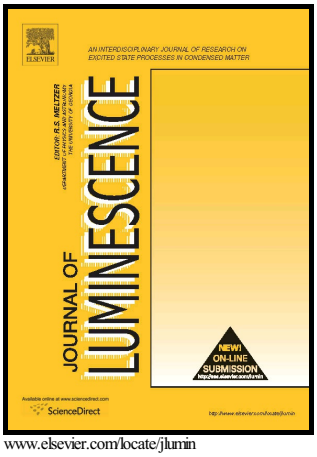

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Tuning of the up-conversion emission and sensitivity of luminescent thermometer in $LiLaP_4O_{12}$:Tm,Yb nanocrystals via Eu^{3+} dopants

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KEYWORDS tetraphosphates, up-conversion, nanocrystals, luminescent thermometer

Abstract

Up-converting properties of $LiLaP_4O_{12}$:1%Tm^{3+}, 50%Yb^{3+}, x% Eu^{3+} nanocrystals were investigated upon 975 nm excitation. It was shown that their emission color can be tuned from blue to orange via changing Eu^{3+} concentration from 10% to 49%. The potential suitability of these nano-phosphors for non-contact temperature sensing was investigated. Thermal changes of luminescence intensity ratio of $^1D_2 \rightarrow {}^3F_4$ and $^1G_4 \rightarrow {}^3F_4$ emission bands of Tm^{3+} ions were strongly affected by Eu^{3+} concentration owing to increasing efficiency of distance-dependent $Tm^{3+} \rightarrow Eu^{3+}$ energy transfer. The sensitivity of such luminescence thermometer was varying from 0.1 %/^{o}C to 1.9%/^{o}C in response to varying Eu^{3+} concentration from 49 down to 10 %.

Introduction

Photon upconversion is a process that relays on the conversion of photon of low energy (usually corresponding to near infrared wavelength) to UV and visible photons[1]. Upconversion process is especially suitable for *in vitro* as well as *in vivo* bioimaging owing to numerous advantages of anti-Stokes emission over Stokes one[2-4]. The most important of them is NIR excitation wavelength being less scattered or dumped by biological tissues as compared to shorter wavelength radiation, what enables extending the usable light penetration depth range for bio-imaging of nanoparticles. Moreover, the autofluorescence of biological tissue is minimized at NIR excitation wavelengths, which significantly improves spectral resolution of emission detection. The most spectacular feature of lanthanide ions, which are typically exploited in bio-related applications is their narrowband emission and low susceptibility of their emission bands' position to chemical environment. Therefore, upconversion emission of such nanoparticles can be considered as a fingerprint of given type of emitting ions. The most common lanthanide ions used for upconversion generation are erbium (with green and red emission bands centered at 520 and 550 nm and 650 nm respectively) [5-11, 13, 16], thulium (UV 320 nm, blue 450, 475 nm and NIR 800 nm