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OSL RESPONSE OF α-Al_2O_3:C,Mg EXPOSED TO BETA AND UVC RADIATION

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Introduction: Carbon and magnesium doped aluminum oxide crystals (Al_2O_3:C,Mg) is very promising in the monitoring of beta, gamma and X-ray radiations. In this research, Al_2O_3:C,Mg single crystal was investigated as a potential UV-C (100-280 nm) detector, using the optically stimulated luminescence (OSL) technique and the parameters of the OSL decay curve. The investigation was realized considering also the parameters of OSL decay curves for beta radiation.

Material and method: An Al_2O_3:C,Mg single crystal grown by the Czochralski method, provided by Landauer, Inc. Crystal Growth Division, Stillwater, OK, USA, was used. The single crystal had 48 mg and a rectangular parallelepiped shape 8 x 1.6 x 0.5 mm^3.

UVC irradiation was executed with different nominal energy densities, from 4.78×10^3 to 1.43×10^5 J/m², with wavelength of 254 nm. For comparison purposes, beta irradiation was executed using the built-in $^{90}Sr/^{90}Y$ source of the TL/OSL Risø reader delivering a dose rate of 10 mGy/s and cumulative doses from 0.1 to 3 Gy.

OSL measurements were carried out using an automated Risø TL/OSL reader, model DA-20, DTU Nutech. The OSL signal was stimulated in CW mode using blue LEDs (470 nm (2.64 eV), FWHM = 20 nm (2.58 to 2.70 eV), 80 mW/cm² at the sample position). Thermal and optical treatment were carried out after each OSL readout.

Exponential fittings of the OSL decay curves were done based on equation 1.

$$I_{cw}(t) = \alpha \sum_i^{traps} C_i p_i \exp(-p_i t) \qquad (1)$$

Where $I_{cw}(t)$ is the total detected OSL emission, α a constant related to the probability of recombination and the efficiency of the detector at the emission wavelength, C_i a constants that include the initial population of trap i and p_i is the probability rate of a trapped electron to transition to the conduction band from a trap i.

Results: In our analysis of approximately 20 decay curves total either UVC- or beta-irradiated, only two components (i= 1,2) were found necessary to obtain a good fitting ($R^2 > 0.99$). The results are presented in Figure 1 for (a) 3 Gy of beta radiation and (b) 1.43×10^5 J/m² of UVC radiation.

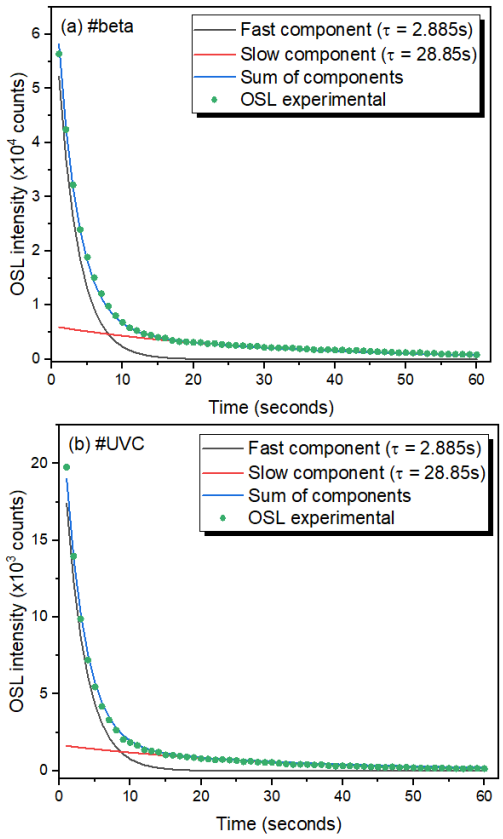

Figure 1: OSL experimental results (green dots), and fitted components for Al_2O_3:C,Mg exposed to (a) 3 Gy of beta radiation and (b) 1.43×10^5 J/m² of UVC radiation.

Conclusions: All OSL curves could be described with two components, and the obtained parameters presented similar values, indicating that the mechanisms involved in both exposures probably are related to the same traps.