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Optical investigation of erbium doped lead tellurite glass: Judd-Ofelt Analysis

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Abstract

Understanding the absorbance characteristics in topically important rare earth doped tellurite is the issue. The characterizations of optical properties of these glasses are very important for the optimization and nanophotonic applications. The superior nonlinear optical properties, low phonon cutoff, and high quantum efficiency amongst many other characteristics make them promising for potential applications. All of these considerations comprise a powerful control feature for the fabrication of rare-earth doped tellurite glass. In the present work, the absorbance effects of Er^{3+} doped tellurite glasses synthesized by melt-quenching technique have been investigated. The measured absorption spectra were analysed by Judd-Ofelt. Our findings may provide some useful information towards the development of functional glasses.

Keywords: Tellurite glass; Rare-earth; Melt-quenching; Absorbance; Judd-Ofelt.

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1. Introduction

Interest in tellurite glass containing rare earth element are expected for nonlinear optical devices as for their large third-order nonlinear optical susceptibility [1-4]. They are not only resistant to atmospheric moisture but also allow incorporating large concentration of rare-earth ions into the matrix [5]. The Er^{3+} doped lead-tellurite glass has been prepared using the conventional melt-quenching method. The results for the optical absorption related to optically-induced transitions and the band arrangement are presented. The main objective is to examine the absorption of the Er_2O_3 doped TeO_2 - PbO - $PbCl_2$ by using UV-Vis measurements. The measured absorption spectra are analysed by Judd-Ofelt analysis.

2. Experimental Procedure

A series of glasses of the form (80-x)TeO_2 - 15PbO - 5$PbCl_2$ - (x) Er_2O_3 with ($0.5 \le x \le 1.5$ mol%) are prepared by using melt quenching technique. The density and refractive index of the glass are measured. The room temperature optical absorption of these samples is measured in the wavelength range of 200-1000 nm using UV-VIS-NIR spectroscopy.

3. Results and Discussion

Figure 1 shows the UV-Vis-NIR absorption spectra for all the TeO2 - PbO - $PbCl_2$ - Er^{3+} glasses. The absorption spectrum consists of seven prominent absorption peaks at 490, 526, 551, 652, 800, 982 and 1520 nm corresponding to the absorptions from the ground state $^4I_{15/2}$ to the excited state $^4F_{7/2}$, $^2H_{11/2}$, $^4S_{3/2}$, $^4F_{9/2}$, $^4I_{9/2}$, $^4I_{11/2}$ and $^4I_{13/2}$ levels respectively. These results are in agreement with other researcher [6, 7]. The experimental oscillator strengths, f_{exp}, of the transitions can be determined by analyzing further the absorption spectrum for each band as shown in previous research [6]. The calculated oscillator strength f_{cal} can be determined by the isolation of both electric-dipole and magnetic-dipole contribution from f_{exp} [6]. Both experimental and calculated oscillator strengths of Er^{3+} = 1.0mol% were shown in Table 1.

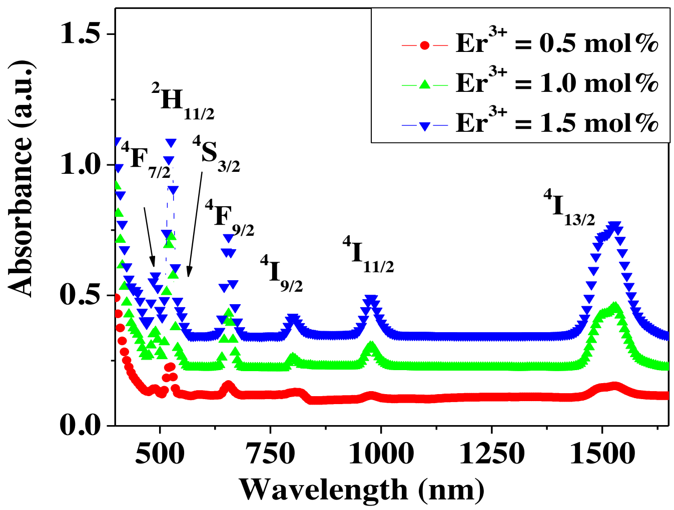

Fig. 1. Absorption spectra of glasses for varying concentration of Er^{3+} ions.