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EFFECT OF BLUE LIGHT BLEACHING IN HIGH TL SENSITIVITY NATURAL QUARTZ

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Introduction: Thermoluminescence (TL) and optically stimulated luminescence (OSL) dosimetry techniques have been widely applied to determine the equivalent dose in quartz grains [1]. Therefore, it is important to know the luminescent properties of the material to ensure an adequate measurement. The relationship between OSL and TL signals is one important point to be considered, especially the bleaching effect on the TL signals [1]. Various works studied this effect, but, as far as we can see, there is no consensus [2,3]. In order to progress in this direction, this study investigates the effect of bleaching with blue light in a natural crystal showing a high TL sensitivity above 200 °C [4].

Materials and Methods: Sensitized quartz grains (30 kGy of ^{60}Co; heat treatment at 400 °C) of MC crystal [4] were used to produce quartz-PTFE (1:1) pellets with 6 mm diameter. The TL curves were recorded from 25 to 400 °C (2 °C.s^{-1}) with a *Lexsyg* SMART reader equipped with ^{90}Sr/^{90}Y source (~63 mGy.s^{-1}). Optical stimulations were performed with blue LEDs (465 ± 5 nm; 80 mW.cm^{-2}) at room temperature and thermally assisted with a preheat (125 °C; 200 °C for 10 s). For each condition, the measurements were performed in five samples with a test-dose of 500 mGy. Data evaluation and plotting were carried out using a self-written R script and using numerical functions from the package *tgcd* [5]. The glow curves were fitted using the Randall-Wilkins first-order kinetics model.

Results: Comparing the glow curves shown in Fig. 1 (a), which displays full TL and bleached TL signals in different conditions, it is possible to observe the effect of blue light bleaching on the TL peaks. The optical stimulation at room temperature significantly reduced the first TL peak. Prolonged bleaching produced a more intense depletion in the initial portion of the peak. For TL peaks above 200 °C, the different conditions resulted in similar glow curves, showing a pronounced reduction at the last part of the sensitized peak. This result suggests that optical stimulation has a limited capacity of depleting charges from the traps responsible for the TL peaks above 200 °C. To advance, glow curves were deconvoluted. Typical results of deconvolutions into seven components are shown in Fig. 1 (b). For the first peak, component c1 (associated with 110 °C peak) is the most affected. This component reduced its intensity by over 99%. For the sensitized peak, c4 e c5 are less affected than c6 (associated with the 325 °C peak). The component c6 reduced its intensity by ~40% compared with the full signal. The last component (c7) is probably related to deep traps responsible for a slow OSL components.

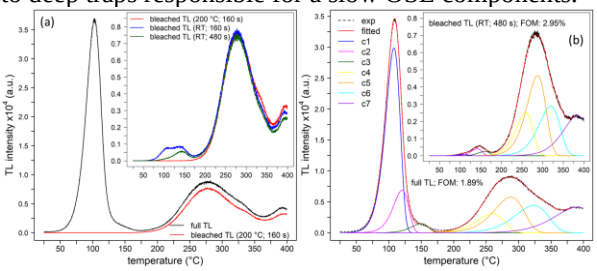

Fig. 1: Full and bleached TL signals (a) and results of deconvolution into seven components (b). The inset plots show TL curves recorded after blue light bleaching carried out at room temperature.

Conclusion: Blue light bleaching at room temperature significantly depletes the first TL peak, especially the component peaked at ~110 °C. The effect of bleaching for TL peaks above 200 °C is limited, suggesting that only part of the traps associated with those TL peaks are optically sensitive. For sensitized peak, the component peaked at 325 °C is most affected than the components peaked at 260 and 288 °C.

References: [1] A. S. Murray & A. G. Wintle. *Radiation Measurements*. **32** 57-73 (2000). [2] N. A. Spooner. *Radiation Measurements*. **23** 593-600 (1994) [3] G. Kitis, N. Kiyak, G. S. Polymeris & N. C. Tsirliganis. *Journal of Luminescence*. **130** 298-303 (2010). [4] P. L. Guzzo, L. B. Ferreira de Souza, V. S. M. Barros & H. J. Khoury, *Journal of Luminescence*. **188** 118-128 (2017).[5] J. PENG, Z. DONG & F. HAN. *SoftwareX*. **5**, 112-120 (2016).