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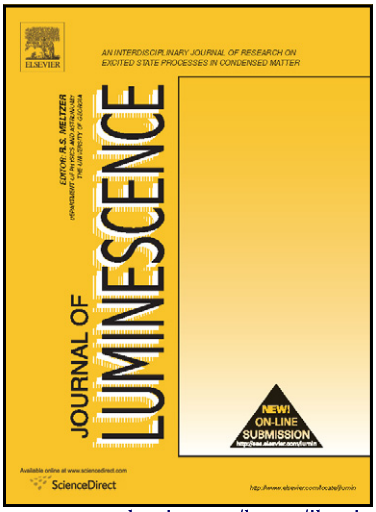

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Spectroscopic properties of Er^{3+} ions in multicomponent tellurite glasses

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Abstract

In the present work, multicomponent tellurite glasses were elaborated by the melt quench technique with different concentrations of Er^{3+} ions. Amorphous nature of all the glasses was confirmed using X-ray diffraction patterns. The thermal parameters, such as glass transition temperature (T_g) and the onset of crystallization temperature (T_X) were determined by the differential scanning calorimetry. Judd-Ofelt parameters were derived for 0.5 mol% Er^{3+} -doped glass from the absorption measurements, and in turn, used to find the radiative properties of $^4S_{3/2}$, $^2H_{11/2}$ and $^4I_{11/2}$ levels of Er^{3+} ion. A green emission corresponding to $^4S_{3/2} \rightarrow {}^4I_{15/2}$ and $^2H_{11/2} \rightarrow {}^4I_{15/2}$ transitions of Er^{3+} ions was observed in the glasses under investigation. Efficient green upconversion luminescence was observed under 976 nm excitation. The emission bands centered at 529 and 543 nm confirmed that two photons contribute to the upconversion processes. We have also analyzed the dependence of downconversion as well as upconversion as a function of Er^{3+} ion concentration, which shows quenching of photoluminescence intensity above 0.5mol % doping. From the emission spectra, CIE color coordinates of 0.5 mol% Er^{3+} -doped glass was examined. Fluorescence decay curves for the $^4S_{3/2} \rightarrow {}^4I_{15/2}$ transition for all the glasses have been measured and analysed. Absorption cross-section and calculated emission cross-section, using the McCumber method, for the $^4I_{13/2} \leftrightarrow {}^4I_{15/2}$ transitions, were evaluated and discussed.

Keywords: Erbium, Tellurite glasses, Fluorescence properties, Judd-Ofelt analysis, Upconversion, McCumber theory

1. Introduction

Optical properties of trivalent rare earth (RE^{3+}) ions doped glassy materials have better prospects to be exploited as good candidates for employment in laser technology [1]. It also plays a vital role in fabricating IR-visible up-converters, optical fibers, waveguides and fiber amplifiers for optical transmission network. Compositional changes carried out systematically in the host matrices may well dictate the optical properties by modifying its covalency and local structure [2]. Erbium has proven its role as a dopant for infrared pumped visible luminescence and laser emission. In particular, lasing at the green transition $^4S_{3/2} \rightarrow {}^4I_{15/2}$ of Er^{3+} leads to excellent results while doped in host matrices [3]. Er^{3+} -doped glasses also significant, since they have very good applicability in the development of infrared lasers and optical amplifiers [4]. They are widely studied for possible laser applications, especially in the spectral range 1.53 μm ($^4I_{13/2} \rightarrow {}^4I_{15/2}$), since they have a low loss in optical waveguides. For the past few years, Er^{3+} doped tellurite glasses and fiber amplifiers based on tellurites have gained attention, because of the demand for high transmission capacity of Wavelength- Division- Multiplexing (WDM) networks. Tellurium based erbium doped fiber amplifier (EDFA) have a wide gain spectrum and thus provides a number of channels for carrying large information. It is also known to be a valid candidate for 1.5 μm broad band optical amplifier. Comparing with other oxide glasses, tellurite based glass systems have peculiarities like effective high refractive index, low phonon energy, good rare earth ion solubility, etc.