Colour tunability in Eu^{3+} doped TiO_2 phosphors for red led applications

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Throughout the last decade, rare earth doped semiconductor oxides have attracted extensive attention for the potential application in different fields including optoelectronics, sensors, solar cells, and photocatalysis due to their unique optical properties. Among many semiconductor oxides, titanium di oxide (TiO_2) is widely chosen because of its high band gap, low cost, non toxic with good thermal and chemical stability [1]. Eu^{3+} ion shows red emission for the f-f transition of Eu^{3+} ion which can be used for recent developments in the display and lighting technology, such as in flat panel displays (FPDs) and Light Emitting Diodes (LEDs) [2]. Commercially used WLEDs were developed using a blue LED chip with $\text{Y}_3\text{Al}_5\text{O}_{12}:\text{Ce}^{3+}$ yellow phosphor [3]. However, these phosphors have a lower color rendering index (CRI) and high color correlated temperature (CCT) due to the deficiency of red emission in the visible spectrum. So, selection of an efficient red phosphor excited by near UV-LED is highly required [4].

Figure 1: Emission spectra of Eu^{3+} doped TiO_2

In this work, our aim is to improve the red emission of Eu^{3+} doped TiO_2 which can be excited by near UV-Light. For this purpose, a series of $\text{Ti}_{(1-x)}\text{Eu}_x\text{O}_2$ ($x = 0.01-0.04$) phosphors were synthesised by combustion method at 600°C . The XRD studies show the lattice formation of Eu^{3+} doped TiO_2 phosphor with single phase tetragonal structure. Structural analysis of doped sample was performed using Rietveld refinement. The FESEM images were taken to study the morphology of particles.

FESEM image shows that particles are agglomerated.

Figure 2: CIE co-ordinate of Eu^{3+} doped TiO_2

Eu^{3+} doped TiO_2 phosphors excited by near UV light of wavelength 395 nm show intense red emission at 618 nm for $^5\text{D}_0$ to $^7\text{F}_2$ transition of Eu^{3+} ions (Figure 1). Maximum intensity was achieved for 3 mol% Eu^{3+} doping. The CIE parameters were calculated using the spectral energy distribution function and McCamy's empirical formula. From the CIE co-ordinate shown in Figure 2 it is clear that colour emission of phosphor is approaching towards the most intense red region with the Eu^{3+} doping concentration. Photometric characterization indicates that Eu^{3+} doped TiO_2 phosphors can be used for red light emitting diodes.

References

1. M.Vranjesa, J.K.Jakovljevic, T. Radeticb, M.Stoiljkovic, M.Mitrica, Z.V.Saponjica and J.Nedeljkovic, Ceram. Int. 38(7) (2012) 5629.
2. S. Som, S. K. Sharma, S. P. Lochab, Mater. Res. Bull. 48(2013) 844.
3. Y.T. Nien, K.M. Chen, I.G. Chen, T.Y. Lin, J. Am. Ceram. Soc. 91(2008) 3599.
4. H. F. Kay and P. C. Bailey, Acta. Crystallogr. 10(1957) 219.