

MODIFIED SOLID STATE SYNTHESIS METHOD AND PHOTOLUMINESCENCE PROPERTIES OF $\text{CaSiO}_3:\text{Ce}^{3+}$

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Abstract : The present study proposed to spread light on the blue emitting phosphor $\text{CaSiO}_3:\text{Ce}^{3+}$ prepared by modified solid state diffusion method. The $\text{CaSiO}_3:\text{Ce}^{3+}$ phosphor was characterized through X-ray diffraction (XRD) and luminescence spectra and compared for both the methods. The $\text{CaSiO}_3:\text{Ce}^{3+}$ phosphor shows strong blue emission under near UV excitation.

Keywords: $\text{CaSiO}_3:\text{Ce}^{3+}$; solid state method; optical property.

I. INTRODUCTION

Silicates are widely used as good phosphor hosts due to their abilities to incorporate rare earth (RE) [1]. Silicates have a basic tetrahedral geometry (SiO_4) with a variety of crystal structures including single, twin, cluster, ring, chain, and network structures [2]. Silicate phosphor has been widely used in TV, flat panel display screen and cathode ray (CRT) tubes. Recently, the luminescent properties of rare-earth ion doped silicates phosphors have been widely investigated because of their possible applications in white LEDs [3, 4]. Moreover among the series of silicates, one of the ceramic materials, Calcium silicates (CaSiO_3) is a 'distorted cubic' structure and found as a mineral in the lower mantle of the earth. CaSiO_3 also known as wollastonite is a good matrix for luminescent materials [5]. It has also many important properties such as good and high temperature strength, chemical inertness, low thermal conductivity and thermal stability [6, 7]. Hence, it is suitable in many applications. $\text{CaSiO}_3:\text{Ce}^{3+}$ is PL sensitive phosphors.

In this paper, we study of synthesis method and photoluminescence property of $\text{CaSiO}_3:\text{Ce}^{3+}$.

II. EXPERIMENTAL METHOD

$\text{CaSiO}_3:\text{Ce}^{3+}$ was synthesized by solid state reaction method using stoichiometric mixtures of calcium nitrate; $\text{Ca}(\text{NO}_3)_2$ and silicic acid; SiO_2 was main ingredients. cerium nitrate [$\text{Ce}(\text{NO}_3)_3$] were used as starting materials (The concentration of Ce is 0.01 and 0.03 mole%). The mixture was taken in crucibles and heated at various temperatures for different time i.e. firstly for two hours at 300°C and at 600°C . Then sample were crushed. Again sample heated for 3 hours at 800°C and 6 hour at 1000°C for subsequently. Finally the synthesized phosphor was cooled down to room temperature and then crushed into the powder.

III. RESULTS AND DISCUSSION

The structure of the as-prepared samples were analyzed by Rigaku Miniflex X-ray diffractometer, using monochromatic $\text{CuK}\alpha_1$ ($\lambda = 1.5405 \text{ \AA}$) radiation in the 2θ range of $10\text{-}70^\circ$. Photoluminescence was studied on a Hitachi F-7000 fluorescence spectrophotometer. Emission and Excitation spectra were recorded using a spectral slit of 1 nm for each window.

XRD analysis

Figure 1 represents the XRD pattern of CaSiO_3 phosphor along with the standard XRD pattern (ICDD 30884). The composition and phase purity of the prepared powder samples were first examined by X-ray diffraction. The XRD patterns shows that XRD patterns of $\text{CaSiO}_3:\text{Ce}$ is in good agreement with the available standard ICDD file no. 30884. However, the materials crystallized in monoclinic phase of CaSiO_3 with space group $\text{P}21/a$ (14) [8].

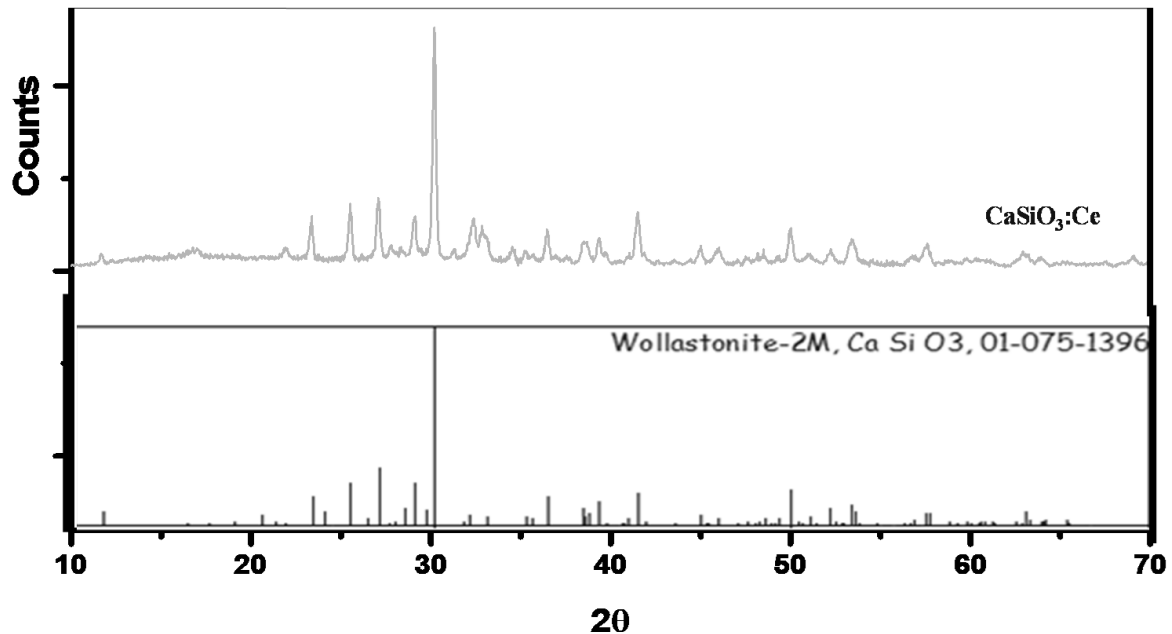


Fig.2 X- Ray diffraction (XRD) pattern of $\text{CaSiO}_3:\text{Ce}^{3+}$ prepared by solid state reaction method.

PHOTOLUMINESCENCE (PL)

Fig 2 shows the combined excitation and emission spectra of $\text{CaSiO}_3:\text{Ce}^{3+}$. The excitation spectra were monitored at 377 nm and emission spectra were monitored at 326 nm. The excitation spectra consists of broad band around 200-350 nm corresponds to the $4f\ 5d^1$ to $4f^7$ ($^8\text{S}_{1/2}$) allowed transition of Ce $3p$ ions [9]. Predominant excitation peak (326 nm) of Ce is near to the UV region under the excitation wavelength of 326 nm. The emission spectra consist of broad band from 350 to 450 nm. The PL intensity increases by increasing Ce concentration of Ce in CaSiO_3 .

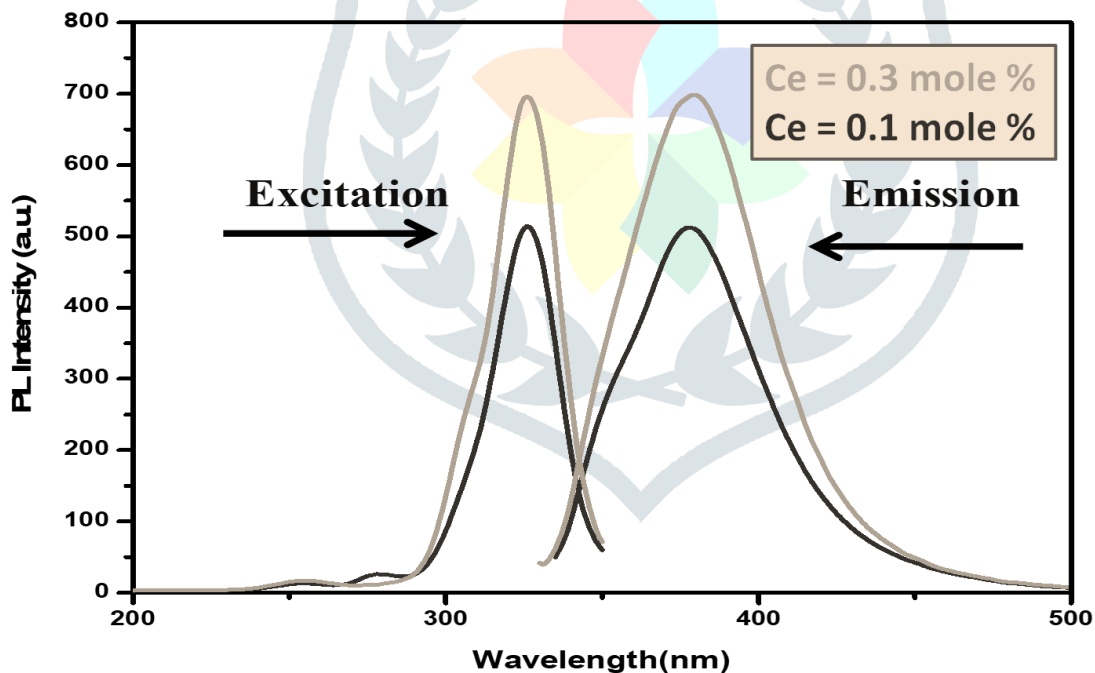


Fig. 2 Photoluminescence excitation and emission spectra of $\text{CaSiO}_3:\text{Ce}^{3+}$.

IV. CONCLUSIONS

The development of the new phosphor can be applicable in luminescence field for one of the application. Synthesis technique of $\text{CaSiO}_3:\text{Ce}^{3+}$ simple, cost effective with readily available raw material and is acquiescent to large-scale production of the phosphor. The X-ray diffraction patterns matches well with the ICDD files and gives the exact crystal structure as required from the synthesized materials. Photoluminescence (PL) emission spectrum consists of broad band characteristics of Ce emission in the range of 350-450 nm.

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REFERENCES

- [1] L. Yang, M. Fang, L. Du, Z. Zhang, L. Ren, Z. Yu, *Mat. Res. Bull.* 43 (2008) 2538–2543.
- [2] K. Komukai, Y. Takatsuka, K. Hideki, M. Kakihana *J. Lumin.* 158 (2015) 328–332.
- [3] D. Wen, G. Yang, H. Yang, J. Shi, M. Gong, M. Wu, *Mater. Lett.* 125, (2014) 63–66.
- [4] L. Ozawa, M. Itoh, *Chem. Rev.*, 103 (2003) 3835–3856.
- [5] R. H. Kaur, M. M. Sinha, *Asian J. Chem.* 21 (2009) 172-175.
- [6] C. I. Bovolo, *Phil. Trans. R. Soc. A* (2005) 363, 2811–2835.
- [7] H. Nagabhushana, B. M. Nagabhushana, M. M. Kumar, Chikkahanumantharayappad, K. V .R. Murthy, C. Shivakumara, R. P. S. Chakradharg, *Spectrochimica Acta Part A* 78 (2011) 64–69.
- [8] D. K. Smith, R. Jenkins, *J Res Natl Inst Stand Technol.* 101 (1996) 259–271.
- [9] L. Van Pieterse, M. F. Reid, R. Wegh, S. Governa, *Physical Review B*, 65 (2002) 045113.

