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Short Communication

Phototransfer Thermoluminescence in LiF: Mg, Cu, P OSL Phosphor with Blue Light

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Abstract

Photo Transfer Thermoluminescence (PTTL) is the phenomenon in which Thermoluminescence (TL) is observed when the material is shined with UV light after routine TL readout. In PTTL the carriers from deep traps are transferred to the shallow traps after the material is shined with UV light. When UV exposed material is heated it gives TL. Up till now this phenomenon is observed only using UV light in many materials. Recently we have developed LiF:Mg,Cu,P OSL material in which OSL comparable to commercially available Al_2O_3:C is observed. In this material the TL intensity of main dosimetric peak gets enhanced by two times after the OSL readout. This phenomenon is similar to PTTL but the wavelength of light is in blue green region.

Keywords: Phototransfer Thermoluminescence, UV light, Thermoluminescence, LiF based OSL material.

Introduction

In recent years dosimetry using OSL is getting wide acceptance. In OSL the electrons and holes which are created during irradiation and get trapped in defects present in the lattice are stimulated by the light in the visible/IR region. The freed carriers and subsequent annihilation at the recombination centre leads to emission of radiation. This radiation is generally at shorter wavelength compared to the wavelength of the stimulating radiation. The materials which give emission in the range 350 to 425 nm and the defects which traps these carriers are photo ionized with the light in blue-green region (450 – 550 nm) or IR region (650 - 800 nm) are the conditions for the suitability of the material as OSL phosphor. Such limitation on the material emission wavelength is due to available instrumentation which is designed to separate stimulating wavelength from the emission wavelength to ensure better signal to noise ratio. The occurrence of OSL and TL in a material is due to same process except the excitation source. In OSL the charge carriers are liberated from the traps with light whereas in TL they are freed by thermal energy.

Recently a highly sensitive LiF:Mg,Cu,P phosphor in OSL domain is developed by us[1]. This finds application in personnel and in medical dosimetry due to its tissue equivalence, In this material for certain combination of Mg, Cu and P, it is observed that the TL intensity of main dosimetric peak increases by two times after the OSL readout. This phenomenon is similar to PTTL due to UV light as observed earlier[2] but the wavelength of light is in blue green region. The observation of PTTL with the visible light is discussed in this paper.

Materials and Methods

The preparation of LiF: Mg, Cu, P OSL phosphor is as described in our earlier work on LiF: Mg, Cu, P TL phosphor[3]. OSL grade LiF was synthesized to which impurities Mg, Cu was incorporated in appropriate amount. The treated material was then given a heat treatment at 450 ^{O}C in a reactive atmosphere for 1 hr and then melted in graphite crucible along with the $NH_4H_2PO_4$ in desired amount (0 mole% in this work). The melted material was poured into a flat graphite crucible maintained at room temperature was then crushed and sieved.

The recording of CW-OSL and TL of the samples was carried out on the lab made equipment described elsewhere[4]. The irradiation of the samples was done using ^{90}Sr/^{90}Y beta source with the dose rate of 20 mGy per min and given a test dose of 100 mGy.

Results and Discussion

Intense Blue Stimulated Luminescence (BSL) (Figure-1a) with very fast decay of 3 s is observed in the sample. Figure-2 shows the TL glow curves for Mg, Cu, P doped LiF samples. In freshly irradiated sample. The main dosimetric peak is observed around 243^{O} C with a small low temperature peak around 86^{O}C (Figure-2a). A high temperature shoulder peak around 338^{O}C is also seen.

Figure-2b shows the TL taken after taking BSL. It is observed that the low temperature peaks around 100^{O} C and 150^{O} C depletes completely. The integral TL is however almost double and increase in dosimetric peak and shoulder peak is observed. This implies that the dosimetric peak is not contributing to the observed OSL.

To find the exact correlation between a particular peak and the observed OSL the irradiated sample is to be heated up to the desired TL peak temperature and then the OSL is taken. The difference in OSL from the unheated sample and heated sample then gives the contribution of the particular peak to the total OSL.

Figure-1b shows the OSL decay from the sample with Mg, Cu, P heated upto 150^{O} C. From the figure it can be seen that nearly 87% OSL is depleted as compared unheated sample. This indicates that 87% of the OSL comes from shallow traps corresponding to the low temperature peaks around 100^{O} C and 150^{O}C. The remaining 13% OSL comes from deep optically sensitive traps beyond 250^{O} C. During optical stimulation some of the freed charge carriers from deep traps get retrapped in the TL traps responsible for 243^{O} C peak increasing the intensity of this peak and integral TL after OSL.

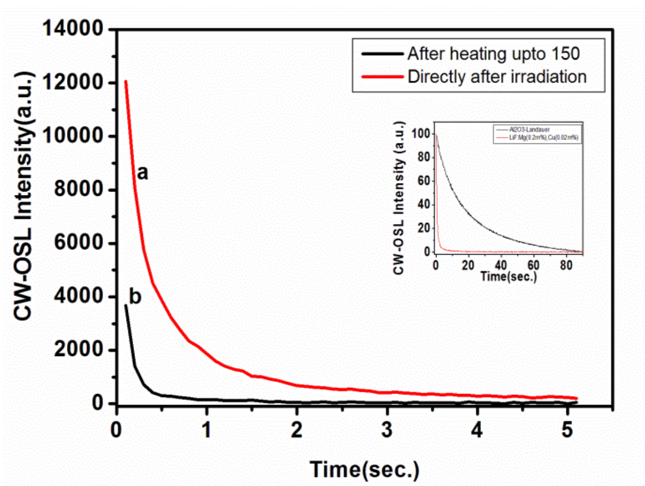

Figure-1
Blue stimulated luminescence in LIF Mg,Cu,P OSL phosphor

Figure-2c shows the TL of heated sample at 150^{O}C after taking BSL. The TL is similar to that of after taking BSL (Figure-2b). The integral area is also same which suggests the presence of deep OSL traps beyond 250^{O}C. This indicates that freed charge carriers from deep traps are getting retrapped and not the carriers from the shallow traps. Thus from the results presented above it can be inferred that carriers freed from deep traps during optical stimulation are getting retrapped into TL traps corresponding to 243^{O}C and 338^{O}C peaks. This is similar to PTTL phenomenon observed in many TL phosphors, only difference between PTTL phenomenon and the one observed in the present case is the stimulating wavelength of light. In the present case the wavelength is much lower compared to what is required to observe PTTL effect in TL phosphors.

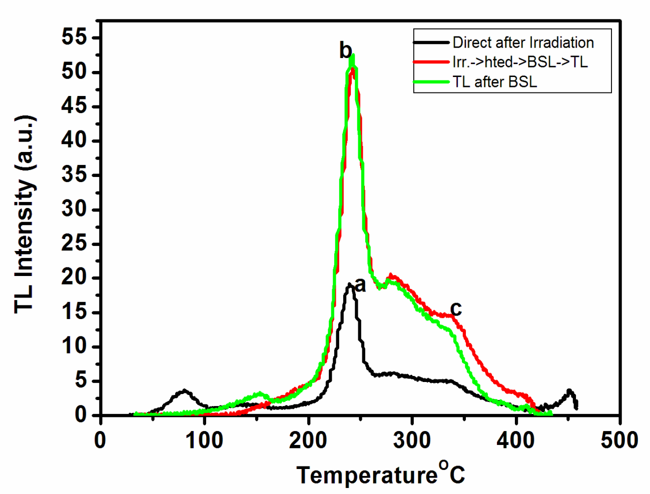

Figure-2
Thermoluminescence in LIF Mg, Cu, P OSL phosphor

Conclusion

A new phenomenon similar to PTTL is observed in LiF: Mg, Cu, P OSL phosphor in which blue light is stimulating wavelength rather than UV light. Using this phenomenon TL sensitivity of the phosphor can be increased and this will be useful in detecting low radiation levels.

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