Accepted Manuscript

Upconversion Multicolor Tuning of $NaY(WO_4)_2$: Tb^{3+} with Eu^{3+} Doping

Zhongxiang Shi, Jing Wang, Xin Guan

PII: S1002-0721(18)30321-1

DOI: 10.1016/j.jre.2018.01.021

Reference: JRE 165

To appear in: *Journal of Rare Earths*

Received Date: 3 November 2017

Revised Date: 14 January 2018

Accepted Date: 15 January 2018

Upconversion Multicolor Tuning of $NaY(WO_4)_2$: Tb^{3+} with Eu^{3+} Doping

Zhongxiang Shi, Jing Wang*, Xin Guan

(Liaoning Key Laboratory for Fabrication and Application of Superfine Inorganic Powders, Dalian Jiaotong University, Dalian 116028, China)

Abstract: A series of Tb^{3+} and Eu^{3+} co-doped $NaY(WO_4)_2$ phosphors were synthesized by hydrothermal reactions. The crystal structure, morphology, upconversion luminescent properties, the energy transfer from Tb^{3+} to Eu^{3+} ions and the $^5D_4 \rightarrow ^7F_5$ transition of the Tb^{3+} ion in $NaY(WO_4)_2$:Tb^{3+},Eu^{3+} phosphors were investigated in details. The results indicate that all the synthesized samples are of pure tetragonal phase $NaY(WO_4)_2$. Furthermore, the micrometer-sized needle spheres and excellent dispersion of the particles are obtained by adding polyethylene glycol (PEG-2000) as the surfactant. Phosphors of $NaY(WO_4)_2$:Tb^{3+},Eu^{3+} exhibit the 492 nm blue emission peak, 546 nm green emission peak, 595 nm orange emission peak and 616 nm red emission peak under 790 nm excitation. The energy transfer from Tb^{3+} to Eu^{3+} is a resonant transfer, in which electric dipole-dipole interaction plays a leading role. By adjusting the doping concentration of Eu^{3+} in $NaY(WO_4)_2$:1.0 mol%Tb^{3+},*x*mol%Eu^{3+} phosphors, the emitting color of UC phosphors can be tuned from green to red.

Key words: up-conversion luminescence; $NaY(WO_4)_2$:Tb^{3+},Eu^{3+}; polyethylene glycol; energy transfer; Rare earths

1. Introduction

Photon upconversion (UC), converting low-energy photons to higher-energy photons, is an anti-Stokes luminescence phenomenon[1]. In recent years, upconversion luminescence materials have been paid much attention owing to their applications in various fields, such as 3D imaging[2], fiber drawing materials[3], temperature sensing[4], color display[5], biological imaging[6]. Especially in the field of biomedicine, upconversion luminescence materials have the characteristics of low energy requirement when compared with traditional fluorescence bioluminescence imaging. Using near infrared light as excitation light not only meets the requirement of penetration depth, but also has less damage to biological tissue. Moreover, the low toxicity and good stability of the material can reduce the damage to the biological tissue. Shifting the excitation wavelength to ≈800 nm can effectively avoid the self fluorescence interference in the biological tissue, thereby improving the sensitivity of detection. The use of upconversion luminescent materials for study biological imaging is one of the most ideal methods[7,8].

Foundation item: Project supported by the National Key Research and Development Program of China (2017YFB0310300), National Natural Science Foundation of China(51274052), Natural Science Foundation of Liaoning Province(201602134) and Department of Education Liaoning Province (JDL2016002)

* **Correspondent author**: J. Wang (**E-mail:** wangjing@djtu.edu.cn; **Tel**.: + 86-411-87109776)

In several common upconversion co-doped systems, the 980 nm laser is often used as the excitation light source. This is because the energy gap between $^2F_{5/2}$ and $^2F_{7/2}$ of Yb^{3+} just coincides