BETA RADIATION DETECTION WITH UT-$CaSO_4$:Dy THERMOLUMINESCENT SAMPLES

Rosa, L.A.R., Cunha, P.G.
Instituto de Radioproteção e Dosimetria - CNEN - Brazil

Caldas, L.V.E.
Instituto de Pesquisas Energéticas e Nucleares - IPEN - Brazil

The possibility of beta radiation detection using ultra-thin thermoluminescent phosphors was investigated. The samples studied were Teledyne UT-$CaSO_4$:Dy with a thickness of 20 microns. The beta irradiations were performed utilizing the Beta Secondary Standard System of the IPEN calibration laboratory, with ^{90}Sr - ^{90}Y, ^{204}Tl and ^{147}Pm sources. The detectors were measured at IRD with a Teledyne 7300C thermoluminescent reader. A special planchet, made at IRD, was used for the TL measurements to avoid triboluminescent effects.

Initially the individual reprodutibility of the detectors was investigated. Fifteen samples were sed and ten irradiations of 35mGy (^{90}Sr - ^{90}Y) under identical condition were performed. The average reproducibility found was 1.51% (1σ).

Dose calibration curves (TLx absorbed dose) were obtained with ^{90}Sr - ^{90}Y, ^{204}Tl and ^{147}Pm sources. The detectores irradiated with the ^{90}Sr - ^{90}Y source, between 0.145 and 300 mGy, presented a linear response from 0.50 mGy. When they were irradiated with the ^{204}Tl source, in the absorbed dose interval from 0.1 to 100 mGy a linear behavior above 1 mGy, was observed whi

le for ^{147}Pm they were exposed to radiation between 0.1 and 45 mGy, presenting a linear response above 2 mGy.

No dependence with the beta absorbed dose rate (within an uncertainty of 1%,1σ) was found for the UT-$CaSO_4$:Dy TL response.

In another experiment, the ^{90}Sr - ^{90}Y irradiated samples were exposed to the ultraviolet (UV) light of a high pressure Hg lamp (250 nm) to study the possibility of optical fading occurrence. The total irradiance was varied between 2.6×10^{-2} and 24.8×10^{-2} (Table I).

The angular dependence of the TL response was investigated for ^{90}Sr - ^{90}Y (20mGy) ^{204}Tl (1mGy) and ^{147}Pm (1mGy) sources at angles of 0.30, 45, 90, 120, 135, 150 and 180º. In the most unfavorable case (90º), the angular dependences found were 70, 70 and 60% respectively for ^{90}Sr - ^{90}Y, ^{204}Tl and ^{147}Pm radiation fields.

Transmission factors for different thicknesses of tissue equivalent materials were obtained for the UT-$CaSO_4$:Dy detectors,using the three available beta sources (Table II).

Finally the energy dependence of the detector TL response was investigated and it was found to be less than 75% for the mean energy of ^{147}Pm, 0.06 MeV.

All results were compared with those of the literature[1,2]. In conclusion, the results obtained for UT-$CaSO_4$:Dy show its usefulness in beta radiation detection and the possibility of using

this phosphor to develop a beta dosimeter.

Table I: Optical fading of UT-$CaSO_4$:Dy samples

Total Irradiance I ($W.S.cm^{-2}.10^{-2}$)	Optical Fading (%)
2.6	3.6
7.4	11.5
15.5	26.1
24.8	48.7

Table II: Transmission factors for UT-$CaSO_4$:Dy samples

Tissue mm	Thickness mg/cm^2	^{147}Pm	^{204}Tl	^{90}Sr - ^{90}Y
0	0	1.000	1.000	1.000
0.01	1	0.868	0.988	1.008
0.02	2	0.737	0.973	1.014
0.03	3	0.637	0.960	1.018
0.04	4	0.575	0.948	1.022
0.05	5		0.930	1.027
0.07	7		0.908	1.034
0.10	10		0.868	1.044
0.20	20		0.740	1.072
0.50	50			1.100
1.00	100			1.083
2.00	200			0.872
3.00	300			0.702

References:

1) Caldas, L.V.E., Thesis, University of São Paulo,Brazil,1980.

2) Charles, M.V., Khan, Z.U., IAEA - SM-229/24 (1979).