

Synthesis of red phosphors $\text{YNbO}_4:\text{Eu}^{3+}$, Bi^{3+} by the Spray Pyrolysis process.

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Introduction

White light-emitting diodes (LEDs) can offer benefits in terms of high luminous efficiency, energy-saving, maintenance and environmental protection, therefore, they are called the next-generation solid-state light, the replacement of conventional incandescent and fluorescent lamps. Because UV LED can offer a higher efficient solid state light, more and more attention has been paid to the development of new phosphors, that can be excited in the range of near-UV (370–420nm) due to the necessity to increase the efficiency of white light emitting solid-state devices [1,2]. At present, $\text{Y}_2\text{O}_3:\text{Eu}^{3+}$ is often used as the red component for near UV InGaN-based LEDs. However, this sulfide-based phosphor is chemically unstable and has low efficiency. Therefore, it is important to find a new red phosphor source that can exhibit intense red emission with high absorption in the near UV spectral region [2]. This work reports the synthesis, characterization and photoluminescence properties of $\text{Y}_{(0.99-x)}\text{Eu}_{(0.01)}\text{Bi}_{(x)}\text{NbO}_4$ (where $x = 0.01, 0.05$ and 0.10% mol) obtained by spray pyrolysis process (SP). SP offers several advantages over conventional material processing techniques. The particles produced by SP are more uniform in composition than those produced by many other techniques due to the reaction being confined to a micrometer scale (within the droplet) [3].

Results and Discussion

Fig. 1 show the X-ray diffractograms of the samples annealed at 900 °C. All samples present peaks indexed to the tetragonal phase of YNbO_4 (JCPDS # 38-187). However, increasing bismuth concentration causes the onset of the phases indexed to the monoclinic Nb_2O_5 (JCPDS # 27-1312) and tetragonal BiOCl (JCPDS # 73-2060).

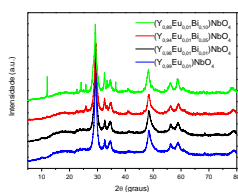


Figure 1. X-ray diffraction patterns for the samples $\text{Y}_{0.99}\text{Eu}_{0.01}\text{NbO}_4$, $\text{Y}_{0.98}\text{Eu}_{0.01}\text{Bi}_{0.01}\text{NbO}_4$, $\text{Y}_{0.94}\text{Eu}_{0.01}\text{Bi}_{0.05}\text{NbO}_4$, $\text{Y}_{0.89}\text{Eu}_{0.01}\text{Bi}_{0.11}\text{NbO}_4$.

Excitation spectra, fig. 2(a) show that Eu^{3+} and Bi^{3+} are both incorporated into YNbO_4 lattice, and the addition of Bi^{3+} provides the appearance of a peak at 306 nm assigned to $\text{Bi}^{3+} \rightarrow \text{O}^{2-}$ charge transfer band (CTB) [2]. Emission spectra reveal bands corresponding to the internal configuration transitions ${}^5\text{D}_0 \rightarrow {}^7\text{F}_J$ ($J = 0, 1, 2, 3$ and 4). Moreover, the photoluminescence properties showed a strong red-emission lines at 612 nm (FWHM ~ 4.5 nm), fig. 2(b).

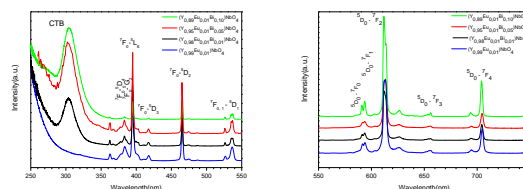


Figure 2. $\text{YNbO}_4:\text{Eu}^{3+}, \text{Bi}^{3+}$ luminescence spectra recorded at room temperature. a) excitation spectrum ($\lambda_{em} = 612$ nm) and b) emission spectra ($\lambda_{exc} = 306$ and 395 nm).

Conclusion

The results show that the SP process can produce red phosphors $\text{YNbO}_4:\text{Eu}^{3+}, \text{Bi}^{3+}$ nanoparticles with a wide excitation range (UV: 306 and 394 nm, Blue: 465 nm and Green: 535 nm). In addition, increasing bismuth concentration causes the onset of different crystalline structures (Nb_2O_5 and BiOCl). The CIE chromaticity coordinates of the samples were higher than NTSC standard values.

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