Influence of Dysprosium incorporation on the Structure and Luminescence Properties of $LaNbO_4$ White Phosphor

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Spray pyrolysis (SP) is an aerosol process commonly used to form or process a wide variety of materials in powder form including metals, metal oxides, non-oxide ceramics, superconducting materials, fullerenes, and nanophase materials. The process involves the nebulization of a precursor solution into droplets which are then directed through a heated region, usually a reaction furnace, by a carrier gas and the solvent evaporation is complete within a few seconds while currently available methods require several hours or days to complete this process. Spray pyrolysis offers several advantages over conventional material processing techniques. The particles produced by spray pyrolysis 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). This work reports the synthesis and characterization (X-ray diffraction, scanning electron microscopy and photoluminescence spectroscopy) of $(La_{1.0-x}\ Dy_{\ x})NbO_4$, (where $0.025 \leq x \leq 0.15$ % in mol) obtained by SP process. The X-ray diffraction patterns showed that the concentration of Dy^{3+} ions did not alter significantly the structure of the crystal. However, the reflections corresponded to a mixture of the monoclinic (JPCDS 22-1125) and tetragonal (JPCDS 50-919) phase of $LaNbO_4$. The SEM images revealed a polydispersed size distribution (50 nm up to 2 µm) with a spherical rough surface. The excitation spectra presented narrow bands assigned to the Dy^{3+} transitions. In addition, a broad band around 254 nm appeared regardless of the concentration of Dy^{3+} ions; this band resulted from charge transfer (CTB) attributed to Nb^{5+} 4d orbitals and the valence band of O^{2-} 2p orbitals. The emission spectrum ($\lambda_{exc.}$: 254 nm – Transfer Charge Band) showed the transitions of the excited state $^4F_{9/2}$ to fundamental state $^6H_{15/2}$ with two peaks at 478 and 488 nm; the $^4F_{9/2} \rightarrow {}^6H_{13/2}$ and $^4F_{9/2} \rightarrow {}^6H_{11/2}$ transitions at 575 and 664 nm, respectively. The increase of Dy^{3+} ions concentration promotes a variation of the CIE chromaticity coordinates to the white color. For the $(La_{0.95}Dy_{0.05})NbO_4$ the CIE coordinates were X = 0.33 and Y = 0.33.

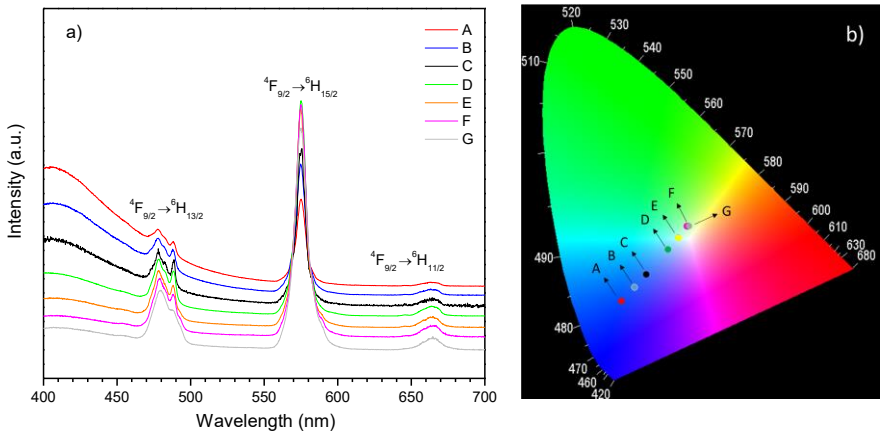

Figure 1: a) Emission spectrum (λ_{ex}: 254 nm) $(La_{\ 1.0-x}\ Dy_{\ x})NbO_4$ e b) CIE coordinates (A x=0.025; B x= 0.05; C x=1.00; D x=3.00; E x=5.00; F x=10.00 e G x=15.00 % mol) of Dy^{3+} ion.