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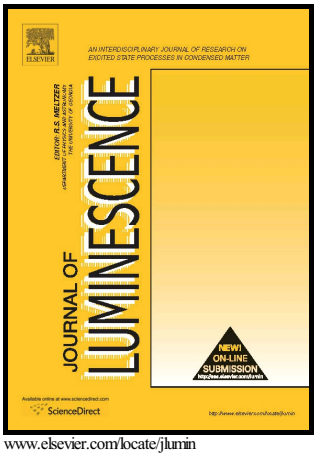

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Impact of plasmonic nanoparticles on up-conversion luminescence and efficiency of Erbium-doped ceria nanoparticles under 780nm excitation

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Abstract

Up-conversion process is being widely studied due to its enormous applications such as bioimaging, energy harvesting, and optical sensors. However, low conversion efficiency can limit these applications. In this paper, a detailed study about the effect of using plasmonic metallic nanostructures is presented, which aims to support the up-conversion process under 780nm excitation. The targeted material is erbium-doped ceria material due to its promising optical properties along with relatively low-phonon nature of ceria host. At average distance of 0.67 nm between Er ions, the efficiency can be improved from 1.584% to 3.327% for green emission and from 0.007% to 0.035% for red one, which corresponds to 5-fold and 2.1-fold respectively. Also, some other parameters such as irradiance and multi-phonon relaxations and their impact on the efficiency, according to the added gold nanoparticles are studied. Such promising modeling results can help in further studies regarding the addition of metallic nanoparticles to improve the quantum conversion efficiency due to its plasmonic effect.

Keywords: Erbium, up-conversion, plasmonics, gold nanoparticles, ceria, quantum efficiency

1. Introduction

Up-conversion (UC) is a process that converts photons of lower energy to ones of higher energy by the help of optical pump signal. The rare earth lanthanide-doped materials are very auxiliary for UC because of its advantages of converting form infra-red (IR) to visible light [1-3]. A variety of applications ranging from bio-imaging/medical therapy [4-7], to lasers [8, 9], and photovoltaics