

Thermoluminescence of nanocrystalline Eu doped BAM Phosphor

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Abstract: $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}$ phosphors have been synthesized by Solid State Reaction method. Results are shown in the well defined glow curves. The achieved TL spectra emission peaks do show changes because of electronic charges and dopant ion size. The experimental results of XRD, SEM, and thermo luminescence showed that the phosphor had hexagonal single phase, the increase of average particle size and the decrease of thermoluminescent intensity when annealed temperature increases. The emission spectra was a broad band with maximum intensity at around temp 450K due to transitions from the $4f65d1$ to the $4f7$ electronic configuration of Eu^{2+} ion that was according to emission of Eu^{2+} ions located at different positions in the lattice.

Keywords: $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}$, nanoparticle, Thermoluminescence.

I. Introduction:

Thermoluminescence as mentioned by McKeever and et al. is one of the processes in Thermally Stimulated Phenomena. In a general view, thermoluminescence is a temperature stimulated light emission from a crystal after removal of excitation. Nevertheless, microscopically, it is much more complicated. Thermoluminescence Radiataion Dosimetry(TLD) is one of the popular technology of the luminescence research. Divalent europium (Eu^{2+}) activated barium magnesium aluminate ($\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}$ - BAM) phosphor, is currently used in plasma display panels (PDP's) as a blue emitting phosphor. A limited number of papers have been published explaining various reasons, but no one is able to fully understand Nanocrystalline $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ blue emitting phosphor. It has been used extensively in manufacturing tricolor fluorescent lamps (FL), field emission displays (FED), plasma display panels (PDPs) and liquid crystal displays (LCD). This phosphor has high luminous efficiency and brightness. Emission spectra of $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}^{2+}$ (BAM) phosphor have a broad band with peak at 450 nm due to transition from the $4f65d1$ excited state to the $4f7$ ground state of ion Eu^{2+} . However, the stability of BAM is not good. Its luminous efficiency decreases during the panel manufacture and also during the operation of the panel (1-4).

II. Methodology

$\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}$ (.5%) phosphors have been synthesized by Solid State Reaction method(5). The chemical used are BaCO_3 , MgO , MgF , Al_2O_3 , MnCO_3 and Eu_2O_3 as starting material. The appropriate oxides were thoroughly ground and the annealed up to 1200°C for 6-8h. The formation of the powder was confirmed by the Powder X-ray Diffraction (PXRD) analysis. Shape and size of the synthesized powder were examined using Transmission Electron Microscope (TEM). Dosimetric characteristics have been carried out of the γ -ray irradiated $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}$ phosphors using Thermoluminescence (TL) technique. The TL glow curve of the samples shows the dosimetric peak at around 450 K which is sufficient above the room temperature. The glow curves were recorded with linear heating rate of $6.67^\circ\text{C s}^{-1}$.

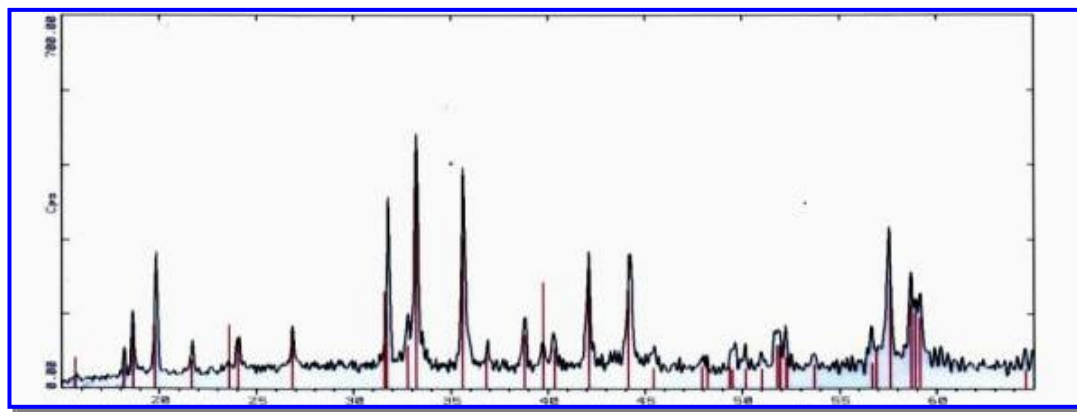


Fig 1. X – ray diffraction pattern of nanocrystalline $\text{BaMgAl}_{10}\text{O}_{17}:\text{Eu}$.

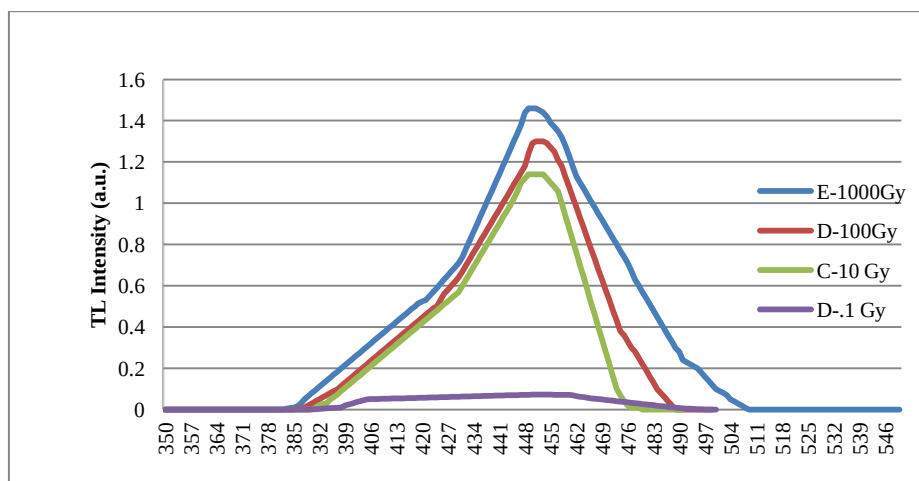


Figure 3: TL glow curves with Temp (K) of nanocrystalline BaMgAl₁₀O₁₇:Eu powder exposed to various doses of γ -rays from a ¹³⁷Cs source.

III. Result and Discussion

TL glow curve for BaMgAl₁₀O₁₇: Eu exposed with .1-1000Gy of ¹³⁷Cs gamma rays are shown in Fig 2. The comparison of these is shown in figure. TL glow curve of the nanocrystalline BaMgAl₁₀O₁₇: Eu shows prominent peak around 445K to 450K. This suggest that the trap responsible for TL at this temperature prominent for nanophosphor. The position of peak along the growth of higher temperature depends on the impurity concentration. At lower temperature range below 383 K and corresponding higher temperature range above 480 these peaks vanishes. The graph brings out the fact that the sample with Eu impurity shows good TL response to various gamma irradiations. Trapping parameters are calculated with the help of Chen's formula (6). The trap depth and frequency factor values are in the range of 0.31 to 0.39ev and 10⁸ to 10⁹ sec⁻¹ for low temperature peak and 0.51 to 0.57ev and 10⁷ to 10⁸sec⁻¹ for high temperature peaks. The broad nature of observed peaks indicates the allowed nature for emission transition of Eu⁺² ion.

IV. Conclusion

Nanoparticles of BaMgAl₁₀O₁₇:Eu phosphors have been synthesized by Solid State Reaction method.. TL properties has been investigated. The average particles size 80 nm were controlled by taking the appropriate concentration of starting materials. The intense dosimetric well defined isolated peak was found at around 445 K, which shows linear dose response. It may be useful in accidental dosimeter in display devices.

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