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Phosphors $MMgAl_{10}O_{17}$: Eu,Dy (M=Ba,Sr,Ca) irradiated by Cs^{137} for thermoluminescence dosimetry

S J Dhoble, G V Bramhe [1], R G Sonkawade [2] & S V Moharil[3]

Kamla Nehru College, Sakkardara Square, Nagpur 440 009
[1]Govt Autonomous P G College,Chhindwara 480 001
[2]Nuclear Science Center, New Delhi 110 067
[3]Department of Physics, RT M Nagpur University , Nagpur 440 033

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The thermoluminescence (TL) of Eu, Dy activated M $MgAl_{10}O_{17}$[M=Ba,Sr,Ca] phosphors has been reported in this paper. These phosphors are prepared by combustion synthesis. TL glow intensity of these phosphors is higher as compared to conventional $CaSO_4$:Dy TL-phosphor. M $MgAl_{10}O_{17}$[M=Ba,Sr,Ca] phosphors may be the possible candidate for thermoluminescence dosimetry of ionizing radiations.

Keywords: Thermoluminescence, Dosimetry, Phosphors, Luminescence

1 Introduction

Sulphates, borates, phosphates, fluorides are known to be good thermoluminescent materials. In recent years we have reported[1-6] several phosphors which exhibits properties useful for thermoluminescence dosimetry [TLD] of ionizing radiations. High sensitivity, tissue equivalent TLD materials are important for the measurement of exposures in the field of medical physics. LiF:Mg,Cu,P is one of the such phosphor[7,8]. However, limited thermal stability of this phosphor have some problems. The limited thermal stability has been attributed to the aggregation of phosphorous impurities[9]. Lithium borate is a good tissue equivalent phosphor[10] with Z_{eff}=7.4. Brunskill[11] developed the preparation of this material to produce a useful, tissue equivalent detector[12] but its main disadvantage was the emission at 600 nm which corresponds to the most insensitive region of the response of most photomultiplier tubes. $CaSO_4$:Dy is such an efficient phosphor that it is used in TLD for ionizing radiations[13] but poor tissue equivalence. The shape of the glow curve also changes with exposures[14]. LiF:TLD100 is tissue equivalent, but its response is poor, about 20 times less than that of $CaSO_4$:Dy. It also has a complicated glow curve structure[15].

After the first report by Frohlich in 1946 on the possibility of using $SrAl_2O_4$ as a phosphor host and subsequent Belgian patent in 1963 on the luminescence behaviour of this host doped with europium, the detailed and systematic study was done by Palilla *et al*[16] .The interest in the rare earth doped alkaline earth aluminates has been largely due to their high luminescence efficiency under UV excitation and their ability to maintain their phosphorescence for several hours. Many researchers have concentrated to developed aluminates as a lamp, scintillator, flat panel display, X-ray imaging phosphors. During the course of our investigation aluminate based materials, we have come across a phosphor showing TLD properties. As an outcome of these studies we have found a new aluminate based TLD phosphors. $BaMgAl_{10}O_{17}$:Eu,Dy; $SrMgAl_{10}O_{17}$:Eu,Dy; $CaMgAl_{10}O_{19}$:Eu,Dy which are more sensitive than $CaSO_4$:Dy. The preparation and TL properties of these phosphors are described in this paper.

2 Experimental Details

Phosphors were prepared by combustion synthesis. The detailed description of the method can be found in the original works of Patil and co-workers[17-21]. Starting materials were respective metal nitrates (oxidizer), and urea as a fuel. All constituents in stoichiometric proportions, along with fuel and oxidizer were mixed together. The mixture after thoroughly grinding was transferred to a pre-heated furnace at 500ºC. On rapid heating, the mixture evaporates and ignites to yield a white product. Entire process completes within few minutes. Hence, the combustion synthesis offers an efficient and easy way for the phosphor preparation.

TL glow of these prepared phosphors was recorded using a standard TL reader Harshaw-3500 at Nuclear Science Centre, New-Delhi. The γ–rays dose (^{137}Cs) employed for irradiation is 1.8 Rad.

3 Results and Discussion

Figure 1 shows the typical TL glow curve of $BaMgAl_{10}O_{17}$:Eu,Dy phosphor after expose to γ–rays dose (^{137}Cs). The prominent TL glow peak observed at 187ºC and another TL peak observed at lower temperature at 59ºC.The prominent TL peak intensity is 18.87 times higher as compared to conventional $CaSO_4$:Dy TLD phosphor. Similar results are observed for $SrMgAl_{10}O_{17}$:Eu,Dy and $CaMgAl_{10}O_{19}$:Eu, Dy phosphors.

Fig. 2 shows the TL glow curve of $SrMgAl_{10}O_{17}$:Eu,Dy phosphor (after expose to γ–rays dose (^{137}Cs).The prominent TL peak is observed at 185ºC and its intensity is 7.75 times higher as compared to $CaSO_4$:Dy dosimetry peak. TL glow of $CaMgAl_{10}O_{19}$:Eu,Dy phosphor is shown in Fig. 3. The higher temperature TL peak is observed at 331ºC, its TL peak intensity is higher by 2.88 times as compared to $CaSO_4$:Dy phosphor for γ–rays dose (^{137}Cs).

The results show the TL intensity in Eu,Dy activated aluminate based phosphors is higher as compared to conventional $CaSO_4$:Dy TLD phosphor after expose to γ–rays dose (^{137}Cs). In the literature, aluminate based high sensitive TL dosimetry phosphor was reported for the first time in this paper. Therefore, the new route opens for investigation of new TLD phosphors in aluminate based materials.The

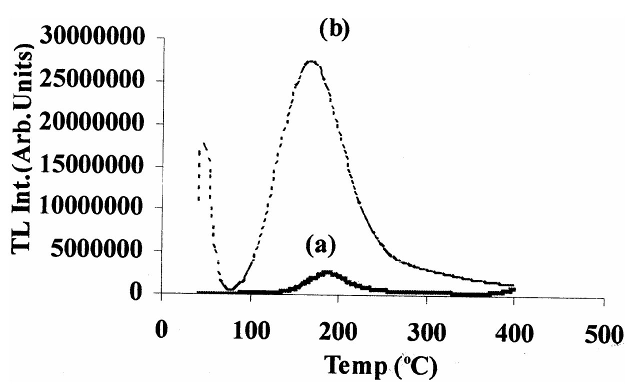

Fig. 1— TL-glow curve of (a) $CaSO_4$:Dy (b)$BaMgAl_{10}O_{17}$:Eu,Dy

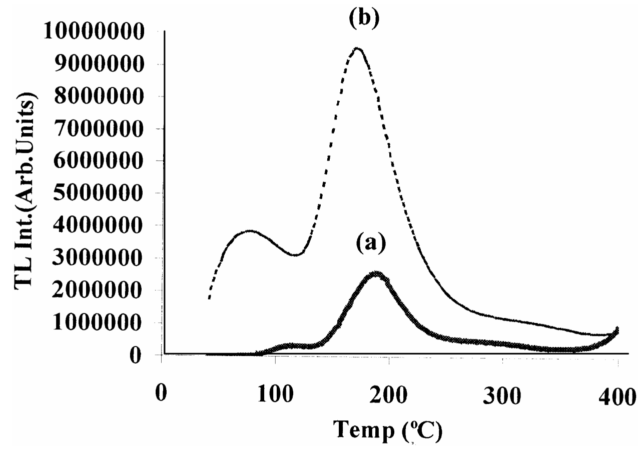

Fig. 2— TL-glow curve of (a) $CaSO_4$:Dy (b)$SrMgAl_{10}O_{17}$:Eu,Dy

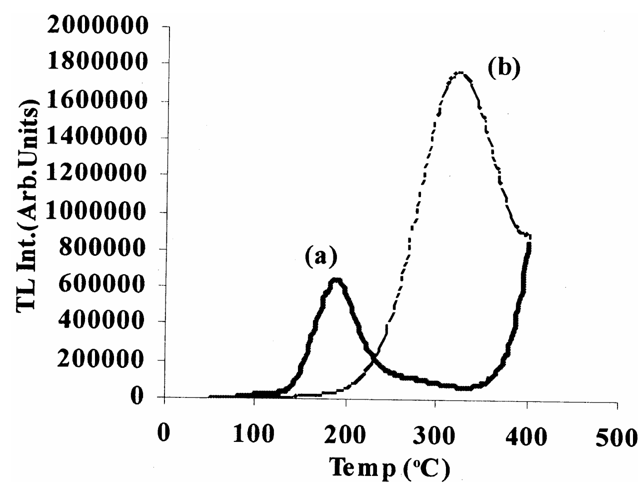

Fig. 3— TL-glow curve of (a) $CaSO_4$:Dy (b)$CaMgAl_{10}O_{19}$:Eu,Dy

detail dosimetric characterization published in future as early as possible. The phosphors $BaMgAl_{10}O_{17}$:Eu,Dy; $SrMgAl_{10}O_{17}$:Eu,Dy and $CaMgAl_{10}O_{19}$:Eu,Dy may be considered as TLD phosphors of ionization radiations.

4 Conclusion

The phosphors $BaMgAl_{10}O_{17}$:Eu,Dy; $SrMgAl_{10}O_{17}$:Eu,Dy and $CaMgAl_{10}O_{19}$:Eu,Dy show prominent TL peak at higher temperature and its intensity is higher as compared to $CaSO_4$:Dy TLD phosphor. Therefore , the phosphors may be used as TLD phosphors of ionization radiations.

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