Synthesis and photoluminescence properties of $X_{(4.95\%)}NbO_4:Eu^{3+}_{(0.05\%)}$, (X = Y, La or Gd) obtained by the Non-Hydrolytic Sol-Gel methodology

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The phosphor-converted light-emitting diode technique is an important solid-state illumination strategy. It employs ultraviolet InGaN or GaN chips that pump tricolor phosphors to generate white light. An ultraviolet light emitting diode present a high light emission efficiency in the light emission wavelengths from 370 nm to 410 nm, and particularly, has the highest light emission efficiency at wavelengths around 390 nm. Sulfide-based materials are the most often employed phosphors, but they are chemically unstable and little efficient. To produce white light, the current phosphor materials based on near UV GaN-LEDs are $BaMgAl_{10}O_{17}:Eu^{2+}$ (BAM) for blue, $ZnS:(Cu^{+}, Al^{3+})$ for green, and $Y_2O_2S:Eu^{3+}$ for red. However, compared with the blue and green phosphors, the efficiency of $Y_2O_2S:Eu^{3+}$ is about eight times lower and a mixture containing 10% blue, 10% green and 80% red is necessary to obtain appreciable color rendering. Therefore, it is important to find a new red phosphor source that can emit intense red light while absorbing light in the near UV spectral region. In this context, Nb_2O_5 is transparent over a wide range of wavelengths (0.35-9.0 μm), it has a wide band-gap (3.6 eV), it is stable under near UV radiation, it has a relatively low cut-off phonon energy (900 cm^{-1}) and high refractive index (2.4). Therefore, this work reports the synthesis, characterization and photoluminescence properties of $X_{(4.95\%)}NbO_4:Eu^{3+}_{(0.05\%)}$, (where X = Y, La or Gd) obtained by the Non-Hydrolytic Sol-Gel methodology. These phosphors were annealed at 900 °C during 4h and characterized by X-ray diffraction and Raman and Photoluminescence spectroscopy. The X-ray diffractograms show a mixture of crystalline phases for the Nb_2O_5 and $XNbO_4$. The excitation spectra (λ_{em}: 613 nm) present that all samples display a broad band at 275 nm attributed to the charge transfer of NbO_4 and NbO_6 in the $XNbO_4$ system. Emission spectra reveal bands corresponding to the internal configuration transitions $^5D_0 \rightarrow {}^7F_J$ (J = 0, 1, 2, 3 and 4) and the CIE chromaticity coordinates are above or very close to the National Television Standard Committee (NTSC) standard values, which confirms the promising LED applications. In addition, all samples presented a wide excitation range, including the light emission region of a light emitting diode emitting UV (275, 394 nm), the blue (465 nm) and green (525 nm) light.