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COMPARISON STUDY OF THE THERMO-LUMINESCENT PROPERTY OF THE LONG AFTER GLOW PHOSPHORS $Ca_2MgSi_2O_7$:EU WITH DIFFERENT CONCENTRATION

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ABSTRACT

A series of eu^{2+} doped di-calcium magnesium di-silicate phosphors with different concentration were prepared by solid state reaction method and thermo-luminescent properties, decay curve were investigated. Only one emission peak can be found in their afterglow spectra. The white coloured afterglow emission can last more than 2.40 h for most of the samples under study.

Keywords: A. White long afterglow phosphor, B. Thermo-luminescence property, C. Decay curve

I. INTRODUCTION

Alkaline earth silicates have become useful host for long afterglow phosphors due to their longer duration of the phosphorescence, high luminosity, improved chemical stability and low cost, easier preparation. The long afterglow eu^{2+} activated phosphor is extensively used because of its high luminescence and long afterglow. The emission of 5d-4f from eu^{2+} is highly efficient. The properties of the white long afterglow phosphors thus far reported do not satisfy the demand of practical application. Therefore, search of better white long afterglow phosphors with a new combination of host and activator is still in progress. In this article, a series of eu^{2+} doped di-calcium magnesium di-silicate $Ca_2MgSi_2O_7$ were prepared by solid state reaction method. The thermo-luminescence properties of the samples were measured and compared. In addition to the calculation of the trap depth and frequency factor for the long afterglow.

II. EXPERIMENTAL

Di- calcium magnesium di-silicate $Ca_{2-x}MgSi_2O_7:eu_x$ (x = 0.01 ,0.02 ,0.04,0.05) were prepared by solid state reaction method .The detailed experimental process was described below. $CaCO_3$, MgO, $SiO_2.H_2O$ and Eu_2O_3 were used as raw materials. The mixture of raw materials was ground to fine particle before sintering for 3h in air at 1100 ^{0}C for $Ca_2MgSi_2O_7$:eu . Thus prepared is white powder. Phase purity and structure of obtained material was determined by X ray diffraction XRD. The thermo-luminescence (TL) glow curves of the all sample were measured after irradiation with the same mercury lamp at room temperature using a thermo-luminescence dosimeter (model I-001) .

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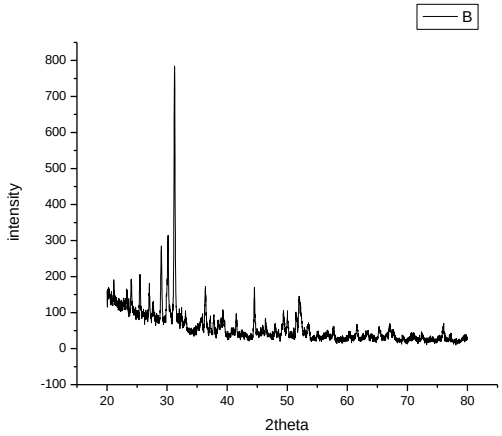
III. RESULT AND DISCUSSION

3.1 Phase Composition of Powder

The phase and structure of prepared sample were checked using XRD spectra. Fig shows XRD patterns of $Ca_2MgSi_2O_7$:eu . For comparison, the XRD patterns of Ca_2 $MgSi_2O_7$:eu shown in fig are those only for the sample of different heating temperature such as 900 ^{0}C and 1100^{0}C with a eu^{2+} doping concentration of 4mol% . The structure of $Ca_2MgSi_2O_7$:eu 0.04 can be indexed to JCPDS number of () , corresponding to akermanite structure .



3.2 Scanning Electron Microscopy SEM

SEM study is useful regarding morphological features of sample. Nano-particle characterization is necessary to establish understanding and control of done by using scanning electron microscopy (SEM) and XRD. The nature of material prepared and grain size etc will be known from such studies. A correlation will be made between SEM and XRD studies.

The SEM image of the prepared sample was displayed in fig. From this image we observed that the prepared sample consists of particle with size distribution 100nm and 200nm.

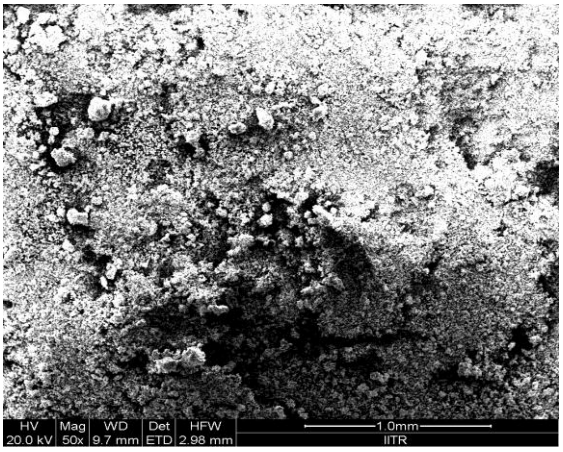


Fig: Full View of SEM image of eu doped phosphor

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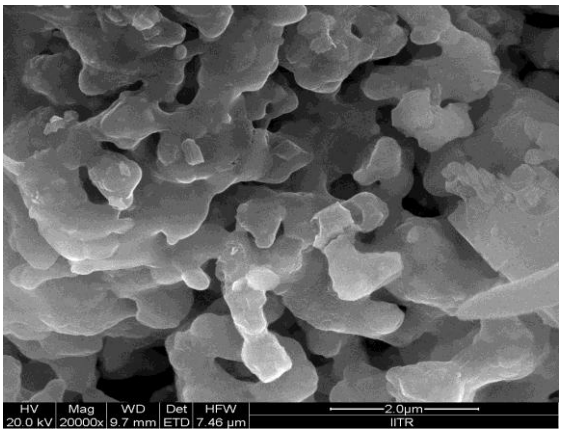


Fig: Partial enlarged view of the powder.

3.3 EDX

The edx pattern is displayed in fig. It indicated that the product obtained is composed of $Ca_2MgSi_2O_7$ and small quantity of eu^{2+}. EDS indicates the presence of Ca (17.48 at. %), O(55.17 at. %, Si (17.90 at. %) and Mg (8.56 at. %). observed that the distribution of the elements is fairly uniform. On the basis of calculations made the ratio of $Ca_2MgSi_2O_7$:eu^{2+} is presented in table .

Table1. Atomic Percentage of element in nano-crystalline $Ca_2MgSi_2O_7$: eu^{2+} phosphor

Elements	At %	Wt %
O	55.17	36.33
Mg	8.56	8.56
Si	17.90	20.70
Ca	17.48	28.83
eu	00.89	5.58

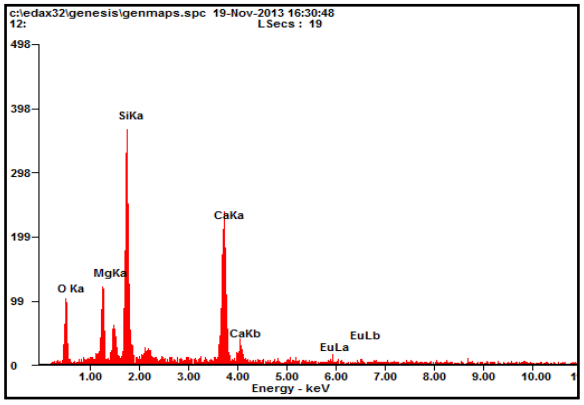


Fig: edx pattern of the prepared sample.

IV. THERMO-LUMINESCENCE PROPERTIES

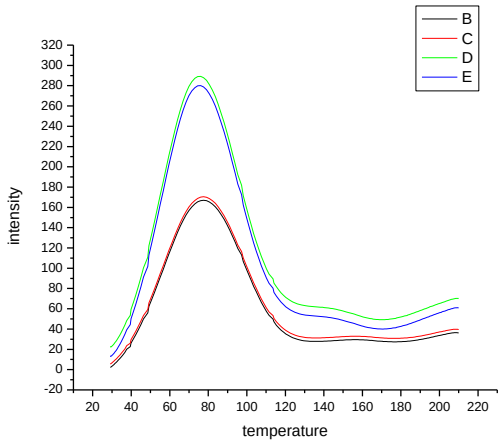
Thermo-luminescence is a useful tool to investigate the properties of the traps responsible for the afterglow. It is well known that trapping centers play an important rope for thermo-stimulable phosphors. Mainly, through thermo-luminescence curves we can easily obtained of the trapping level information. The thermo-luminescence curves of prepared sample with different concentration after irradiation with the mercury lamp at

room temperature are recorded. Thermo-luminescence curves of the prepared sample with 1%, 2%,4% and 5% eu^{2+} concentration are presented in fig. The entire samples with different concentration of eu^{2+} have similar spectral shape. From the fig, all the thermo-luminescence curves recorded exhibit rich structure substantial intensity in the range from 30 ^{0}C to 210 ^{0}C for the sample with the one strong peak around at 70^{0}C.

The feature of the TL graph is nearly symmetric which means they accord with IInd order kinetics. Therefore it is responsible for the deal with the trap parameters corresponding TL bands of prepared samples using half width method. Here E= E_1+ E_2 /2 where E_1= $1.51KT_MT_1/T_M-T_1$ and $E_{2=}$ KT_M^2/T_2-T_M , T_M is maximum temperature in K.

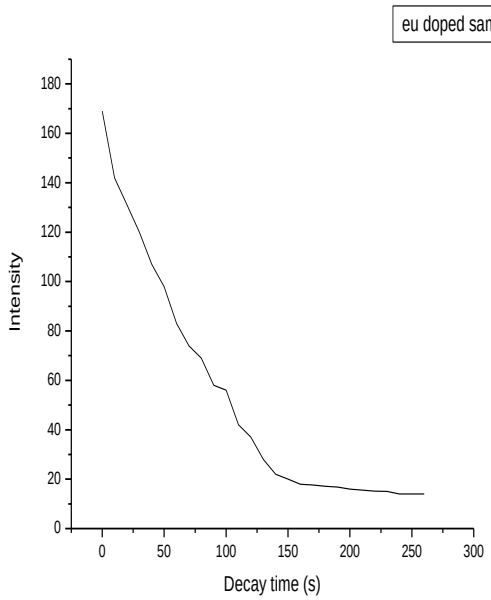
Table2. Trap parameters of corresponding TL bands of prepared sample with different concentration.

Concentration	Peak temp. (K)	Trap depth (e V)	Frequency factor(Hz)
0.01	343.61	0.55	$0.33x10^8$
0.02	356.41	0.58	$0.35x10^8$
0.04	365.78	0.57	$0.24x10^8$
0.05	352.78	0.57	$0.24x10^8$



4.1Afterglow Characteristic

Fig is the decay curve of $Ca_2MgSi_2O_7$:eu^{2+} . It can seen that $Ca_{1.96}MgSi_2O_7$:$eu_{0.04}$ has the optimum brightness and long lasting than the other samples. Its afterglow time is more than 2.40h in a dark place after the excited light source is removed, which means $Ca_{1.96}MgSi_2O_7$:$eu_{0.04}$ is a good kind of long lasting phosphor.



V. CONCLUSION

In conclusion , a series of silicate compound $Ca_{2-x}MgSi_2O_7:eu_x$ x=0.01,0.02,0.04,0.05 with white long afterglow after irradiation with mercury lamp have been prepared by solid state reaction method. One strong emission peak are found in different concentration of eu doped samples. The afterglow time of $Ca_{1.96}MgSi_2O_7:eu_{0.04}$ is nearly 2.40h which means it is good long lasting phosphor.

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