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Analyzing gamma irradiated Spectrolite in relation to the photo-transfer TL and OSL effects

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INTRODUCTION

There are materials that have the property of emitting light when they are irradiated and subsequently suffering an optical or thermal stimulus; this characteristic is studied by means of the thermoluminescence (TL) and optically stimulated luminescence (OSL) phenomena. These materials can still present a photo-transfer effect on their luminescence signal, with displacement of the electrons from deeper traps to the shallower traps after illumination; they are the photo-transfer TL (PTTL) and photo-transfer OSL (PTOSL) processes.

The purpose of this work was to verify the presence of the PTTL and PTOSL responses on the Spectrolite signal after exposure to gamma radiation (^{60}Co) and illumination by LEDs with wavelengths in the UV region, for application in gamma radiation dosimetry.

MATERIALS AND METHODS

✓ *Dosimetric material:*
Spectrolite (diameter: 6.0 mm; thickness: 0.2 mm)

Spectrolite:
(a) natural material;
(b) pellets

✓ *Thermal treatment for reutilization:* 400˚C/1 h

✓ *Radiation source*:
- Cobalt-60, Gamma-Cell, model 220, Atomic Energy of Canada LTD (347.29 Gy/h, July 2023)

✓ *Reader system:*
- Risø, model TL/OSL-DA-20 (TL/PTTL and OSL/PTOSL responses (in terms of counts)

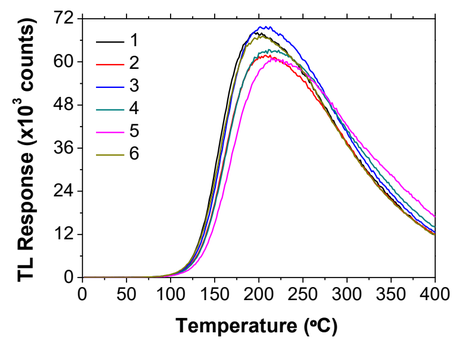
✓ *Parameters at the reader system*:
- TL/PTTL:
  - Heating rate = 10˚C/s
  - Final temperature = 400˚C
- OSL/PTOSL:
  - Stimulation time = 100 s
  - Blue LEDs power = 90%

RESULTS

❖ *Study of TL/OSL Responses after Irradiation*

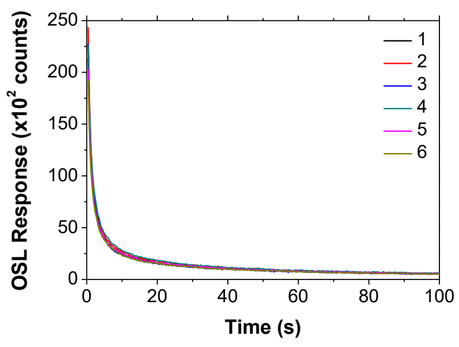
A. TL Glow Curve

✓ Absorbed dose = 1 kGy
✓ Standard deviation = 3.8%



B. OSL Decay Curve

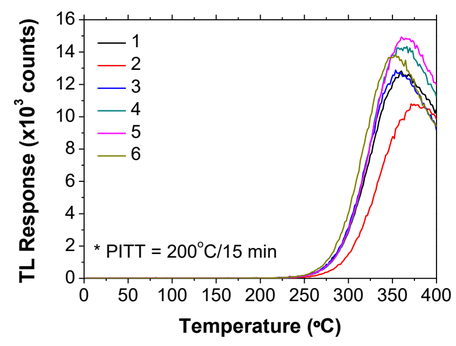
✓ Absorbed dose = 1 kGy
✓ Standard deviation = 6.5%

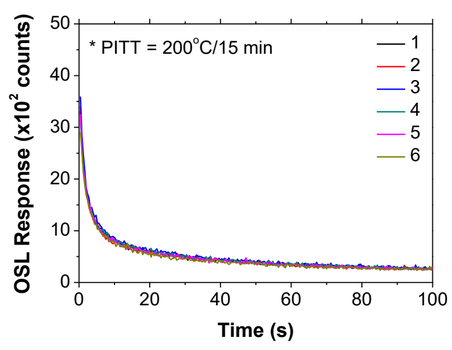


❖ *Study of TL/OSL Responses after PITT*

✓ Steps:
1. Irradiation
2. Post-irradiation thermal treatment (PITT)

✓ Standard deviation: 6.9% (TL) and 3.8 (OSL)

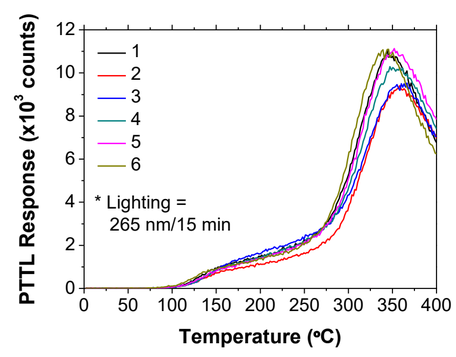


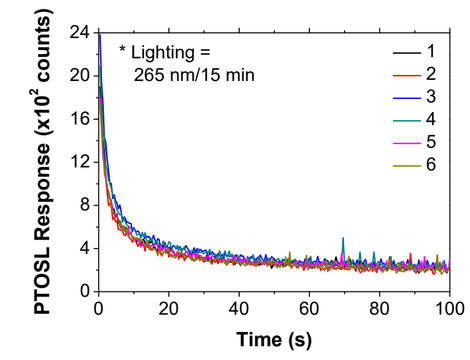


❖ *Study of PTTL/PTOSL Responses*

✓ Steps:
1. Irradiation / 2. Irradiation + PITT /
3. Irradiation + PITT + Illumination

✓ Standard deviation: 4.3% (PTTL) and 6.5% (PTOSL)





CONCLUSIONS

The data obtained allow observing the presence of a photo-transfer effect in the PTTL response, but not in the PTOSL response. Therefore, for application of this material for gamma radiation dosimetry, using these techniques demonstrated here, more studies are needed, as the signal in function of the wavelength and illumination time.

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