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INVESTIGATION ON THERMALLY ASSISTED OPTICALLY STIMULATED LUMINESCENCE (TA – OSL) SIGNAL IN CALCIUM FLUORIDE SAMPLES

LIMA, L.S., YOSHIMURA, E.M., and UMISEDO, N. K.

Instituto de Física, Universidade de São Paulo, 05508-090 São Paulo, SP, Brazil, Lslima@if.usp.br,MSc

Introduction: Terminally assisted OSL is an experimental technique that consists of combined action of thermal and optical stimulation. This technique appears as a promising tool for stimulating electrons from very deep traps (Polymeris, 2016). Furthermore, it is also possible to use deep traps for high (or low)-dose measurements. In this work we started to investigate the TA-OSL, of a known dosimeter, natural fluorite.

Material and method: The manufacturing process employs green fluoride powder ground to a grain size between 85 and 185 µm, mixed with a liquid binder of a high temperature resistant commercial glue, and is cold-pressed using a hydraulic press. The 5 mm diameter disc-shaped (0.050g) samples were sanded to obtain the appropriate thickness (0.9 mm) and a smooth surface. A commercial TL/OSL reader (Risø National Laboratory) was used for TA-OSL measurements. Irradiations were performed using the Sr^{90}/Y^{90} beta source emitting β particles with a maximum energy of 2.27 MeV, incorporated in the TL/OSL reader (approximate dose rate of 10 mGy/s). The experimental procedure in TA-OSL measurement is:

- Sample irradiation with a test dose
- TL measurement to release charge carriers from shallow and main traps.
- Sample irradiation with a test dose.
- Increase temperature and hold it at T_i(°C); measure OSL at this temperature in order to obtain the TA – OSL signal.
- Measurement of residual TL (RTL), in order to record any signal induced by photo-transfer after the TA – OSL measurement.
- Sample irradiation with a test dose.
- TL readout in order to check sensitivity changes and/or glow curve structure variations compared to the TL obtained previously.

Results: There are some models that describe TA-OSL, one of them (Przegiętka and Chruścińska, 2010) proposes that the phenomenon is explained in terms of the temperature dependence of the photoionization cross section. It has been suggested that, at a wavelength of stimulus (λ), the photoionization cross section (σ) can be written as:

$$\sigma\,(T,\,\lambda)\;=\;\sigma_0(\lambda)e^{\frac{-E_A}{\kappa T}}$$

where σ (T, λ) is the photoionization cross section at temperature T (K) for the stimulus wavelength λ,κ is the Boltzmann constant, σ_0 (λ) is the pre-exponential term of the photoionization cross section, and E_A is the thermal activation energy. Temperature (T_i) was varied from room temperature to 350ºC, and a graph was made of ln (TA-OSL) by $1/\kappa T_i$ as shown in figure 1. The linear part has a slope corresponding to the thermal activation energy, E_A=0.45(2) eV. Furthermore, the dose dependence of TA-OSL was also investigated, and the result was a linear variation with the dose.

Conclusions: In this work, the TA-OSL of fluorite pellets was investigated, it was possible to obtain some parameters of interest. More studies are still needed to better understand TA-OSL and the role of deep traps in the signal of fluorite. More experimental work is still required to investigate possible correlation between TA-OSL and RTL, and the use of TA-OSL applications in radiation dosimetry.

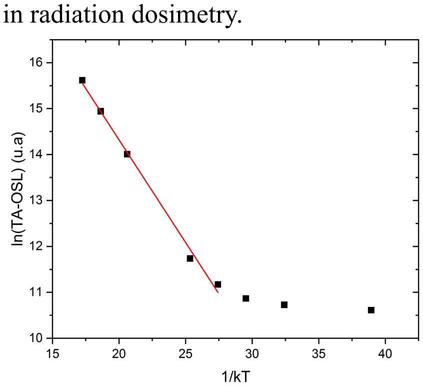

Figure 1: Arrhenius diagram for calculating the activation energy for fluorite.

References:

1. G. S Polymeris. *Radiat. Meas*. **90**, 145-152, 2016.
2. K. R Przegiętka and A. Chruścińska. *Radiat. Meas*. **45**, 317-319, 2010.