



## Comprehensive study on the nonlinear optical properties of lanthanum nanoparticles and lanthanum oxide doped zinc borotellurite glasses

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### HIGHLIGHTS

- Lanthanum element doped zinc borotellurite glasses were successfully fabricated.
- FTIR proved the existence of TeO<sub>4</sub>, TeO<sub>3</sub>, BO<sub>4</sub> and BO<sub>3</sub> in the prepared glass.
- Nonlinear optical properties of the glasses were extensively investigated.
- Inconsistent trends in the nonlinear parameters are due to structural changes.
- La NPs doped glass can possibly be used as efficient optical switching device.

### ARTICLE INFO

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Figure of Merit

### ABSTRACT

Recently, the rapid growth in photonic field has increased the demand for nonlinear materials with higher performance and greater efficiency. Hence, a thorough investigation on the nonlinear optical properties of materials are essential and need to be done for possible future application of the material in photonic field as optical limiting or optical switching devices. Thus, through this research, the crucial parameters in nonlinear optical properties of zinc borotellurite glasses doped with lanthanum oxide and lanthanum nanoparticles were studied and investigated extensively. The two series of glasses were successfully fabricated via conventional melt-quenching technique. The fabricated samples were characterized by using Fourier Transform Infra-Red (FTIR) spectroscopy as well as Z-scan technique in order to study the structural and nonlinear optical properties of the glass systems. The existence of various amount of TeO<sub>4</sub>, TeO<sub>3</sub>, BO<sub>4</sub> and BO<sub>3</sub> in all the prepared glasses are proven through the observable absorption bands in the FTIR spectra. Inconsistent trends recorded for both nonlinear absorption coefficient and nonlinear refractive index might be associated with the simultaneous creation of bridging as well as nonbridging oxygen which eventually affect the values for both parameters. The figure of merit of the prepared glasses with values ranging from 0.055 to 0.267 which are smaller than one hints that the glass materials possess potential to be employed as all optical devices. 0.03 M fraction of lanthanum nanoparticles doped zinc borotellurite with FOM value larger than 1 has proven the ability of the respective glass to be employed as efficient all optical switching devices. The determined nonlinear optical parameters of the glasses should be able to provide sufficient and useful information on the fabricated glass samples for future application in photonic field.

### 1. Introduction

Nonlinear optical properties of materials are one of the most potential approach used for controlling a light signal through another light beam for optoelectronic and photonic application [1]. Materials with nonlinear absorbing capability which possess various nonlinear

absorption process such as saturable absorber, reverse saturable absorption and two-photon absorption have great potential to be applied in science and technology field [2]. Meanwhile, materials possessing high third-order nonlinear susceptibility with response times of less than a subpicosecond are essential for all-optical signal processing in integrated and fiber optics [3]. Previous researches indicates that

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