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Highly efficient infrared to visible up-conversion emission tuning from red to white in Eu/Yb co-doped NaYF₄ phosphor

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Abstract

Eu/Yb co-doped NaYF₄ phosphors have been synthesized by the combustion method. The Eu doping was fixed and the effect of Yb doping concentration on the structural, morphological and luminescence properties has been investigated. X-ray diffraction analysis revealed that the phosphors consisted of mixed α - and β -phases, but the β -phase was dominant. All elements of the host and dopants, as well as adventitious C, were detected using X-ray photoelectron spectroscopy. The surface morphology showed a microrod-like structure with sharp hexagonal edges. Energy dispersive X-ray spectroscopy spectra proved the formation of the desired materials. The photoluminescence spectra illustrated the optical emission properties of Eu³⁺ in the red region when excited at 394 nm, while, under the same excitation, Yb³⁺ ions gave emission at 980 nm. The up-conversion (UC) emission of Eu/Yb co-doped NaYF₄ produced a white color at the higher concentration of Yb excited by a 980 nm laser, which was made possible by green emission of Er contamination (from Yb source) and blue emission of Eu²⁺ ions. The lifetime of the Eu³⁺ UC luminescence at 615 nm was also affected by the Yb doping concentration. The temperature sensitivity associated with the Er³⁺ peaks at 520 and 542 nm was assessed as a function of temperature and the maximum of 0.0040 K⁻¹ occurred at 463 K.

Keywords: NaYF₄; Phosphor; Up-conversion; White light emission; Temperature sensitivity.

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