

Photoluminescence and thermoluminescence properties of Ca₂CeO₄ : Eu Phosphor P.Sujitha and and B.Subba Rao V.S.R.&N.V.R. College, Tenali-522201

Abstract:

This paper reports the photoluminescence properties of Ca_2CeO_4 phosphor with different concentrations of trivalent Europium as dopant. The method used for the synthesization is solid state reaction. Photoluminescence spectra and thermoluminescence techniques were used to investigate the luminescent properties. From XRD the crystallite size is calculated using Scherer's formula. The SEM micrographs of Ca_2CeO_4 : Eu phosphor was also studied.

Keywords: Photoluminescence, Thermoluminescence, solid state reaction method

Introduction:

The luminescence associated with Eu contained in different host lattices has found applications related to its red light emission. Oxides based luminescent materials exhibits photoluminescence properties which are used as the display displaying devices. The rare earth materials exhibit sharp emission luminescence properties. The characterization of the prepared materials was done using PL,TL,XRD,SEM and particle size analysis techniques.

Experimental:

The phosphor sample was prepared by solid state reaction method. The phosphor Ca_2CeO_4 is prepared from the compounds calcium carbonate (CaCO₃) and cerium oxide (CeO₂) . The prepared Ca_2CeO_4 phosphor is weighed and grounded into a fine powder using agate mortar and pestle about an hour. The grounded phosphor was placed in an alumina crucible and heated from room temperature to 1200° c in a muffle furnace with a heating rate of 5° c/min. After reaching 1200° c the phosphor heated for 3hours and the furnace was set for sample.

The basic reaction is as follows, $2CaCO_3 + CeO_2$

 $-Ca_2CeO_4 +$

$2CO_2$

Characterizations:

The characterizations like Photoluminescence. Thermoluminescence, XRD, SEM and particle size analysis were studied. The photoluminescence spectra was recorded at room temperature using spectroflurometer(SHIMADZU, RF-5301PC) xenon lamp as excitation source. The thermoluminescence spectra were recorded by TL glow curve reader. Through XRD crystallite size is calculated. The structure of the crystal is observed from SEM.

Results and Discussions:

Photoluminescence study:

Fig 1(a) and fig 1(b) shows the PL spectra of Ca_2CeO_4 : Eu^{3+} . The excitation is formed at 248nm wavelength. The PL emission spectra of samples

were recorded at the excitation peak wavelengths of 254nm and 325nm at different concentrations.

The excitation of the Ca₂CeO₄ : Eu³⁺ phosphor with 254nm wavelength generates photoluminescence emission at 470,593 and 611nm. The peak at 470nm shows intensity 73a.u. It is due to magnetic dipole transition ${}^{5}D_{2}$ ${}^{7}F_{0}$. The peak at 593mm shows intensity around 16a.u and small peaks are observed at 611nm.

PL emission of Eu doped Ca_2CeO_4 phosphor at 325nm excitation shows peaks 593,611 and 633nm with intensities of around 25a.u. The peaks at 611 and 633nm is due to electric dipole transition.



Fig 1(a) : PL of Ca_2CeO_4 : Eu with 254nm excitation



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Fig 1(b) :PL of Ca_2CeO_4 : Eu with 325nm excitation

XRD Study:

The crystal structure of the product was examined by XRD analysis. Fig. 2 shows the X-ray diffraction pattern of synthesized sample Ca_2CeO_4 : Eu^{3+} .The peaks in the diffraction pattern seems to be single phase.The crystallite size of the particles of powder sample were calculated by Scherer's formula D=0.9lambda/ β cos(theta).The average crystallite size of undoped Ca_2CeO_4 phosphor is 63nm and when doped with Eu dopants the crystallite size is 55nm.Which conclude us the solid state reaction method is good to prepare nano crystallites also.



Fig.2: XRD of $Ca_2CeO_4 : Eu^{3+}$ SEM Study:

Fig. 3 shows the scanning electron micrograph of Ca_2CeO_4 : Eu³⁺.From fig it is observed that the

particles are spherical in shape having an average basal diameter of 77.86nm



Thermoluminescence study:

Fig. 4 represents TL glow curve of Ca_2CeO_4 phosphor doped with different concentrations of Eu^{3+} . It exhibits well defined and well resolved peaks around $142^{0}c$ and other emission peaks around $345^{0}c$ temperatures with decreasing intensities.





Particle size analysis:

The particle size distribution histograms of Ca_2CeO_4 : $Eu^{3+}(1.5\%)$ particle is shown in fig.5.From particle size histogram it is found that two maximum particle size of 4microns and 12 microns are found. This allows us to draw a conclusion that two different phases may be existing and majority may be in a single phase.



Fig.5: Particle size analysis of Ca₂CeO₄ : Eu³⁺

Conclusions:

Eu doped with Ca_2CeO_4 phosphor was synthesized via.solid state reaction. As the Eu concentration increases the host emission intensity increases s. Which conclude us the solid state reaction method is good to prepare nano crystallites also and the particles are spherical in shape. The two different phases may be existing and majority may be in a single phase. **References:**

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