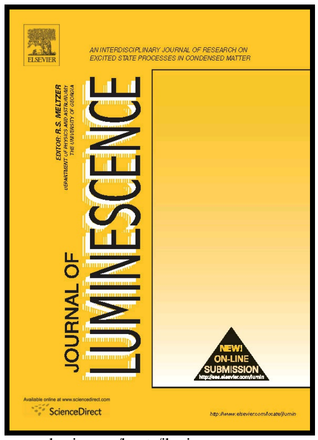
Author's Accepted Manuscript



www.elsevier.com/locate/jlumin

$LaAlO_3:Cr^{3+}$, Sm^{3+}: nano-perovskite with persistent luminescence for *in vivo* optical imaging

M. Pellerin, E. Glais, T. Lecuyer, J. Xu, J. Seguin, S. Tanabe, C. Chanéac, B. Viana, C. Richard

PII: S0022-2313(17)32096-3
DOI: https://doi.org/10.1016/j.jlumin.2018.05.024
Reference: LUMIN15606

To appear in: *Journal of Luminescence*

Received date: 4 December 2017
Revised date: 8 May 2018
Accepted date: 9 May 2018

Cite this article as: M. Pellerin, E. Glais, T. Lecuyer, J. Xu, J. Seguin, S. Tanabe, C. Chanéac, B. Viana and C. Richard, $LaAlO_3:Cr^{3+}$, Sm^{3+}: nano-perovskite with persistent luminescence for *in vivo* optical imaging, *Journal of Luminescence,* https://doi.org/10.1016/j.jlumin.2018.05.024

$LaAlO_3$:Cr^{3+}, Sm^{3+}: nano-perovskite with persistent luminescence for *in vivo* optical imaging

M. Pellerin[a,b], E. Glais[a,b], T. Lecuyer[c], J. Xu[d], J. Seguin[c], S. Tanabe[d], C. Chanéac[a], B. Viana[b], C. Richard[c]

[a]*Sorbonne Universités, UPMC Univ Paris 06, CNRS, Collège de France, LCMCP, Paris, France*
[b]*PSL Research University Chimie ParisTech, IRCP, CNRS, Paris 75005, France*
[c]*UTCBS, UMR 8258 CNRS, U1022 Inserm, Sorbonne Paris Cité, Faculté de Pharmacie de Paris, France*
[d]*Graduate School of Human and Environmental Studies, Kyoto University, Kyoto, Japan*

Abstract

Persistent luminescence (PersL) nanoparticles offer attractive capabilities for *in vivo* imaging applications as an optical excitation of the nanoparticles outside the animal before injection is possible. Therefore, long-lasting emission of light allows performing *in vivo* imaging with high signal to noise ratio and with high sensitivity. Here we report the development of $LaAlO_3$ (LAO) nano-perovskite doped with Cr^{3+} and Sm^{3+}, the trivalent chromium cation being the recombination center, while Sm^{3+} is used to enhance the persistent properties. Nanoparticles are synthesized by co-precipitation method and are tailored to present deep red persistent luminescence at 734 nm due to the Cr^{3+}: $^2E(^2G) \rightarrow {}^4A_2(^4F)$ transition after UV excitation. The intense deep red PersL matches well with the first biological window (650–950 nm). These nanoparticles have been successfully functionalized with polyethylene glycol (PEG) and the stealth obtained nanoparticles were tested for the first time for imaging on small animal in order to have access to their *in vivo* biodistribution.

Keywords: persistent luminescence; nanoparticles; perovskite; bioimaging

1. Introduction

Optical imaging constantly demands more sensitive tools for biomedical research and medical applications [1-7]. Persistent luminescence nanoparticles (PersL) emitting in the deep red range have been recently introduced to enable highly sensitive *in vivo* imaging on small animals [1-6]. These nanomaterials are able to emit light once the excitation source is cut off. For such applications, persistent luminescence must emit in one of the biological windows, where tissues are the most transparent [7, 8]. We have recently introduced the use of persistent luminescence nanoparticles for *in vivo* bioimaging applications in living animals [2, 9-13]. To date, mainly Cr^{3+}-activated persistent phosphors have been studied since their transition wavelengths are suitable for *in vivo* applications, being coincident with the high transmittance range of biological tissues, such as $ZnGa_2O_4$:Cr^{3+} (PersL peaking at 695 nm) or $LiGa_5O_8$:Cr^{3+} (peaking at 716 nm) [14] but only few of them have been studied at the nanoscale [15, 16].

Persistent luminescence properties in the case of $ZnGa_2O_4$:Cr^{3+} can be improved by adding a co-dopant or by modifying the matrix [17]. For instance, Zhuang *et al*. [18] proposed to add Bi^{3+} ions as a co-dopant to improve the persistent luminescence properties. We confirm this results at the nanoscale by showing that Bi^{3+} ions contribute to decrease the disorder in the structure [19]. Allix *et al*. showed that by substituting some of the Ga^{3+} ions by Ge^{4+} ions,