Luminescence characteristics of color tunable Eu^{2+} activated $KSrPO_4$-$(Ba,Sr)_2SiO_4$ phosphors for near-UV light emitting diode applications

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White LEDs in which a near UV-LED (nUV-LED) is combined with blue, green-yellow, and red emitting phosphors have recently been receiving attention due to less current droop and improved binning of the nUV-LEDs, and a better control over color rendering index and color temperature through manipulation of phosphor blends [1]. Nevertheless, the degradation of luminous efficiency due to the strong reabsorption of the blue emission by the green or red-emitting phosphors still remains one of the problems with this system [2]. For these reasons, there have been reports on double or triple color emission from single phase phosphors by activation with an Eu-Mn energy transfer or by co-activators such as $Eu^{2+}/Eu^{3+}/Tb^{3+}$ and Ce^{3+}/Tb^{3+} [3,4]. However, the quantum efficiency (QE) and thermal stability of phosphors using an Eu-Mn energy transfer are dramatically reduced due to the relatively slow decay time of the forbidden Mn^{2+} d–d emission band. In multi-activator phosphors, the efficient excitation band is mostly in the deep UV region (250-330 nm) resulting in lower quantum efficiency in the nUV [4].

A solid solution phosphor is also a possible way to tune the emission wavelength and luminescence output. A number of efficient solid solution phosphors have been investigated with respect to partial changes of the host compound through either cation or anion substitution [5]. In this study, the luminescence properties of $KSrPO_4$-$(Ba,Sr)_2SiO_4$ solid solution activated with Eu^{2+} were investigated.

We reported $KSrPO_4$ and $(Ba,Sr)_2SiO_4$ compounds form ideal solid solution, despite the different end groups, since these compound have same space group (# 62) [6]. Figure 1 shows the emission spectra of Eu^{2+} activated solid solution of $(KSrPO_4)_{1-x}•(Ba_2SiO_4)_x$ (KBPSO) and $(KSrPO_4)_{1-x}•(Sr_2SiO_4)_x$ (KSPSO) for $0 \le x \le 1$ under 380 nm excitation, respectively. The emission spectra $KSrPO_4:Eu^{2+}$ (at $x = 0$) consist of a blue emitting broad band ($\lambda_{em} \sim 430$ nm) with a prominent shoulder at 490 nm. The spectra of $(Ba,Sr)_2SiO_4$ (at $x = 1$) consist of two broad bands and one of them shows weak emission near 475 nm and the other shows strong green- yellow ($\lambda_{em} \sim 505 – 570$ nm) emission. In addition, both show good thermal stability and high QE (>70% for $x = 0$, >90% for $x = 1$). The ratio of emission intensity of shorter wavelength to that of longer wavelength decreases with increasing x in KBPSO and KSPSO. The emission spectra of KBPSO and KSPSO at x = 0.1, showed the highest emission intensity, with good comparison to the highly efficient blue-emitting $LiCaPO_4:Eu^{2+}$ phosphor (QE ~ 80%). The luminescence characteristics of $KSrPO_4$ and $(Ba,Sr)_2SiO_4$ is related to the two possible cation sites for Eu^{2+}. The red-shift of emission peak as a function of x will be discussed more in detail.

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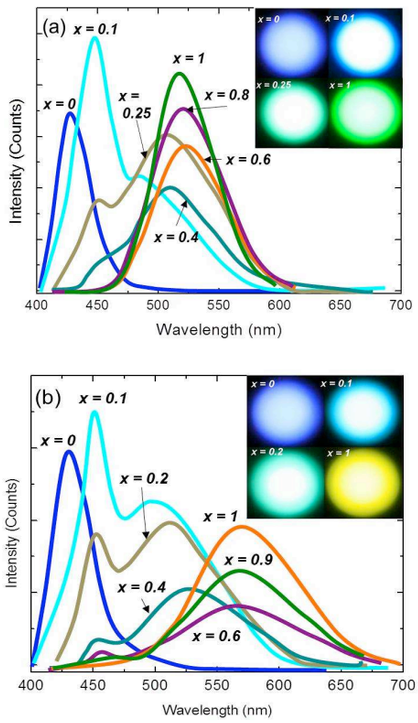

Figure 1. Photoluminescence emission spectra of Eu^{2+}-activated (a) $(KSrPO_4)_{1-x}•(Ba_2SiO_4)_x$ and (b) $(KSrPO_4)_{1-x}•(Sr_2SiO_4)_x$ at various x under 380 nm excitation. The insets are photos showing colors of the corresponding samples, which were taken with a 380 nm emitting UV-LED.

References.

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