13th International Congress of the International Radiation Protection Association
Living with Radiation – Engaging with Society
Glasgow, Scotland, 13 – 18 May 2012

APPLICATION OF THE OSL TECHNIQUE FOR DETERMINATION OF THE USEFUL CALIBRATION DISTANCE RANGES FOR BETA RADIATION DETECTORS

Patrícia L. Antonio[1], Teresa C.N.O. Pinto[1,2], Claudia C. Gronchi[1,2], Yvone M. Mascarenhas[3] and Linda V.E. Caldas[1]

[1] Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear, IPEN-CNEN/SP, Av. Professor Lineu Prestes 2242, 05508-000, São Paulo, Brazil
[2] FUNDACENTRO, Ministério do Trabalho e Emprego, MTE, Rua Capote Valente 710, 05409-020, São Paulo, Brazil
[3] Sapra Landauer, Serviço de Assessoria e Proteção Radiológica Ltda., Rua Cid Silva Cezar 600, 13560-900, São Carlos, Brazil
patrilan@ipen.br, nathan@fundacentro.gov.br, cgronchi@gmail.com, ymascarenhas@gmail.com, lcaldas@ipen.br

1. Introduction

The dose rate monitors have to be calibrated to verify their behavior when exposed to standard radiation beams [1], and in the case of beta-gamma radiation detectors, they have to be initially calibrated in standard gamma beams and then in standard beta radiation beams at the specific conditions provided in their calibration certificates. However, there are several kinds of monitors that can not be calibrated at these reference distances, because they are not adequate in relation to the monitor scales. Optically stimulated luminescence (OSL) detectors, as for example Al_2O_3:C, present good performance when exposed to beta radiation [2,3], and therefore, they were utilized in this study.

2. Objective

The objective of this work was to determine the useful source-detector distance ranges for the calibration of dose rate monitors, presenting importance for the Calibration Laboratory, because several different kinds of beta-gamma radiation detectors are calibrated every year.

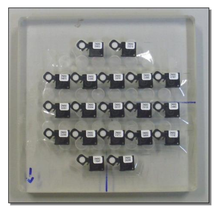
3. Materials and Methods

✓ *OSL commercial detectors:*
- nanoDot of Al_2O_3:C, Landauer

✓ *Optical treatment:* $26x10^3$ lux (during 24 h) for reutilization

✓ *OSL reader:*
- microStar OSL portable reader, Landauer

✓ *Characterization tests*:
- OSL detectors fixed on a PMMA support



✓ *OSL measurements taken after irradiation*

Characteristics of the standard beta radiation sources used in this work

Beta Secondary Standard System	Radiation Source	Absorbed Dose Rate (μGy/s)	Nominal Activity (MBq)	Calibration Distance (cm)	Reference Date
BSS1	$^{90}Sr+^{90}Y$	518.4 ± 5.180	1850	11	04.02.81
BSS2	$^{90}Sr+^{90}Y$	16.46 ± 0.220	460	30	12.01.05
	^{147}Pm	2.350 ± 0.050	3700	20	19.11.04
	^{85}Kr	39.70 ± 0.500	3700	30	30.11.04

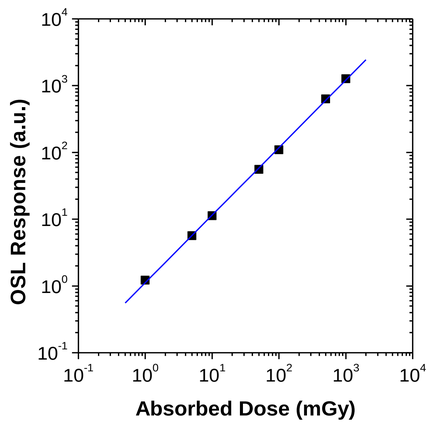
4. Results

1. Reproducibility

✓ Five series of irradiation, measurement and optical treatment
✓ Absorbed dose = 10 mGy ($^{90}Sr+^{90}Y$, BSS2)
✓ Reproducibility = 3.6%

2. Dose-Response Curve

✓ Interval dose: 1 mGy to 1 Gy
✓ Source: $^{90}Sr+^{90}Y$ (BSS1)
✓ Source-detector distance = 11 cm
✓ Maximum standard deviation = 6.9%
✓ ***Linearity in the whole dose interval***



3. Energy Dependence Study

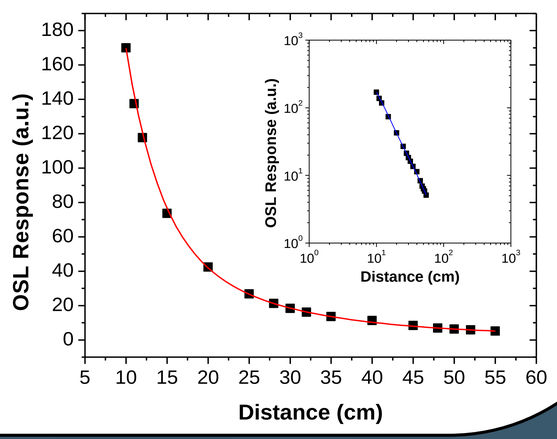
Radiation Source	Absorbed Dose (mGy)	Beta Mean Energy (MeV)	OSL Response/ Absorbed Dose
$^{90}Sr+^{90}Y$	10	0.8	1.0213 ± 0.0214
^{147}Pm	10	0.14	0.4965 ± 0.0110
^{85}Kr	1654	0.06	0.0029 ± 0.0001

51%

✓ Maximum standard deviation = 4.9%

4. Variation of the OSL Response with the Source-Detector Distance

✓ Source: $^{90}Sr+^{90}Y$ (BSS1)
✓ Interval distances: from 10 cm to 55 cm
✓ Maximum standard deviation = 5.2%



5. Conclusions

The characterization tests showed the efficiency of nanoDot detectors in standard beta radiation fields, and a strong dependence of the nanoDot OSL response with the beta radiation energy. The results of this study of the variation of the OSL response with the source-detector distance showed that the OSL response follows the inverse square law. The conclusions were important for the Calibration Laboratory, because the calibration of several different models and kinds of monitors will be possible determining the absorbed dose rates at any distance among those tested.

References

[1] IAEA, International Atomic Energy Agency. Calibration of radiation protection monitoring. Safety Reports Series 16, Vienna (2000).
[2] Akselrod, A.; Akselrod, M. S.; Larsen, N. A.; Banerjee, D.; Bøtter-Jensen, L.; Christensen, P.; Lucas, A. C.; McKeever, S. W. S.; Yoder, R. C. Optically stimulated luminescence of Al_2O_3:C to beta radiation. Radiat. Prot. Dosim. 85 (1-4), 125-128 (1999).
[3] Pinto, T. N. O.; Cecatti, S. G. P.; Gronchi, C. G.; Caldas, L. V. E. Application of the OSL technique for beta dosimetry. Radiat. Meas. 43, 332-334 (2008).

The authors thank Dr. Yvone M. Mascarenhas for microStar OSL Reader, Landauer, and FAPESP, CNPq, CAPES and MCT: Project INCT for Radiation Metrology in Medicine), for partial financial support.