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Novel Green Emission Observed from Er^{3+} Doped Sr_2CeO_4 Phosphor

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Abstract— *High temperature Solid state reaction method was explored to synthesize Er^{3+} (0.5 mol%) rare earth ion doped Sr_2CeO_4 phosphor. The characteristics of the phosphor material were analyzed by PL and CIE techniques. The excitation spectra displayed that this phosphor could be effectively excited from 250 - 340nm wavelengths. The emission spectra corresponding to 254, 265 and 280nm excitation show bluish green emission. The broad emission centered at 475nm is attributed to $Ce^{4+} \rightarrow O^{2-}$ and the sharp emission in the green band centered at 527 and 536nm are attributed to $^2H_{11/2} \rightarrow {}^4I_{15/2}$ transition and the 553, 559nm are attributed to $^4S_{3/2} \rightarrow {}^4I_{15/2}$ transition of Er^{3+} ion.*

Keywords— *Inorganic compounds, Solid state reaction method, Luminescence, Light, Phosphor,*

1. INTRODUCTION

Nowadays a great attention is paid to the research and development in the field of lighting technology in relation to the global problem of saving energy. One of the rapidly developing technologies is based on using very efficient light emitting diodes [LED] in light sources for general lighting. There has been much interest in light emitting diodes (LEDs) with emission wavelengths in the ultraviolet to infrared range. Major developments in wide band gap III-V nitride compound semiconductors have led to the commercial production of high efficiency LEDs. Traditional colored LEDs have proven effective in signal applications, as indicator lights, and in automotive lightning. The development of white LEDs as a cost-competitive, energy-efficient alternative to conventional electrical lightning is very important for expanding LED applications toward general white lightning. The first reported white light LEDs were based on blue InGaN technology, which uses a combination of blue emission from a blue LED (+ yellow from $Y_3A_{l5}O_{12}$: Ce and red from Y_2O_3:Eu^{3+}emissions). However, these two-band white LEDs suffer from limited color rendering and color temperature, and are unable to produce all nature-equivalent colors, especially in the red region. To improve the color temperatures and the rendering index of phosphor-converted white LEDs, various phosphors with different components have been developed. Another type of phosphor-combined white LED uses a blue chip as a pump source with a blend of a green and a red phosphor to generate high-quality white light.

The present paper reports the photoluminescence study of Er^{3+} (0.5%) doped Sr_2CeO_4 phosphor.

2. EXPERIMENTAL WORK

Solid state reaction method was utilized for preparing this phosphor, which is the simpler and standard method. The inorganic compounds like Strontium Carbonate ($SrCO_3$), Cerium Oxide (CeO_2) and Erbium Oxide (Er_2O_3) of high purity (99.9%) chemicals were used as starting materials for the host and activator. All the compounds were weighed and were mixed with a spatula and then ground into a fine powder using agate mortar and pestle manually about an hour at room temperature. The grounded sample was placed in an alumina crucible and heated at 1200°C in air for 3 hours in a muffle furnace with a heating/cooling rate of 5^oC/min.

The Photoluminescence emission and excitation spectra were measured by Spectrofluorophotometer (SHIMADZU, RF-5301 PC) using Xenon lamp as excitation source. All the spectra were recorded at room temperature.

3. RESULTS AND DISCUSSION

3.1 Photoluminescence Study (PLE & PL)

The PLE spectrum of the Sr_2CeO_4 doped with erbium prepared by solid state reaction method is shown in figure 1. A broad excitation spectrum was observed monitored under 400nm wavelength. The broad emission can be attributed to the CTB.

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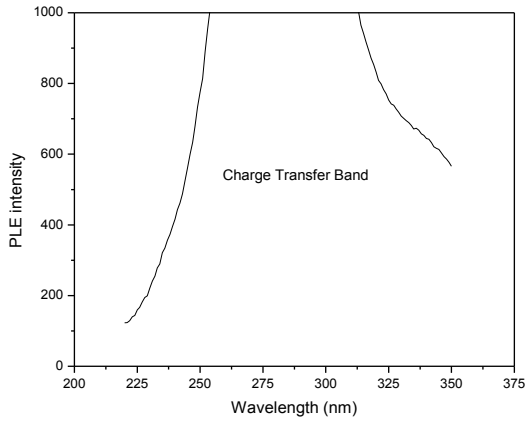

Fig. 1: PLE spectra of $Sr_2CeO_4:Er^{3+}$ (0.5 %) phosphor monitored under 400nm wavelength

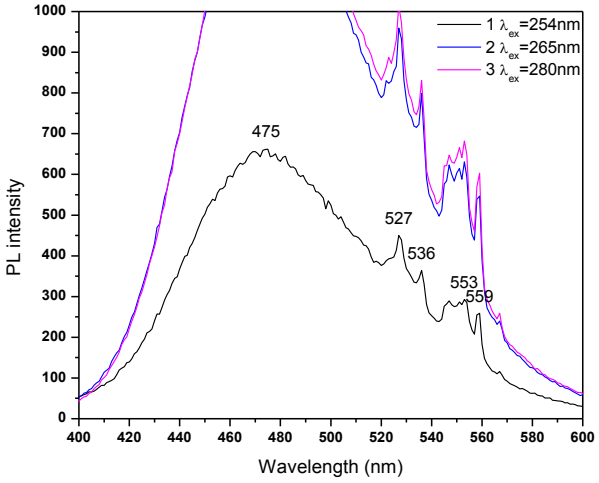

Fig. 2: PL spectra of $Sr_2CeO_4:Er^{3+}$ (0.5 %) phosphor under different excitation wavelengths

The emission spectra of sample with Erbium doping (0.5 mol%) under different excitation wavelengths is shown in figure 2. When the excitation of the sample was varied from 254nm - 280nm, the emission peaks appeared at 475, 527, 536, 553 and 559nm. It is interesting to note that the emissions are in bluish green region.

Pallavi Page et al., Rahul Gildyal et al., K.Suresh et al., BNRao et al., reported that the pure Sr_2CeO_4 phosphor emission is in the blue region centered around 470nm and presently our sample also matched with above results with high intensity. As per the literature, the Er ion gives up-conversion emission in most of materials. But our material showed in the green band, under 254, 265 and 280nm excitation wavelengths which is novel result. The broad emission centered at 475nm is attributed to $Ce^{4+} \rightarrow O^{2-}$ and the sharp emission in the green band centered at 527 and 536nm are attributed to $^2H_{11/2} \rightarrow {}^4I_{15/2}$ transition and the 553, 559nm are attributed to $^4S_{3/2} \rightarrow {}^4I_{15/2}$ transition of Er^{3+} ion.

4. CONCLUSIONS

The Er^{3+} ion doped Sr_2CeO_4 phosphor was synthesized via solid state reaction method successfully. Novel emission of Er ions was observed in the green band under UV excitation. Results show that this phosphor emits bluish-green which is useful in many decorative lamps.

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