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Spectral Characteristics of Er^{3+} Doped Magnesium Zinc Sulfophosphate Glasses

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Abstract

This paper evaluates the spectroscopic properties of the Erbium (Er^{3+}) ions doped magnesium zinc sulfophosphate glass system synthesized via melt-quenching method. Prepared glass samples are characterized using UV-Vis-NIR absorption and photoluminescence (PL) spectroscopy to determine the Er^{3+} ions concentration dependent spectral characteristics. The absorption spectra displayed nine prominent absorption bands aroused from the the ground state ($^4I_{15/2}$) to the excited state ($^4I_{13/2}$, $^4I_{11/2}$, $^4I_{9/2}$, $^4F_{9/2}$, $^2H_{11/2}$, $^4F_{7/2}$, $^4F_{3/2}$, $^2H_{9/2}$ and $^4G_{11/2}$) transitions of Er^{3+} ion. The intensity parameters (Ω_2, Ω_4 and Ω_6) and radiative properties associated to the spectral transitions of Er^{3+} ion are calculated using Judd-Ofelt (JO) expressions. Room temperature PL spectra revealed two significant emission bands centered at 541 and 654 nm. Appearance of luminescence intensity quenching beyond 1 mol% of Er^{3+} is attributed to the cross-relaxation mechanism. The value of stimulated emission cross-section for $^4S_{3/2} \rightarrow {}^4I_{15/2}$ spectroscopic transition in Er^{3+} ion is found to be very high (85.8211×10^{-22} cm^2). Present glass composition is demonstrated to be advantageous for various photonic applications.

Keywords: Sulfophosphate glass, Er^{3+}-doped glass, Hypersensitive transition, Judd-Ofelt parameters, Radiative properties, Energy transfer

1. Introduction

In recent years, optical absorption and luminescence properties of the rare earth ions (REIs) doped borate, silicate, phosphate and tellurite based glasses have been widely investigated. These materials are demanded for various technological and commercial applications including fluorescent display devices, optical detectors, bulk lasers, optical fibers, waveguide lasers and optical amplifiers, optical fibers for telecommunication and the fabrication of new opto-electronic devices [1, 2, 3, 4]. Generally, for developing various optical devices, REIs such as Eu^{3+}, Sm^{3+}, Dy^{3+}, Er^{3+} and Pr^{3+} have been exploited [5, 6]. In this regard, selection of good glass host is very crucial to achieve efficient luminescence of REIs. Among oxide glasses, phosphate glasses have received much attention compare to silicate and borate glasses due to their unique characteristics include high transparency, low melting point, high thermal stability, high gain density that is mainly due to high solubility of RE ions besides low refractive index