# Synthesis And Study of TL Glow Curve Sensitivity And Analysis of Libabo3 Phosphor By Activators Dy, Cu, Ce, Eu And Mn

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***Abstract-*** *The present paper reports the combustion synthesis of $LiCaBO_3$ phosphor by various dopants Dy, Cu, Ce, Eu and Mn and study their TL intensity and TL glow curve analysis.* *During the combustion synthesis we have synthesized $LiCaBO_3$ phosphor by using various activators Ce, Cu, Eu, Dy and Mn so as to explore the possible compound for TL glow curve analysis. The combustion synthesis method is very simple and time saving method, the detail procedure of synthesis and the observed TL intensities, TL glow curve analysis and luminescent characteristics of $LiCaBO_3$ phosphors are discussed in this paper.*

***Keywords***- $LiBaBO_3$; combustion method; TL intensity; TL glow curve

## I. INTRODUCTION

Synthesis of luminescent materials specifically for silicates, oxides, borates and aluminates, the combustion method is found to be very useful. Since this method provides uniform and narrow distribution of the particle size of the product. Thus we have attempted combustion method for the synthesis of $LiBaBO_3$ and study its TL behavior

During the combustion synthesis proper molar ratios of fuel and oxidizers depending on the moles of precursors are very much necessary for evacuation of unwanted various molecules so that fine powders of required product could be finally obtained (1-5).

## II. SYNTHESIS OF $LiBaBO_3$ PHOSPHORS

During the synthesis of $LiBaBO_3$ phosphor the stoichiometric amounts of high purity starting materials, $Li_2CO_3$ (G.R.), $Mg(NO_3)_2{\cdot}6H_2O$ (A.R.), $H_3BO_3$ (A.R.), $CO(NH_2)_2$ (G.R.), $NH_4NO_3$ (G.R.) were mixed thoroughly in agate mortar for about 30 minutes, so that the paste was formed. A stock solution of stoichiometric amount of dopant chloride $CuCl_2{\cdot}2H_2O$ was then mixed in paste. It was put in the pre-heated furnace (550°C) after warming it for 5 minutes. The self heat generating redox reaction was completed and the fine powder of $LiBaBO_3$was finally obtained. This raw powder was sintered for 1.5 hour at 700°C and quenched to room temperature on aluminum plate (6-10). The balanced chemical reactions of each of the phosphors prepared are reported in the following balance chemical reactions

**Chemical reactions for synthesis of $LiBaBO_3$:Cu:**

$0.5Li_2CO_3 + Ba(NO_3)_2 + H_3BO_3 + 5CO(NH_2)_2 + 4NH_4NO_3 + 0.0001CuCl_2{\cdot}2H_2O + 4O_2 \rightarrow \mathbf{LiBaBO_3{:}Cu} + (5.5CO_2 + 4NH_3 + 4NO_2 + 13.5H_2O + 6N_2)\uparrow$

**Chemical reactions for synthesis of $LiBaBO_3$:Ce:**

$0.5Li_2CO_3 + Ba(NO_3)_2 + H_3BO_3 + 5CO(NH_2)_2 + 4NH_4NO_3 + 0.001CeCl_3 + 4O_2 \rightarrow \mathbf{LiBaBO_3{:}Ce} + (5.5CO_2 + 4NH_3 + 4NO_2 + 13.5H_2O + 6N_2)\uparrow$

**Chemical reactions for synthesis of $LiBaBO_3$:Eu:**

$0.5Li_2CO_3 + Ba(NO_3)_2 + H_3BO_3 + 5CO(NH_2)_2 + 4NH_4NO_3 + 0.001EuCl_3 + 4O_2 \rightarrow \mathbf{LiBaBO_3{:}Eu} + (5.5CO_2 + 4NH_3 + 4NO_2 + 13.5H_2O + 6N_2)\uparrow$

**Chemical reactions for synthesis of $LiBaBO_3$: Dy:**

$0.5Li_2CO_3 + Ba(NO_3)_2 + H_3BO_3 + 5CO(NH_2)_2 + 4NH_4NO_3 + 0.001DyCl_3 + 4O_2 \rightarrow \mathbf{LiBaBO_3{:}Dy} + (5.5CO_2 + 4NH_3 + 4NO_2 + 13.5H_2O + 6N_2)\uparrow\uparrow$

**Chemical reactions for synthesis of $LiBaBO_3$:Mn:**

$0.5Li_2CO_3 + Ba(NO_3)_2 + H_3BO_3 + 5CO(NH_2)_2 + 4NH_4NO_3 + 0.001MnCl_2{\cdot}2H_2O + 4O_2 \rightarrow \mathbf{LiBaBO_3{:}Mn} + (5.5CO_2 + 4NH_3 + 4NO_2 + 13.5H_2O + 6N_2\uparrow$

## III. IRRADIATION OF PHOSPHORS

**Comparison of γ Rays Sensitivity of $LiBaBO_3$ phosphors with other phosphors:**

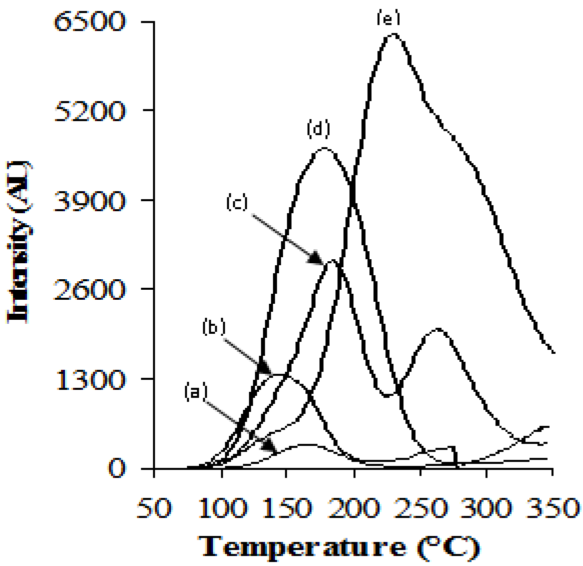


Fig. 1 Comparison of Glow curve sensitivities of selected $LiMBO_3$:Dy exposed to 5 Joule/kg of γ rays $LiMgBO_3$:Dy, $LiCaBO_3$:Dy, $LiSrBO_3$:Ce, $LiBaBO_3$:Dy and $CaSO_4$:Dy

We have compared the performance of $LiMgBO_3$:Dy, $LiCaBO_3$:Dy, $LiSrBO_3$:Ce, $LiBaBO_3$:Dy and $CaSO_4$:Dy phosphors and the TL glow curves are shown in figure 1.

The curves (a), (b), (c), (d) and (e) are for $LiMgBO_3$:Dy, $LiCaBO_3$:Dy, $LiSrBO_3$:Ce, $LiBaBO_3$:Dy and $CaSO_4$:Dy phosphors respectively.

It was found that the sensitivity of $LiBaBO_3$:Dy is maximum ( ~ 74 %) and that of $LiMgBO_3$:Dy is minimum (~5 %). The effective Z value of $LiMgBO_3$:Dy ($Z_{eff}$ = 9.15) and that of $LiBaBO_3$:Dy, the value of $Z_{eff}$ is 48.19, which is very large. Though it gives maximum sensitivity, this phosphor is not suitable for TLD applications due to its high Z value. For such applications, the phosphor should have Z value around 7.4

## IV. RESULTS AND DISCUSSION

Figure 2 show the typical glow curves for $LiBaBO_3$ doped with various impurities exposed to γ ray exposure of 5 Joule/Kg. Curve (a), (b), (c), (d) and (e) are for Dy, Cu, Ce, Eu and Mn respectively. In these studies TL peak is found around 175°C and in case of Dy it is found to be higher than that of the rest activators.

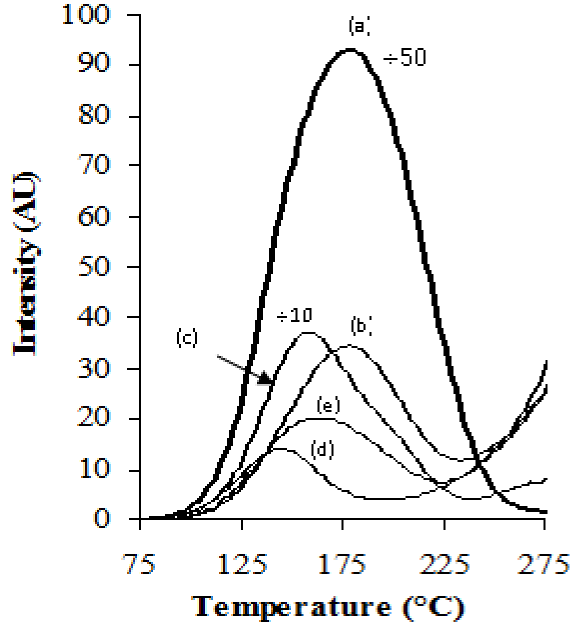


Fig. 2 Typical glow curves for $LiBaBO_3$ doped with various impurities exposed to 5 Joule/kg. (a) Dy, (b) Cu, (c) Ce, (d) Eu and (e) Mn. Curves (a) and(c) are divided by 50 and 10 respectively to fit the ordinate scale

## V. CONCLUSIONS

1. Dy is the most suitable activator than others studied
2. Typical glow curves for $LiBaBO_3$ doped with Dy shows most ideal performance
3. TL peak is found around 175°C and in case of Dy it is found to be higher than that of the rest activators.

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