dot dosimeters were positioned at 9 cm from the lamps inside the box.

The sunlight exposure studies were realized during summer in São Paulo (23°S and 46°W and 750 m a.s.l.), in a clear sky day. The OSL dot detectors were positioned on the ground, and the temperature was measured using a TP870A sensor as 40 °C. Sunlight intensity exposure was 100,000 lux.

After that, the three experiments were repeated, this time using irradiated detectors. The detectors were exposed to beta radiation ($^{90}Sr + ^{90}Y$) of the secondary standard system of the Calibration Laboratory of IPEN, Buchler GmbH & Co, Germany, with radiation sources calibrated by the primary standard laboratory of Physikalisch – Technische Bundesanstalt (PTB), Germany. The source detector distance was 30 cm. During each exposure to beta radiation the InLight personal dosimetry systems were kept in the dark.

All readings were normalized to the initial measurement values.

3. Results and discussion

The light induced fading of the OSL response in Al_2O_3: C detectors, as a function of exposure time to 260 lux (environmental light) and to 26,000 lux of fluorescent light (2 fluorescent lamps in a closed box) is presented in Figs. 1 and 2, respectively, for different initial beta radiation absorbed doses. No fitting method was used in all figures presented in this work; the curves are just guides for a better data viewing.

The results show that the percentage fading response of OSL detectors exposed to beta radiation for doses varying from 0.1 mGy up to 15 mGy and subsequently exposed to environmental fluorescent light (260 lux) varied between 16% and 24% in the first 5 min. After 30 min of light exposure, the fading of the OSL response varied between 49% and 53%.

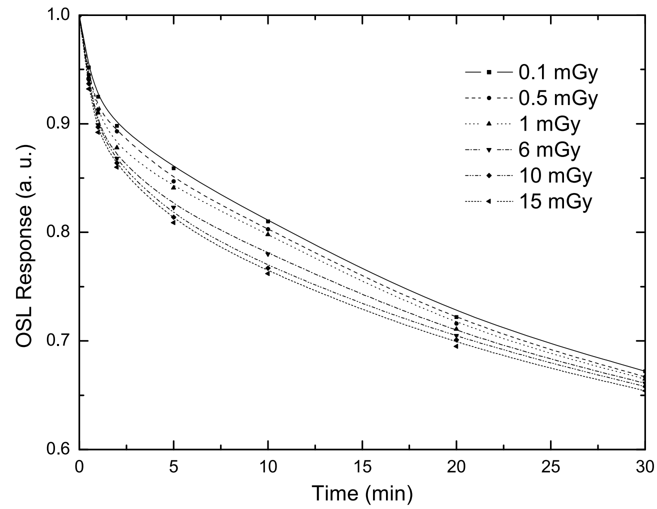

Fig. 1. Light induced fading of OSL response of Al_2O_3: C detectors as a function of exposure time to 260 lux of fluorescent light after irradiation with beta radiation.

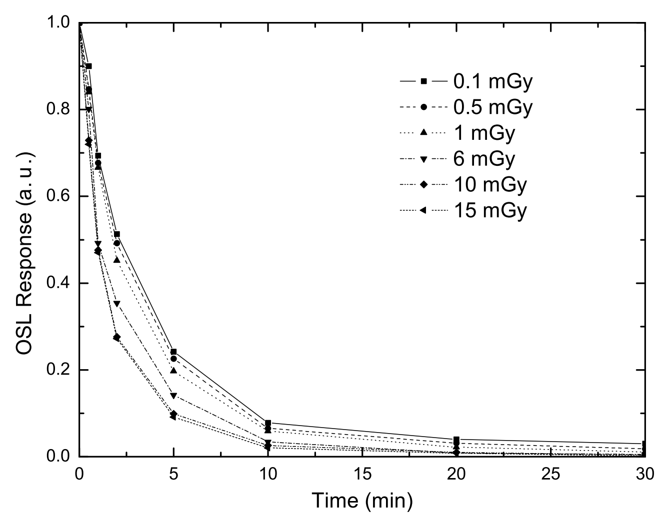

Fig. 2. Light induced fading of OSL response in Al_2O_3: C detectors as a function of exposure time to 26,000 lux of fluorescent light after irradiation with beta radiation.

The percentage fading of the α-Al_2O_3: C detectors exposed to 26,000 lux of fluorescent light inside the box, the OSL fading was 76–91% after the first 5 min of exposure. After 30 min of exposure to fluorescent light (26,000 lux), the Al_2O_3: C detector response was almost null.

Fig. 3 shows the light induced fading of OSL detectors response of Al_2O_3: C detectors as a function of exposure time to different light levels (260 lux, 17,000 lux and 26,000 lux) of fluorescent light after irradiation with 15 mGy of the $^{90}Sr + ^{90}Y$ beta source. It was observed that the optical treatment with 26,000 lux is a better choice for "zeroing" the detector OSL response.

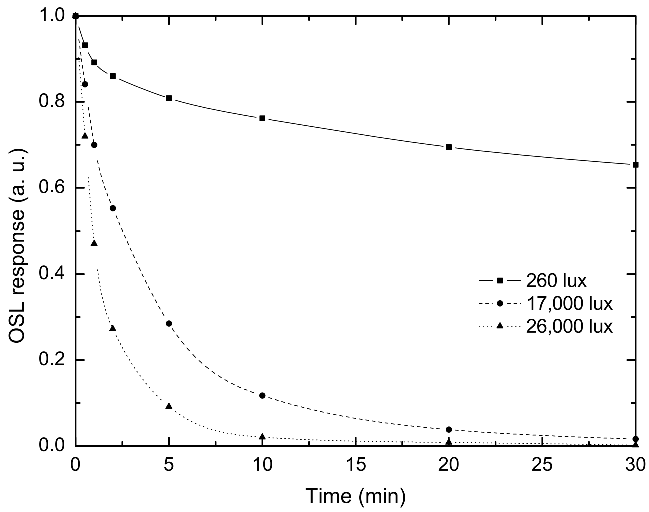

Fig. 3. Light induced fading of OSL response in Al_2O_3: C detectors as a function of exposure time to 260 lux, 17,000 lux and 26,000 lux of fluorescent light after irradiation with beta radiation (15 mGy).

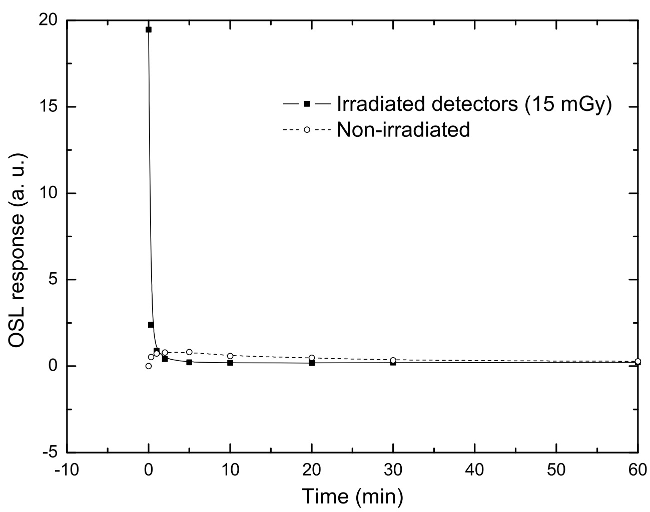

Fig. 4. Light induced fading of OSL response as a function of exposure time to sunlight of Al_2O_3: C detectors irradiated (15 mGy) and non-irradiated.

In addition, another study of these detectors was carried out with sunlight exposure. The OSL dot detectors were separated into two groups; the first group was previously irradiated with 15 mGy of the $^{90}Sr + ^{90}Y$ beta source and the dots of the second group were not exposed to any radiation. The irradiated detectors exposed to sunlight present a strong response decrease in the first 30 s, and the non-irradiated detectors exposed to sunlight showed an initial activation on their response followed by signal decay (Fig. 4). Fig. 5 shows the details of the initial activation of OSL detectors in time periods on the order of seconds.

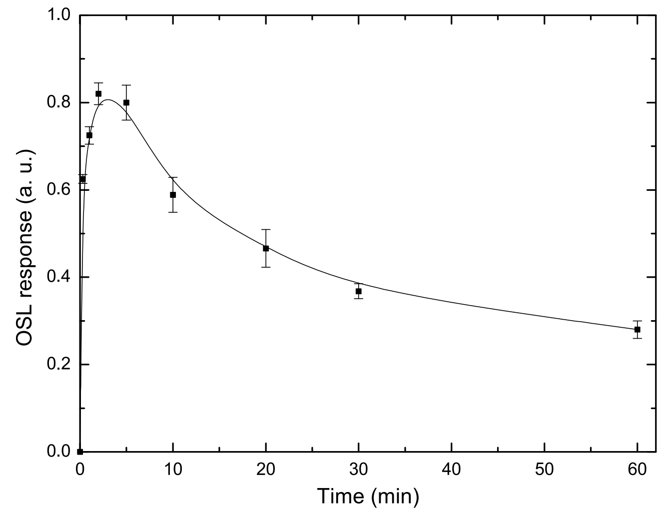

Fig. 5. Detailed curve of light induced fading of OSL response as a function of exposure time to sunlight in non-irradiated Al_2O_3: C detectors.

4. Conclusions

This paper shows the percentage fading of OSL signal of Al_2O_3: C detectors induced due to different light levels. It was observed that these detectors present a high sensitivity to light, and their fading has to be taken into consideration for environmental and personal dosimetry. For this reason, it is recommended that the detectors of Al_2O_3: C should be manipulated in a dark room to avoid the OSL signal decay. This study confirms that the exposure to 26.000 lux is an excellent optical treatment for re-utilization of the OSL detectors of Al_2O_3: C.

Acknowledgements

The authors acknowledge the partial financial support of Consellho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

References

[1] L. Botter-Jensen, S.W.S. McKeveer, A.G. Wintle (Eds.), Optically Stimulated Luminescence Dosimetry, Elsevier, 2003.
[2] M.S. Akselrod, S.W.S. McKeveer, Radiat. Prot. Dosim. 81 (1999) 167.
[3] S.W.S. McKeever, M.W. Blair, E. Bulur, E.R. Gaza, R. Kalchgruber, R.D.M. Klein, E.G. Yukihara, Radiat. Prot. Dosim. 109 (2004) 269.
[4] F.D. Walker, L.E. Colyott, N. Agersnap Larsen, S.W.S. McKeever, Radiat. Measur. 5 (1996) 711.
[5] M.S. Akselrod, B.S. Kortov, D.J. Kravetsky, V.I. Gotlib, Radiat. Prot. Dosim. 33 (1990) 119.
[6] W.G. West, K.J. Kearfott, S.M. Bernal, Radiat. Prot. Dosim. 119 (2006) 344.
[7] Landauer, User manual InLigth Systems, Laudauer, Illinois, 2006.
[8] C.C. Gronchi, S.G.P. Cecatti, T.C.N.O. Pinto, L.V.E. Caldas, in: Proceedings of the International Nuclear Atlantic Conference, September 29– October 5, 2007, Santos, Brazil.