Synthesis of $A_3B_8X_{15}$-type new oxynitride phosphors starting from a single crystal composition

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Recently, we reported a simple and rapid approach to discover novel phosphors. This approach is based on characterizing a single luminescent crystalline particle distinguished from a complex powder mixture by using single-crystal X-ray diffraction together with single-particle fluorescence imaging and spectroscopy techniques.[1] Using this approach, a blue single crystal with the composition of $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}:Eu^{2+}$ was discovered. Starting from the composition of the single crystal, we successfully prepared the phase-pure blue $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}:Eu^{2+}$ powder phosphor by using gas-pressure sintering.

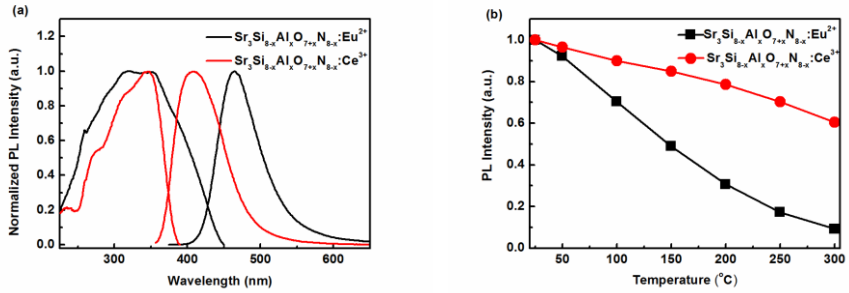

Figure 1. (a) Normalized excitation and emission spectra, and (b) thermal stabilities of $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}$: 2%$Eu^{2+}$ and $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}$: 3%$Ce^{3+}$ phosphors.

The emission spectrum of the $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}$:2%$Eu^{2+}$ powder phosphor measured under the 355nm, is shown in Fig.1(a). It shows a band emission with a peak maximum at 465 nm. The excitation spectrum monitored at 465 nm covers a broad range of 220-450 nm, which enables the phosphor to be used in UV-LEDs (Fig. 1a). The thermal stability of the $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}$:2%$Eu^{2+}$ phosphor is given in Fig. 1(b). The thermal quenching temperature is about 150 ^{o}C. The quantum efficiency of the blue phosphor is 42% under the 355 nm excitation. In addition, we also applied Ce^{3+} as an activator for $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}$. Under the 350 nm excitation, the $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}$:3%$Ce^{3+}$ phosphor exhibits a blue-violet band emission peaked at 410 nm (Fig. 1a).The excitation spectrum monitored at 410 nm also shows a broadband extending from ultraviolet part to 390 nm, which matches well with the emission of UV-LEDs. The $Sr_3Si_{8-x}Al_xO_{7+x}N_{8-x}$:3%$Ce^{3+}$ phosphor possess a better thermal stability, retaining its emission intensity of 85% at 150 °C, as shown in Fig. 1(b). Moreover, the phosphor has a higher quantum efficiency, which is 63% under the 350 nm excitation.

[1] N. Hirosaki, T. Takeda, S. Funahashi, and R. -J. Xie, *Chem. Mater.*, 26 (2014) 4280.