Poster

Synthesis and luminescence properties of Sm^{3+}-doped $Sr_3B_2SiO_8$ phosphors for near-UV pumped light-emitting diodes

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GaN-based white light-emitting diodes (LEDs), the so-called next generation solid-state lighting (SSL) technology, have attracted substantial attention for lighting, display, and scintillation applications because of their merits of high energy efficiencies, long operation lifetimes, lower power consumptions, and ecofriendly constituents.[1,2] White LEDs, therefore, are promising candidates to replace the conventional SSL sources in the coming future. However, there is still a trade-off between higher color rendering index (CRI) and higher luminance among these phosphors. Until now, the task of searching for efficient inorganic rare-earth phosphors with strong absorptions in the near-UV spectral region is still urgent and attractive.

In this abstract, we reported the $Sr_3B_2SiO_8$: $x$$Sm^{3+}$, $x$$Na^{+}$ (SBSO: $x$$Sm^{3+}$, $x$$Na^{+}$)phosphor system with *Pnma* space group by using high-temperature solid-state reactions. The crystal structure and overall luminescence performance (i.e., PL intensity, quantum efficiency, thermal-quenching behavior, and CIE coordinates) of the as-prepared phosphors were investigated for the first time. The results indicated that SBSO: $x$$Sm^{3+}$, $x$$Na^{+}$ phosphors could be efficiently excited by the near-ultraviolet light (400 nm) to realize three novel emission bands peaking at 561, 600, and 648 nm, respectively, corresponding to the characteristic emission transitions of $^4G_{5/2}$-^6H_J (J = 5/2, 7/2, and 9/2) of Sm^{3+} ions in the SBSO host. Based on the theoretical calculation, the dipole-dipole interaction was dominantly involved in the mechanism of concentration quenching of Sm^{3+} in the phosphors, and the critical distance (R_C) as well as the activation energy for thermal quenching (ΔE) were determined to be 16.12 Å and 0.21 eV, respectively. In addition, the effects of charge compensation on the luminescence behaviors of SBSO: $x$$Sm^{3+}$, $x$$M^{+}$), where M^{+} represented a monovalent cation like Li^{+}, Na^{+}, or K^{+} acting as a charge compensator, were also investigated in detail. In view of their strong absorption in the near-ultraviolet, the intense visible emitting light, as well as the relatively low thermal quenching, the Sm^{3+}-doped SBSO phosphors can serve as potential new materials for phosphor-converted LEDs.

Keywords: Borosilicate phosphor; $Sr_3B_2SiO_8$: Sm^{3+}; Luminescence; White LEDs

References

(1) Hashimoto, T.; Wu, F.; Speck, J. S.; Nakamura, S. *Nat. Mater.***2007**, *6*, 568.

(2) Lin, C. C.; Xiao, Z. R.; Guo, G. Y.; Chan, T. S.; Liu, R. S. *J. Am. Chem. Soc.***2010**, *132*, 3020.

(3) Sun, J. F.; Zhang, W. L.; Shen, D, Z.; Sun, J. Y. *J. Electrochem. Soc.***2012**, *159*, J107.

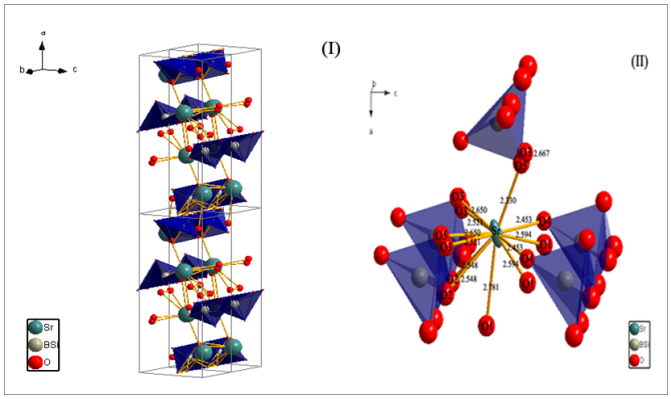

Figure 1 The sketch map of $Sr_3B_2SiO_8$ crystal structure (I), and coordinate environment around Sr atom (II) drawn by referring the crystallographic data in Ref. 3. Green, gray, and red spherical balls represent Sr, B/Si, and O atoms, respectively.

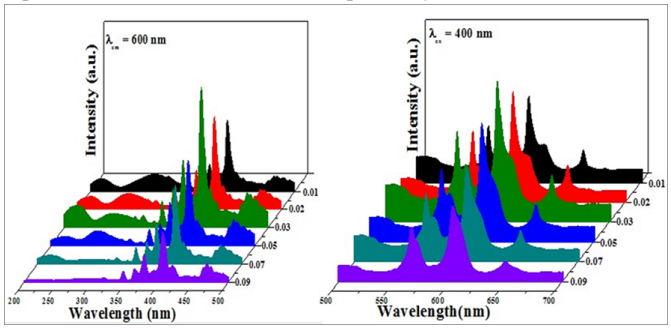

Figure 2 The PLE and PL spectra of SBSO: $x$$Sm^{3+}$, $x$$Na^{+}$ (x = 0.01-0.09, λ_{ex} = 600 nm, and λ_{em} = 400 nm.)

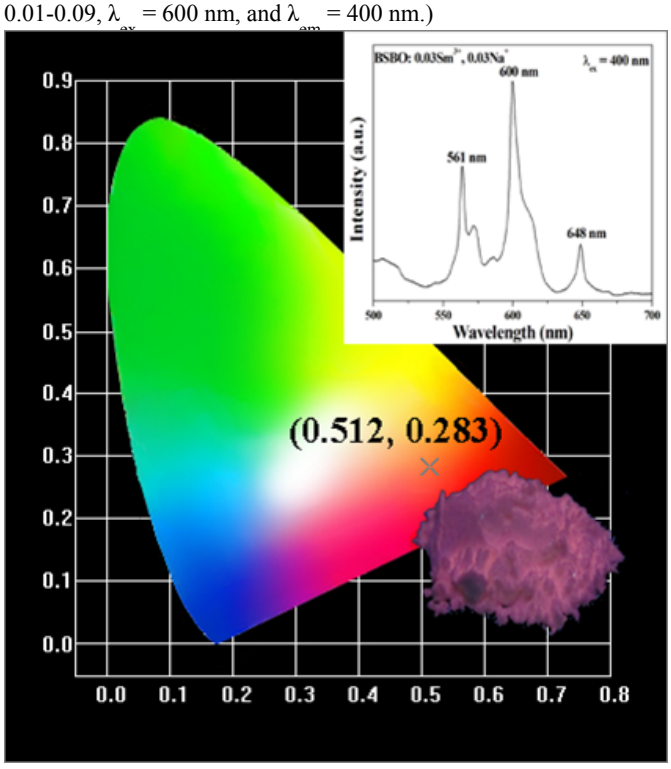

Figure 3 CIE chromaticity diagram from PL spectra of the SBSO: 0.03Sm^{3+}, 0.03Na^{+} phosphor excited at 400 nm. The inset below shows the image of the SBSO: 0.03Sm^{3+}, 0.03Na^{+} phosphor taken in the daylight and irradiated under 365 nm UV lamp box.