Chapter – VI

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From the results, discussions and summary the following conclusions can be drawn. The work presented in the thesis concerned with PL and TL studies of Eu^{2+}, Eu^{3+}, Ce^{3+}, Nd^{3+}, Nd^{4+}, Pr^{3+} , Mn^{2+} and double dopants rare earth (RE): non rare earth (NRE) as well as RE:RE doped BaMg-aluminates. Very good and interesting luminescent characteristics have been exhibited by different prepared phosphors. Series of experiments have been made first to examine the luminescent behaviors of these specimens in different irradiated conditions. And then, an attempt has been made to find out the applicability of the studied materials in the lamps.

After comparing the PL and TL of the commercial phosphors with the prepared samples of various single and double dopants and dopant concentrations the following conclusions are drawn. The present technique for preparation of the phosphors is solid-state diffusion process in open air appears good. The requirement of lamp phosphors in lamps are the fine particles (around 5 μm), narrow particle size distribution, and large surface area without disturbing luminescence efficiency etc., From the above PL and TL studies and the above noted characteristics are mostly fulfilled. Since the solid-state reaction is in open air (presence of oxygen) the formation of Eu^{2+} and Eu^{3+}, are equally possible. The same is observed in Eu doped BAM's where the PL emission is in the blue green region as well as in red region around 615nm.

To compare our results and check the statements made in the above discussions an other experiment is carried out on commercial BAM: Blue phosphor. The TL and PL curves are presented in **Fig.6.1.A and 6.1.B**. The TL peak is a mixed one with three peaks and a maximum at 177°C followed by 284 and 348°C. The PL emission is around 460nm well resolved one.

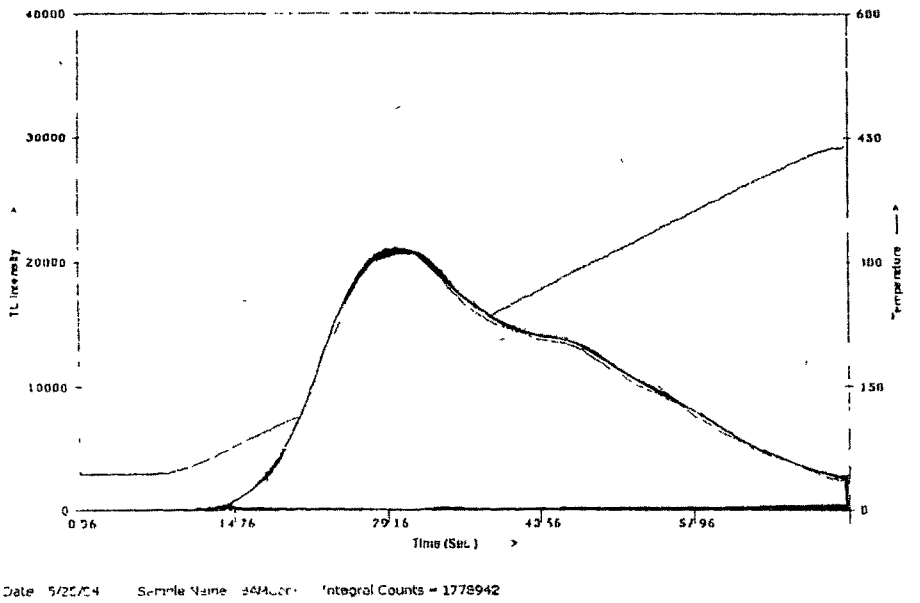
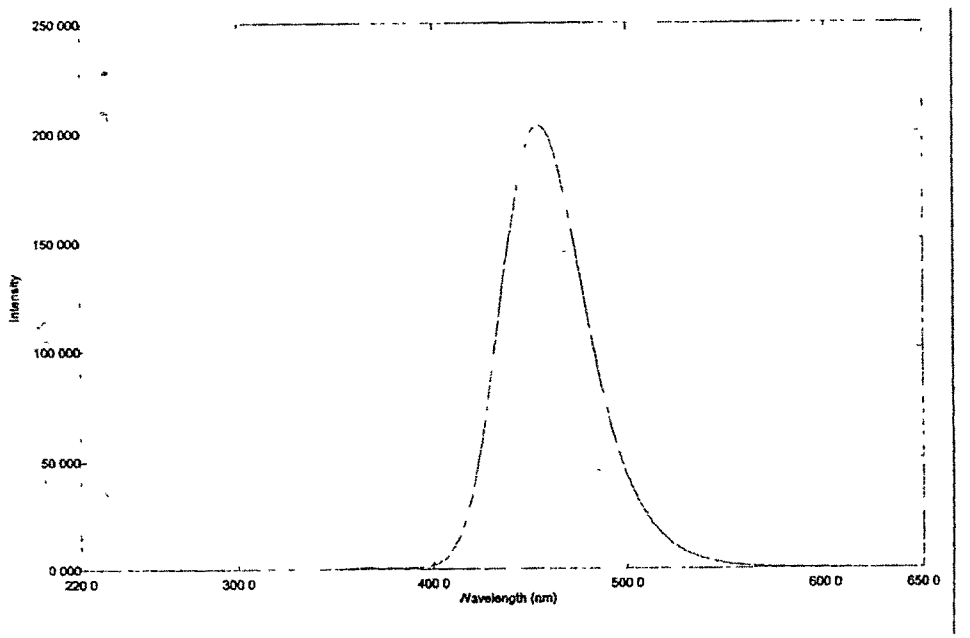


Fig. 6.1.A TL of beta irradiated Commercial BAM TL peaks at 177,284 and 348°C

Fig. 6.1.B PL of Commercial BAM peaking at 460nm.



The fluorescent experiments on the specimens offered following interesting results,

i) Eu^{3+} and Ce^{3+} activated Barium Magnesium aluminates displays PL emissions respectively at 366-469 and at 616nm wavelengths under 254 nm excitation.

ii) The excitation with 254 nm, develops emissions around 366-469 nm peaking at 366 along with weak blue one[around 469 nm] respectively in Nd^{3+} and Pr^{3+} Nd^{2+} activated $BaMgAl_{10}O_{17}$ phosphors.

iii) PL of double dopant of Ce^{3+} and Mn^{2+}, Eu^{3+} and Mn^{2+} phosphor results the emission in red region, particularly 628 and 616 nm as well as even PL intensity in the region 366-469nm in $BaMgAl_{10}O_{17}$ with excitation 254 nm wavelength

iv) PL of double dopant of Ce^{3+} and Nd^{3+}, Ce^{3+} and Eu^{3} phosphors shows the emission, particularly as an even PL intensity in the region 366-469nm in $BaMgAl_{10}O_{17}$ with excitation 254 nm wavelength. However the effect concentration of dopant did not influence any change in PL characteristics of the phosphors except the intensity variation.

The experimental results presented above have been interpreted on the basis of the recent understanding of luminescence exhibited by single and multi activated BAMs. It is believed that the nature of impurity introduced (divalent, trivalent and tetravalent), ionic size of the dopant, concentrations of dopants, structure of $BaMgAl_{10}O_{17}$ host matrix, crystalinity of BAM and crystalline interactions of the host are responsible for the particular PL and TL emission in the specimens.

The basic requirements for the use of phosphors as lamp phosphor have been examined for the material under investigations. It is observed that phosphors under study satisfy most of the requirements of the efficient lamp phosphor. It has been concluded that some of them are found to be useful in lamp industry. The important experimental findings are mentioned below:

1. The $BaMgAl_{10}O_{17}Eu$, $BaMgAl_{10}O_{17}Ce$ and $BaMgAl_{10}O_{17}$:Ce:Mn are found to be good blue, green and red-emitting phosphors.
2. Amongst the phosphors studied , Eu^{3+} doped $BaMgAl_{10}O_{17}$ specimens appear better however the best phosphors are $BaMgAl_{10}O_{17}Eu^{3+}$,(1% and 1.5). Therefore these two are considered as best phosphors for lamps.
3. BAM doped with Ce^{3+}, Nd^{3+}, Pr^{3+}, Mn^{2+}, Ce:Eu and Ce:Nd seems to be useful as blue-green emitting phosphors.
4. $BaMgAl_{10}O_{17}$: Eu (1.0, 1.5%) , $BaMgAl_{10}O_{17}$: Ce,Mn and $BaMgAl_{10}O_{17}$: Eu,Mn are found suitable phosphors for Trichromatic, low pressure mercury vapor [LPMV] as well as high pressure mercury vapor [HPMV] fluorescent lamps..
5. It is found that all double dopant beta irradiated BAMs, do not exhibit noticeable TL pattern compared to that of single doped ones. However, Ce,Nd activated BAM results an excellent TL emission with very high intensity. The TL of such specimens are also found better compared to all 26 specimens along with commercial BAM.
6. It is very clear from the TL results of the materials with different grain sizes results that the TL glow peaks show reduction in the number of humps or kinks when grain size of the phosphor reduces from 180 to 45 microns. This also promotes in the rise of intensity of the main TL peak.

Suggestions for future research work:

The above prepared and studied materials are suitable to Indian conditions. These prepared materials also fulfill many requirements of lamp phosphors. However the $BaMgAl_{10}O_{17}$:X, XY Phosphors prepared with different contents of varieties of impurities must be done to investigate for better material for their application in Lamp and other display industry.

- The effect of change in relative concentrations of different impurities on the fluorescence and TL characteristics should be examined. It is believed that such information will assist lot to the selection and use of the material in lamp as well as radiation dosimetry (BAM,:Ce,Nd) phosphors.

- Tri band phosphors are widely used in lamps at present like Blue, Green, and Red emitting three different phosphors to obtain required color Rendition Index (CRI) for getting white light of required color temperature. It is also envisaged that incorporation of suitable multi activated BAMs with appropriate co-dopant may give emission as all the three required emission at a particular content of impurities. Such new phosphors may stop chemical decomposition expected in the lamp at operating temperature amongst the three different phosphors used to get the emission in visible region. This fact encourages to suggest that a systematic research programme must be undertaken in future to investigate such important phosphors.
- The defect structure of Eu^{3+} and Ce^{3+} doped BAM can be determined by means of thermoluminescence. The glow curves revealed that BAM comprises several shallow traps below the recombination center. It was demonstrated that the type of activator does not affect the energetic position of the traps in the band gap of BAM

- From the comparison of the experimental results with the $BaMgAl_{10}O_{17}$ (Commercial) Oshram No.2464 to the laboratory prepared BAM:Eu (1.5%) it is found that almost both shows the same TL characteristics. It is also concluded by considering the TL emission from 90 – 380°C many trap levels may be present.

- This is the first attempt made by us to study the X-ray irradiated LTTL of BAM:Eu. The LTTL of all the four phosphors displays a prominent peak around -160°C. It is interesting to note that the TL displayed by BAM doped with Eu or Ce below room temperature. Irrespective of the PL emissions in blue to red region these phosphors displays a well resolved peak at the -160°C. Therefore it is suggested that the detailed investigation of the irradiated BAM's using X-ray, gamma ray may give a useful data to find out the nature of defects and develop and suggest the proper PDP phosphor or Lamp application phosphor.