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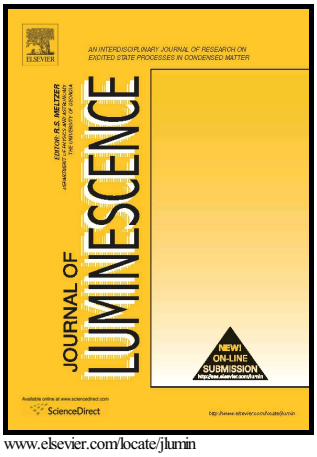

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PII: S0022-2313(18)30622-7
DOI: https://doi.org/10.1016/j.jlumin.2018.07.033
Reference: LUMIN15780

To appear in: *Journal of Luminescence*

Received date: 9 April 2018
Revised date: 21 July 2018
Accepted date: 23 July 2018

Cite this article as: F. Ahmadi, R. Hussin and S.K. Ghoshal, On the optical properties of Er^{3+} ions activated magnesium zinc sulfophosphate glass: Role of silver nanoparticles sensitization, *Journal of Luminescence,* https://doi.org/10.1016/j.jlumin.2018.07.033

On the optical properties of Er^{3+} ions activated magnesium zinc sulfophosphate glass: role of silver nanoparticles sensitization

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Abstract

Effects of silver (Ag) nanoparticles (NPs) on the physical and optical properties of erbium ions (Er^{3+}) doped magnesium zinc sulfophosphate glasses of composition (59.5-*x*)P_2O_5-20.0MgO-20.0$ZnSO_4$-0.5Er_2O_3-*x*AgCl (where $x \leq 1.5$ mol%) were examined. Transparent bubble free glasses were prepared using melt quenching method. As-quenched samples were characterized by transmission electron microscopy (TEM), X-ray diffraction (XRD), Fourier transform infrared (FTIR), ultraviolet-visible (UV-Vis) absorption and photoluminescence (PL) spectroscopy to determine the feasibility of achieving their improved optical properties useful for photonic devices. Furthermore, Judd-Ofelt intensity and radiative parameters were evaluated to complement the experimental observations. XRD patterns of as-quenched samples confirmed their amorphous nature. TEM images of glasses revealed the nucleation of Ag NPs with average size of 10 nm. UV-Vis spectra of glasses exhibited nine absorption bands assigned to 4f-4f transitions of Er^{3+} ions. An enhancement in the PL emission intensities corresponding to the $^2H_{11/2} \rightarrow {}^4I_{15/2}$ and $^4S_{3/2} \rightarrow {}^4I_{15/2}$ transitions by a factor of 6 and 5 were achieved. Such enhancement was attributed to the local field effect (LFE) stimulated by the surface plasmon resonance (SPR) of Ag NPs alongside energy transfer mechanism among Er^{3+} ions and Ag NPs.

Keywords: Sulfophosphate glass, Silver nanoparticle, Surface plasmon resonance, Er^{3+} ion, optical properties

1. Introduction

Metallic nanoparticles (MNPs) embedded rare earth ions (REIs) doped glasses are useful for varieties of applications due to their excellent third-order nonlinear optical performance and enhanced absorption through surface plasmon resonance (SPR) [1, 2]. Recently, light energy up-conversion luminescence of such nonlinear optical glasses generated renewed interests in biological labeling and solar near infrared concentration for photovoltaic applications [3, 4, 5, 6, 7]. Meanwhile, REIs doped crystals and glasses