 ISSN: 2321-8169
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Synthesis and preliminary TL/OSL properties of $MgB_4O_7:Tb^{3+}$ Phosphorfor Radiation Dosimetry

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Abstract: The OSL technique is a now well-developed for its application in personnel monitoring. AntonovRomanovskii*et al.* were firstly suggested use of OSL for personal dosimetry. However compared to thermoluminescence (TL) technique, optically stimulated luminescence (OSL) is becoming more popular in radiation dosimetry. The polycrystalline $MgB_4O_7:Tb^{3+}$ phosphor was successfully synthesized via Solid State Diffusion Method (SSDM). The structural of prepared phosphor was confirmed by using XRD (X-ray diffractiontechnique). Additionally, the photoluminescence (PL), thermoluminescence (TL) and optically stimulated luminescence (OSL) behaviors of $MgB_4O_7:Tb^{3+}$ phosphor was studied.The PL excitation of prepared phosphor was monitored at 544 nm while emission was monitored at 228 nm. The TL glow curve consist single peak in temperature rang 150-350°C. Also effective atomic number of prepared phosphor is 8.4. Hence this phosphor is promising candidate for radiation dosimetry.

Keywords: *OSL; personnel monitoring; $MgB_4O_7:Tb^{3+}$; TL and radiation dosimetry.*

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I. INTRODUCTION

Radiation dosimetric methods are used for the estimation of dose absorbed by radiation in a detector material. These methods are required for estimation of absorbed dose in various applications of radiation, such as personnel and environmental dosimetry, retrospective/ accidental, dosimetry and medical applications of radiation. The use of thermoluminescence (TL) as a method for radiation dosimetry of ionizing radiation has been established for many decades and has found many useful applications in various fields, such as personnel, environmental, medical, archaeological, geological dating and space dosimetry. Several high sensitive TL phosphor materials and thermoluminescent dosimeters (TLDs) are now commercially available in different physical forms. There are many commercial TLD systems which are being used for various dosimetric applications and even presently, TL is a popular technique in the field of radiation dosimetry, particularly in personnel monitoring [1-4].

In the last two decades an alternative technique namely optically stimulated luminescence (OSL) has been developed and widely used. Several workers haddeveloped many materials for radiation dosimetry applications [5-11].

In the present report we develop $MgB_4O_7:Tb^{3+}$ phosphor via stearic acid Sol-gel route and studies its luminescence properties.

II. EXPERIMENTAL DETAILS

The Solid State Diffusion Method (SSDM) was employed for the synthesis of $MgB_4O_7:Tb^{3+}$ phosphor. The phase purity of $MgB_4O_7:Tb^{3+}$ phosphor was checked by means of X-ray diffraction (XRD) using a Rigakuminiflex II diffractometer. Irradiations of sample was performed at room temperature using a calibrated $\gamma(^{60}Co)$ source at department of chemistry RTM University, Nagpur. The dose rate was 0.3712KGy/hr. The TL/OSL measurements were carried out using PC CONTROLLED TL/OSL-1008 reader [12]. The PL and PL excitation (PLE) spectra was measured using Hitachi F-7000 fluorescence spectrophotometer.

III. RESULTS AND DISCUSSIONS

3.1 X-ray diffraction pattern (XRD)

The XRD pattern of the $MgB_4O_7:Tb^{3+}$ phosphor was shown in **Fig. 1.**

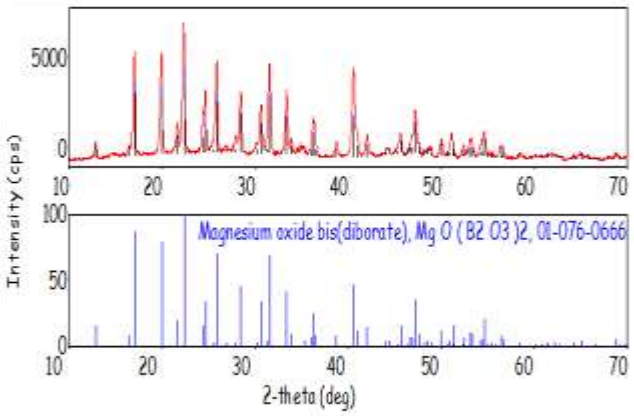

Fig. 1 XRD pattern of $MgB_4O_7:Tb^{3+}$ with ICDD file with card No. 01-076-0666.

The peak positions in the diffraction pattern of the synthesized material were comparing with the standard data available in the international center for diffraction files (ICDD) with card no. ICDD-01-076-0666 and found to be in agreement confirming the formation of the material.

3.2 Photoluminescence (PL)

The excitation and emission spectra of $MgB_4O_7:Tb^{3+}$phosphor was shown in **Fig. 2**. The excitation

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and emission spectra were observed under 544 and 228 nm respectively. The excitation spectra consist of broad band in range 200–250 nm corresponds to 4f–5d transitions of Tb^{3+}ion.

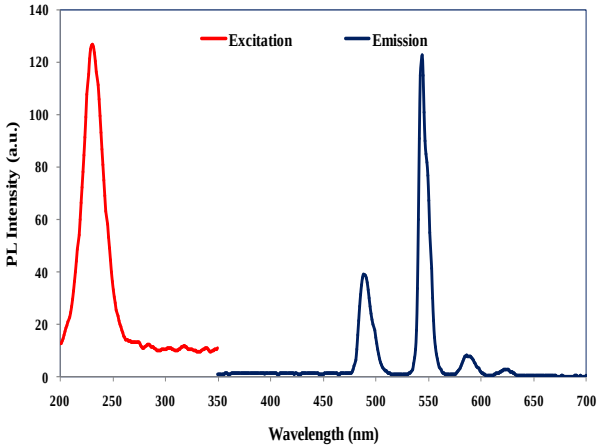

Fig. 2 Excitation and emission spectra of $MgB_4O_7:Tb^{3+}$ phosphor

3.3Thermoluminescence (TL)

TL glow curve of $MgB_4O_7:Tb^{3+}$ phosphor under γ irradiation was shown in **Fig. 3**. The TL glow curve of prepared $MgB_4O_7:Tb^{3+}$ phosphor consist single peak in temperature 150-350ºC range. The kinetics parameters were calculated by using peak shape method [13, 14]. The calculated kinetics parameters were given in **Table. 1.**

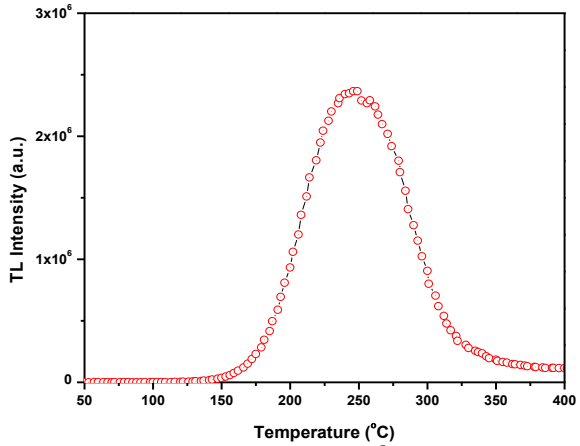

Fig. 3TL glow curve of $MgB_4O_7:Tb^{3+}$ phosphor under γ irradiation

Table 1. Kinetics parameters of $MgB_4O_7:Tb^{3+}$ phosphor

Phosphor	Activation energy (eV)	Frequ-ency factor	Peak temperat-ure (ºC)	Shape factor (μ_g)
$MgB_4O_7:Tb^{3+}$	0.812	1.06 x 10^7	246	0.52

3.3Optically stimulated luminescence (OSL)

The CW-OSL response of $MgB_4O_7:Tb^{3+}$ phosphor under blue stimulation as shown in **Fig. 4**. The decay pattern of prepared phosphor is very similar to decay pattern of commercially available α-Al_2O_3:C phosphor.

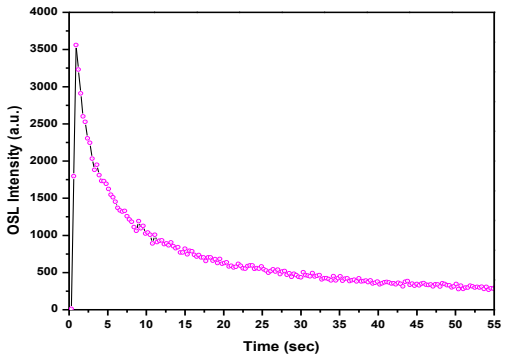

Fig. 4CW-OSL response of $MgB_4O_7:Tb^{3+}$ phosphor under blue stimulation

IV. CONCLUSIONS

The polycrystalline $MgB_4O_7:Tb^{3+}$ phosphor was successfully synthesis by using SSDM. The XRD pattern of prepared phosphor is well matched with ICDD file with card no.01-076-0666. The emission spectra of prepared phosphor consist of series of sharp peaks at 488, 544, 583 and 621 nm corresponding to transitions, $^5D_4 - {}^7F_6$, $^5D_4 - {}^7F_5$, $^5D_4 - {}^7F_4$ and $^5D_4 - {}^7F_3$ respectively. The TL glow curve of prepared phosphor consist single peak in range 150-350ºC and kinetics parameters such as activation energy, frequency factor and shape factor were calculated by using peak shape method. The CW-OSL decay pattern of prepared phosphor is very similar to decay pattern of commercially available α-Al_2O_3:C phosphor. Also effective atomic number of prepared phosphor is low (Z_{eff} =8.4) and phosphor shows excellent TL/OSL response under γ irradiation. Hence this phosphor may be proposed as a suitable candidate for radiation dosimetry, after further studies

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References

[1] S. W. S. McKeever, M. Moscovitch, *Radiat. Prot. Dosim.***2003**, 104, 263.
[2] S. W. S. McKeever, M. Moscovitch, P. D. Townsend, Nuclear Technology Publishing, Ashford (1995).
[3] S. W. S. McKeever, *Radiat. Prot. Dosim.***2002**, 27, 100.
[4] S. W. S. McKeever*Radiat. Prot. Dosim.***2004**,109, 269.
[5] C.B. Palan, N.S. Bajaj, D.K. Koul, S.K. Omanwar,*Int. J. Lumin. Appl.***2015**, 5, 12.
[6] C.B. Palan, N.S. Bajaj, A. Soni, M.S. Kulkarni, S.K. Omanwar*Bull. Mater. Sci.***2015**, 38, 1527.
[7] C.B. Palan, N.S. Bajaj, S.K. Omanwar,*St. Petersb. Polytech. Univ. J.: Phys. Math.***2015**, 1, 410.
[8] C.B. Palan, S.K. Omanwar,J. Lumin. **2016**, 178, 340.
[9] B. Dhabekar, S.N. Menon, E.A. Raja, A.K. Bakshi, A.K. Singh, M.P. Chougaonkar, Y.S. Mayya, *Nucl. Instrum. Methods Phys. Res., Sect. B***2011**, 269, 1844.
[10] P. Sahare, M. Singh, P. Kumar, *RSC Adv.***2015**, 5, 3474.
[11] M.S. Kulkarni, D.R. Mishra, D.N. Sharma, *Nucl. Instrum. Method. Phys. Res.Sect. B*, **2007**, 348, 262.
[12] J. Reddy, J. Reddy J. Reddy, *Int. J. Lumin. And Appl.***2015**, 5,344.
[13] C.B. Palan, N.S. Bajaj, S.K. Omanwar, *Mater. Res. Bull.***2016,** 76, 216.
[14] C.B. Palan, N.S. Bajaj, A. Soni, S.K. Omanwar, *J. Lumin.* **2016**, 176,106.