International Journal of Luminescence and its applications
Volume 4(II), 04/04/2014, ISSN 2277 – 6362

Photoluminescence study of Eu^{3+} doped CeO_2 Phosphor

Jagjeet Kaur; Deepika Chandrakar ; [1]Vikas Dubey; Yogita Parganiha; Deepti Singh; N.S.Suryanarayana
Department of Physics, Govt. VishwanathYadavTamaskar Post Graduate Autonomous College, Durg (C.G.), India, 491001
[1]Bhilai Institute of Technology, Raipur, Kendri, New Raipur (C.G.)
Corresponding Author: deepikachandrakar31@gmail.com 09893495541

Abstract

Photoluminescence (PL) studies of Eu^{3+} doped CeO_2 phosphor using inorganic materials like Cerium oxide (CeO_2), and Europium Oxide (Eu_2O_3). The sample was prepared by the modified solid sate reaction method, which is the most suitable for large-scale production. Photoluminescence (PL) emission and excitation spectra recorded in room temperature. The PL emission was observed in the range 591, 611 and 632nm range.

Keywords: Photoluminescence, Eu^{3+} doped phosphor, solid state method.

1.0 INTODUCTION

Cerium doped oxide are very important for their optical as well as lasing properties, due to strong optical absorption and fluorescence in near UV or Visible and infrared region [1–3]. Trivalent cerium ($^4f_1$) possesses parity allowed 4f–5d electronic transitions and due to the large energy gaps, non-radiative decay is less likely to occur and 5d emission can beobserved [12] whereas in case of tetra valent [$^4f_0$] cerium, absorption belongs to character of charge transfer and has no luminescence [4]. In this paper we reports synthesis of CeO_2 doped with Europium by solid state reaction method which is suitable for large scale production and eco friendly method. The prepared sample was characterized by XRD, photoluminescence studies as well as particle size was calculated by Debye-Scherer formula.

2.0 EXPERIMENTAL

The Eu^{3+} activated CeO_2 phosphor was prepared via high temperature modified solid state reaction.The mixture of reagents was ground together to obtain a homogeneous powder. After being ground thoroughly in stoichiometric ratios by using an agate mortar by dry grinding for nearly 45 minutes, to ensure the best homogeneity and reactivity, powder was transferred to alumina crucible, and then heated in a muffle furnace at 1250 °C for 2 hr [5]. The sample was characterized at the Inter University Consortium (IUC) Indore for X-ray diffraction. XRD data were collected over the range 20–70˚ at room temperature. The XRD measurements were carried out using a Bruker D8 Advance X-ray diffractometer. The X-rays were produced using a sealed tube, and the wavelength of the X-ray was 0.154 nm (Cu K-alpha). The X-rays were detected using a fast counting detector based on silicon strip technology (Bruker Lynx Eye detector).The particle size was calculated using the Debye–Scherer formula [6]. The photoluminescence studies were carried out using RF5301 spectrophotofluorometer in the wavelength range400–650nm at room temperature.

3.0 RESULTS AND DISCUSSIONS

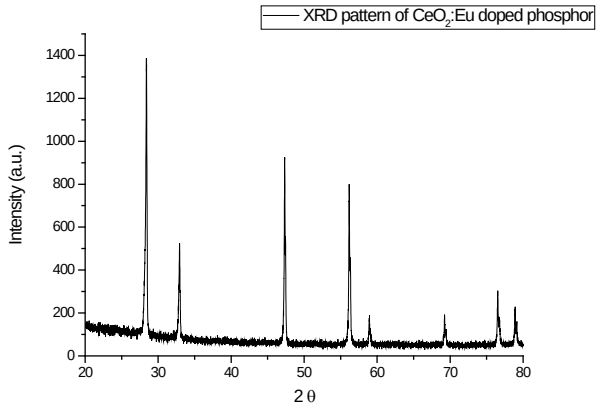

Figure 1 XRD pattern of CeO_2:Eu doped phosphor

The XRD pattern of the sample is shown in Fig.1. It shows a cubic structure.The width of the peak increases as the size of the particle decreases. The size of the particles has been computed from the full width half maximum (FWHM) of every peak using the Scherrer formula. The particle size was calculated using Scherrer's formula [8-10]. The Scherrer formula is given by:

$D = 0.9 \lambda / \beta \cos \theta$

International Journal of Luminescence and its applications
Volume 4(II), 04/04/2014, ISSN 2277 – 6362

Where, D is the average particle size perpendicular to the reflecting planes, λ is the X-ray wavelength, β is the FWHM, and θ is the diffraction angle. The average particle size of prepared phosphor was 27nm range.

Photoluminescence studies

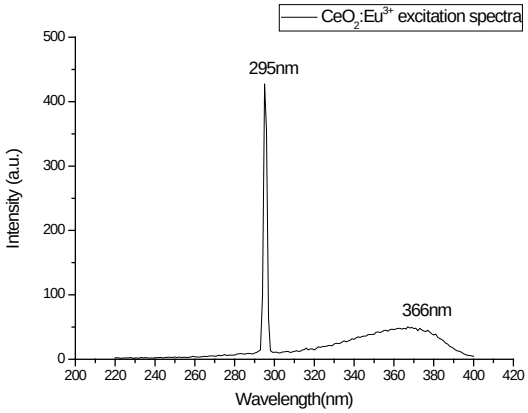

Figure2 PL excitation spectra with 591nm excitation

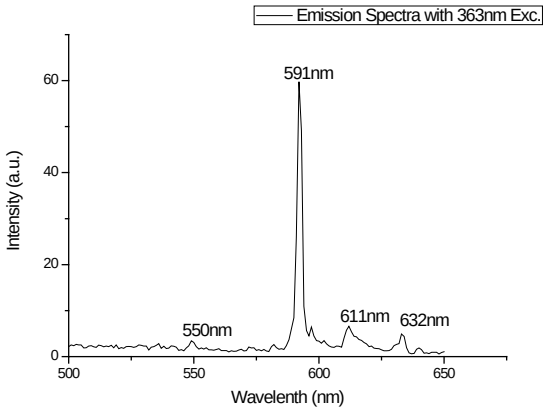

Figure3 PL emission spectra with 366nm excitation (500-650nm range)

Figure 2 and 3 represent the PL excitation and emission spectra of CeO_2:Eu^{3+} phosphor. Excitation monitored at 591nm and emission spectra found in orange region due to magnetic dipole transition of Eu^{3+} $^5D_0$ – $^7F_1$. An emsission peak which is very weak at 611nm due to electronic dipole transition.

Figure 2 shows the PL excitation spectra of CeO_2 phosphor monitored at 591 nm. It exhibits a broad excitation band in the range of 280– 400 nm is caused by the charge transfer state (CTS) of the Eu^{3+},which originates from interaction between $Eu^{3+}$and O^{2-}. Intense excitation peak found at 295 nm range and broad excitation occurs at 366nm range.

From the emission spectra (figure 3) it has been concluded that these phosphor exhibit orange – red emission and useful for display devices application for 366nm excitation.

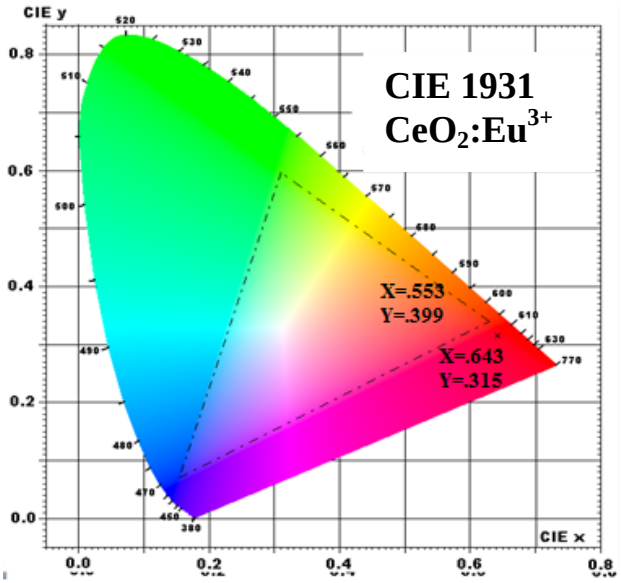

Figure 4 CIE coordinate for CeO_2:Eu doped phosphor

Figure 4 shows the spectrophotometric determination of prepared phosphor by CIE 1931 coordinates. The dominant peaks found at 591nm and 611nm range which shows the phosphor is very sensitive for orange – red emission.

4.0 CONCLUSION

It is concluded that the phosphor was prepared by solid state reaction menthod. The Eu concentration used for preparation is 0.2mol%. The sample was characterized by XRD technique and Photoluminescence study. Also the spectrophotometric determination was done by CIE coordinate. The prepared phosphor found at nano range 27nm of particle size calculated by debye-scherer formula. Prepared phosphor is useful for display device application at orange-red emission.

ACKNOWLEDGEMENT

Authors are very thankful to Dr. KVR Murthy for photoluminescence spectra.

References:

1. U. Caldino, J. Phys. Cond. Mater 15 (2003) 7127.
2. M.A. Garcia, J. Llopis, M.A. Villegas, S.E. Paje, J. Alloy. Compd. 323 (2001) 367.
3. M.J. Weber, J. Solid State Commun. 12 (1973) 741.
4. G.K. Das Mohaptra, Phys. Chem. Glasses 39 (1998) 5.
5. W.M.Yen, S. Shionoya and H. Yamamoto, Phosphor Handbook, CRC Press, Boca Raton, FL (USA) 2007.

6. Vikas Dubey, Jagjeet Kaur , Sadhana Agrawal , N.S. Suryanarayana , K.V.R. Murthy Superlattices and Microstructures 67 (2014) 156–171.
7. Arunachalam Lakshmanan, Luminescence and Display Phosphors: Phenomena and Applications. Nova Publishers, NY, USA, ISBN 978-1-60456-018-3 (2008).
8. VikasDubey, Suryanarayana N.S., JagjeetKaur, Kinetics of TL Glow Peak of Limestone from Patharia of CG Basin (India), Jour. Miner.Mater.Charac.Engin., 9(12) 1101-1111, (2010).
9. VikasDubey, JagjeetKaur, N.S. Suryanarayana, K.V.R.Murthy, Res. Chem. Intermed. (2012). doi: 10.1007/s11164-012-0872-7.
10. VikasDubey, JagjeetKaur, N.S. Suryanarayana, Sadhana Agrawal , International Journal of Luminescence and its applications, Volume 3(II)(2013), pp. 98-101.