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PL and ML characterization of $Sr_3Eu_xAl_{10-x}SiO_{20}$ phosphor

Varsha Rangari[1] , Vineet Nayar[2] and S.J. Dhoble[3]

[1]Department of Electronics, Dharampeth M.P.Deo Memorial Science College, Nagpur, India
[2]Dept. of Physics, C.M.D. P.G. College, Bilaspur (C.G.), India
[3]Department of Physics, RTM Nagpur University, Nagpur-440033, India.

Abstract
$Sr_3Eu_xAl_{10-x}SiO_{20}$ phosphors were prepared by solid state diffusion method. The photoluminescence and mechnoluminescence properties have been studied. Prepared $Sr_3Eu_xAl_{10-x}SiO_{20}$ phosphor shows the broad emission at 421nm due to $4f^65d^1 \rightarrow 4f^7$ of Eu^{2+} ion in the blue region of the spectrum. The excitation spectra of $Sr_3Eu_xAl_{10-x}SiO_{20}$ phosphor shows at 356nm in the range of solid state lighting is useful for display devices. The ML activity of $Sr_3Eu_xAl_{10-x}SiO_{20}$ (1 mole %) was determined for different impact velocities of piston and also for different masses of piston and results are discuss in this paper.

Keywords: PL and ML characterization, $Sr_3Eu_xAl_{10-x}SiO_{20}$ phosphor

INTRODUCTION

Mechnoluminescence (ML) is a type of luminescence induced during any mechanical action on solids. It can be excited by grinding, rubbing, cutting, cleaving, shaking, scratching, compressing or crushing of solids. They can also be excited by thermal shocks or by the shock waves produced during exposure of samples to powerful laser pulses. ML also appears during the deformation caused by the phase transition or growth of certain crystals as well as during separation of two dissimilar materials in contact. This phenomenon of ML is also called as trennugslicht, triboluminescence , piezoluminscence, deformation luminescence and stress- activated luminescence.

Nearly one half of all inorganic solids and from one forth to one third of all organic solids both crystalline and non crystalline exhibits the phenomenon of ML. Most of the crystal exhibit ML only during their deformation and the ML emission stops as soon as the deformation is interrupted. When such crystals are deformed mechanically, the ML intensity initially increases, attains maximum value and then decreases. Thus one peak is observed in a plot between the ML intensity and time. However when the ML is excited impulsively in gamma irradiated inorganic materials, the ML appears in deformation region as well as in the post deformation region. One or two peaks are observed in the ML intensity versus time curve where the 1st peak lies in the deformation region but the second peak lies in the post deformation region.

Present paper reports the PL and ML glow curve of $Sr_3Eu_xAl_{10-x}SiO_{20}$. It also reports the ML in the deformation region as there is only one peak in the ML intensity versus time curves

EXPERIMENTAL

Synthesis of phosphors $Sr_3Eu_xAl_{10-x}SiO_{20}$ (x=0.05,0.1,0.2,0.5,1 mole %)were done by solid state diffusion method. The starting materials were Al_2O_3, $SrCO_3$, SiO_2 and Eu_2O_3, for $Sr_3Eu_xAl_{10-x}SiO_{20}$. These starting materials with proper schiometric ratio were mixed thoroughly and heated at 800°C for 24 hrs and cooled slowly. Photoluminescence measurement of excitation and emission were recorded on Shimadzu RF5301PC spectrophotometer. Emission and excitation spectra were recorded using a spectral slit width of 1.5nm.

The prepared samples were irradiated with gamma rays. Then the phosphor $Sr_3Eu_xAl_{10-x}SiO_{20}$ (x=0.05,0.1,0.2,0.5,1 mole %) with different concentration of impurity europium were fractured by an air driven piston of mass 600gm moving with velocity 30cm/s to determine the ML activity on samples. The ML was monitored by an IP28 Photomultiplier Tube and its amplified output was monitored by a blastic galvanometer. The ML activity of $Sr_{3\ 3.979}Eu_{0.2}Al_{10-x}B_xSiO_{20}$ (1 mole %) was determined for different impact velocities of piston and also for different masses of piston.

RESULTS AND DISCUSSION

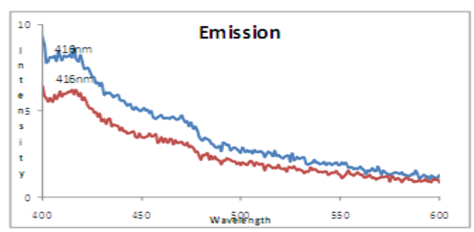

Fig 1. Emission spectra of $Sr_3Al_{10}SiO_{20}$:Eu, blue curve for maximum intensity for 1m% and red curve for 0.5 m% concentration of Eu^{2+} ion (excitation wavelength is 356 nm)

Photoluminescence of prepared $Sr_3Eu_xAl_{10-x}SiO_{20}$ phosphor shows in fig. 1, the broad emission observed at 421nm due to $4f^65d^1 \rightarrow 4f^7$ transition of Eu^{2+} ion. The excitation spectra fig. 2 of $Sr_3Eu_xAl_{10-x}SiO_{20}$ phosphor shows at 356nm in the range of solid state lighting is useful for display devices.

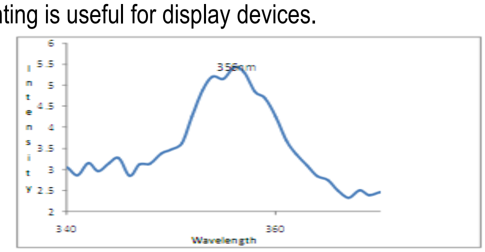

Fig 2. Excitation spectra of $Sr_3Al_{10}SiO_{20}$:Eu(monitor at 416 nm)

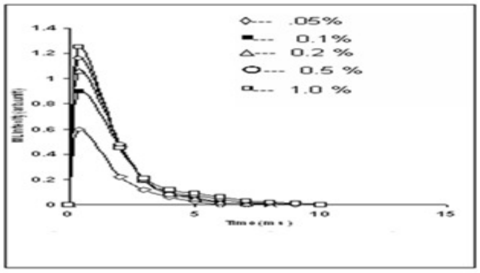

Fig 3. Time dependence of the ML intensity of gamma irradiated $Sr_3Al_{10}SiO_{20}$:Eu phosphors with different Eu concentration.

Fig. 3 shows the time dependence of ML intensity of $Sr_3Eu_xAl_{10-x}SiO_{20}$ quenched sample for different concentration of impurity. The ML intensity increases with increasing concentration of Eu. The ML intensity for a particular 1 mole% of Eu^{2+} ion concentration increases linearly with time and then it attains a maximum value at a nanosecond of time Tm. After Tm the ML intensity decreases exponentially at fast rate and then it decreases exponentially at a slow rate. However there is no considerable change in Tm. It shows maximum intensity for 1m% concentration Eu^{2+} ion.

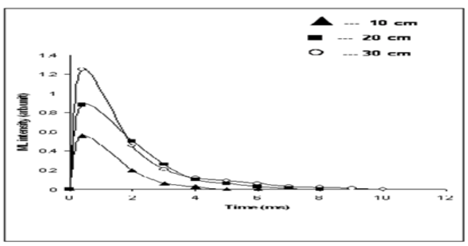

Fig.4 Time dependence of the ML intensity of gamma irradiated $Sr_3Al_{10}SiO_{20}$:Eu phosphors with different impact velocity by load applied from different heights.
Fig.5 Time dependence of the ML intensity of gamma irradiated $Sr_3Al_{10}SiO_{20}$:Eu phosphors with impact of piston with different load.

Fig.4 shows the time dependence of ML intensity of $Sr_3Eu_xAl_{10-x}SiO_{20}$ (1m%)quenched sample for different impact velocity . ML increases with increase in velocity. The ML intensity is indicate with increasing impact velocity with increases the stress for releasing the charge particle from traps in the lattice and releases with high stress due it is developed form high velocity.

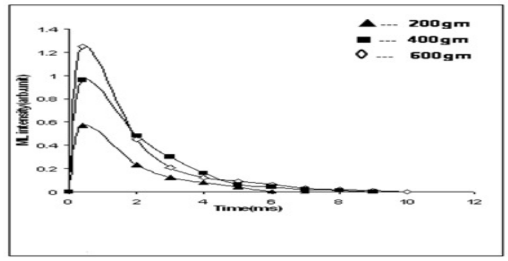

Fig 5.Time dependence of the ML intensity of gamma irradiated $Sr_3Al_{10}SiO_{20}$:Eu phosphors with impact of piston with different load.

Fig.5 shows the time dependence of ML intensity of $Sr_3Eu_xAl_{10-x}SiO_{20}$ (1m%)quenched sample for impact of mass form constant height. ML increases with increases in load or mass.

All the results form ML characterization of phosphors show the energy traps are created during the gamma irradiation and stable at room temperature. With increases the stress on the excited phosphors only theses traps involve and responsible for recombination of electron and hole due to good impact developed by with increases load or load applied from maximum heights. The PL and ML results are also co-related and indicate the more Eu^{2+} ion shows the high ML emission in the phosphors and it is 1 mole % concentration are allow in the present host lattice.

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