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INFLUENCE OF ALUMINUM IN LUMINESCENCE RESPONSE OF CERIUM-DOPED CaF_2 BY COMBUSTION SYNTHESIS

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Introduction: Rare-earth doped calcium fluoride in natural form is a well-known high sensitivity material for thermoluminescent (TL) applications[1]. Recently, research has demonstrated a potential for Optically Stimulated Luminescence (OSL) dosimetry by using sintered CaF_2 by Combustion Synthesis[2,3]. In comparison to TL dosimetry, OSL has advantages such as (a) time between stimulation and readout is short, (b) the heating is not necessary, (c) compact and rather inexpensive instrumentation[4]. This work shows results for TL and infrared optically stimulated luminescence (IRSL) of CaF_2:Ce,Al with different Al concentrations.

Material and method: Calcium Fluoride (CaF_2) crystalline powders were produced via Solution Combustion Synthesis (SCS) technique by mixing appropriate stoichiometric amounts of $Ca(NO_3)_2$, ammonium fluoride, a rare-earth nitrate dopant and urea ($CO(NH_2)_2$ as fuel. Rare-earth elements (cerium nitrate ($Ce(NO_3)_3.6H_2O$) was added as dopant in a concentration of 0.2 mol% with respect to each mol of calcium, that means that the ratio between Ca and the dopant material corresponds to 0.002. The aluminum nitrate ($Al(NO_3)_3$) added with concentration ranging from 0,1 mol% until 2mol% with respect to each mol of calcium too. The reagents were placed in a 200 ml beaker and approximately 10 ml of distilled water was added. The beaker was then placed on a hot placed at 225ºC and its contents mixed using a magnetic sit bar for water evaporation and then transferred to a muffle furnace at 565 °C where an intense flame type combustion occurred.

For TL and OSL measurements, the resulting powder was cold pressed in pellets with 6 mm diameter, 1 mm in thickness. The TL signal was integrated from 50 ◦C up to 350 ◦C at a heating rate of 2 ◦C/s. The TL and OSL of these pellets was measured using an automated Lexsyg Smart OSL/TL reader equipped with an internal 90Sr/90Y source with a dose rate of 100 mGy/s and a Hamamatsu H7360-02 bialkaline type photomultiplier tube. For the IRSL were acquired under constant illumination intensity mode (CW), LEDs with peak emission at 850 nm and power set to 250 mW/cm2 was used.

Results: The TL intensity of CaF2:Ce increased 6.5 times when the aluminum concentration was 0.5mol% and the main peak practically remained close to 125ºC shown in Figure 1. The IRSL intensity increased 2.6 times shown in Figure 2.

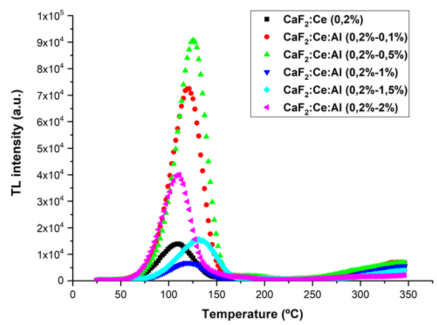

Figure 1: Glow curve of CaF_2:Ce:Al for different Al concentrations for dose 100 mGy.

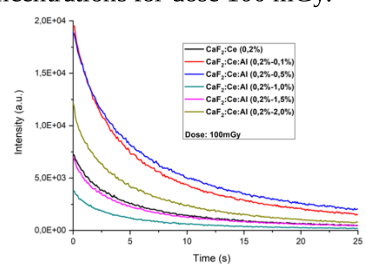

Figure 2: IRSL response for Al co-doped CaF_2:Ce with Al for different concentrations.

Conclusions: The aluminum influenced the luminescence response of CaF_2:Ce and further measurements such as heating treatment and fading for better understanding of this material.

References:

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