Blue-white-red color tunable emission of Tb^{3+}/Eu^{3+} co-doped $CaYAlO_4$ phosphors for WLEDs

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Rare earth ions (RE^{3+}) have been playing an important role in producing white LEDs (WLEDs). The commercially available WLEDs are usually produced by combining a blue emitting LED chip and a yellow emitting phosphor ($Y_3Al_5O_{12}:Ce^{3+}$) or by junction of a UV LED chip with tri-color (red, green and blue) phosphors. However, these two manufacturing methods have some defects. The first one shows low color rendering index, due to lack of red light emitters, while the other one presents host aging on the emission colors.[1,2] To overcome these problems, a single-phase full-color emitting phosphor, which can be excited under UV radiation, could be useful to generate white light emission. Based on that, a series of color tunable blue-white-red emitting $CaYAlO_4$:1% Tb^{3+}/x% Eu^{3+} (x = 0.1 - 10 mol% as function of Y^{3+}) phosphors were synthesized via citrate method and heat-treated at 1200 °C for 4 h. The structural and photoluminescent properties of the obtained materials were evaluated. The XRD analysis showed the formation of tetragonal structure of $CaYAlO_4$ without the presence of secondary phases. All of the XRD patterns are in accordance to the crystallographic card ICSD 72104, indicating that the doping of Tb^{3+} and Eu^{3+} did not generate any impurities or induce significant changes in the host structure. The photoluminescence spectra were collected between 400 and 750 nm. The luminescent colors can be tuned by adjusting the excitation energy and relative doping ratio Tb^{3+}/Eu^{3+} in $CaYAlO_4$. The white light emission consists of three emissions bands: blue and green, from $^5D_3$, $^5D_4 \rightarrow {}^7F_J$ transitions of Tb^{3+} and red, from $^5D_0 \rightarrow {}^7F_J$ transitions of Eu^{3+}. The materials $CaYAlO_4$:1% Tb^{3+}/x% Eu^{3+} (x = 0.3, 0.5, 0.7, 1.0 and 1.5 mol%) showed the following CIE chromaticity coordinates: (0.313, 0.311), (0.327, 0.340), (0.350, 0.332), (0.356, 0.307), (0.342, 0.323), which are very close to the standard white (0.333, 0.333).[2] Furthermore, it was observed that with increasing of Eu^{3+} concentration, the wavelength of excitation needed for white light emission generating ranging from 252 to 243 nm. The emission mechanism in $CaYAlO_4:Tb^{3+}/Eu^{3+}$ occurs mainly through the individual emissions of Tb^{3+} and Eu^{3+}. In this way, the above results indicate that $CaYAlO_4:Tb^{3+}/Eu^{3+}$ phosphor may have a potential application for WLEDs.

1. Perrella, R. V.; Nascimento Júnior, C. S.; Góes, M. S.; Pecoraro, E.; Shiavon, M. A.; Paiva-Santos, C. O.; Lima, H.; Couto dos Santos, M. A.; Ribeiro, S. J. L.; Ferrari, J. L.; *Opt. Mater.* **2016**, *57*, 45.

2. Xu, Y.; Wang, Y.; Shi, L.; Xing, L.; Tan, X.; *Opt. Laser Technol.* **2013**, *54*, 50.

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