SYNTHESIS, GROWTH AND CHARACTERIZATION OF NON- LINEAR OPTICAL MATERIAL OF BISTHIOUREA ZINC BORATE BY SLOW EVAPORATION METHOD

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Abstract: *The nonlinear optical crystal of Bisthiourea Zinc Borate was synthesized and the crystals (BTZB) were grown by slow evaporation solution growth technique at room temperature using ethanol as solvent. The grown crystals were characterized by Powder XRD, FTIR, UV- VIS - NIR and fluorescence spectral analyses. The powder X-ray diffraction pattern shows a high degree of crystallinity of the grown crystals. The FTIR spectrum was recorded in the region 400 – 4000 cm^{-1} to identify the presence of functional groups. The transparency of the crystal was tested using UV - VIS - NIR spectral analysis. Florescence spectrum recorded shows a peak at 513 nm. The SHG efficiency of BTZB was measured by the Kurtz powder technique.*

Key words: *FTIR, UV-Visible, Powder XRD, SHG Efficiency.*

1. INTRODUCTION

Bisthiourea zinc borate(BTZB) is a promising material that plays an important role in piezoelectric, ferroelectric, electro optic and nonlinear optical industries. This material attracts the many researchers probably because of their simple structure and many desirable properties associated with a hydrogen bond system involving a large isotopic effect, broad transparency range, high laser damage threshold and relatively low production cost. Nonlinear optics (NLO) has wide applications in the field of telecommunication, photonics and optoelectronics technologies [1-5]. New nonlinear optical frequency conversion materials have a significant impact on laser technology, optical communication and optical data storage. Recent interest in quantum electronics has focused on finding new materials for efficient second harmonic electro optic modulation.The organometallic complexes have been proposed as new materials with interesting nonlinear optical properties as they possess high thermal and mechanical stability. The present work deals with the synthesis, growth, powder XRD, FTIR,UV – VIS – NIR, Fluorescence and SHG studies of BTZB material.

2. MATERIAL SYNTHESIS AND CRYSTAL GROWTH

The title compound was grown by slow evaporation solution growth technique. Bisthiourea and zinc borate were taken in 1:1 stoichiometric ratio as starting material without purification to synthesize the title compound. The measured amounts of these materials were dissolved in ethanol and the solution was stirred for about 3 hours. Then the solution was filtered by Whatmann filter paper of pore size 11 µm. The filtered solution was kept in a controlled evaporation condition. Transparent single crystals of BTZB with size 17 x 5 x 3 mm^3 are harvested in a period of 20 days. The as grown crystal is shown in figure 1.

Figure 1. Photograph of btzb crystal.

3. RESULTS AND DISCUSSION

3.1 Powder X – ray Diffraction Studies

Powder sample of BTZB was taken for the X – ray diffraction studies. The X- ray diffraction spectrum of the grownBTZBwas recorded at room temperature. The powder XRD pattern of BTZB crystal is shown in figure 2.Distinct peaks were observed at 2θ value 16.723°, 23.787°, 29.12°, 33.75°, 38.017°, 45.252°. This shows the perfect crystalline structure and long-range periodicity of the grown crystal.

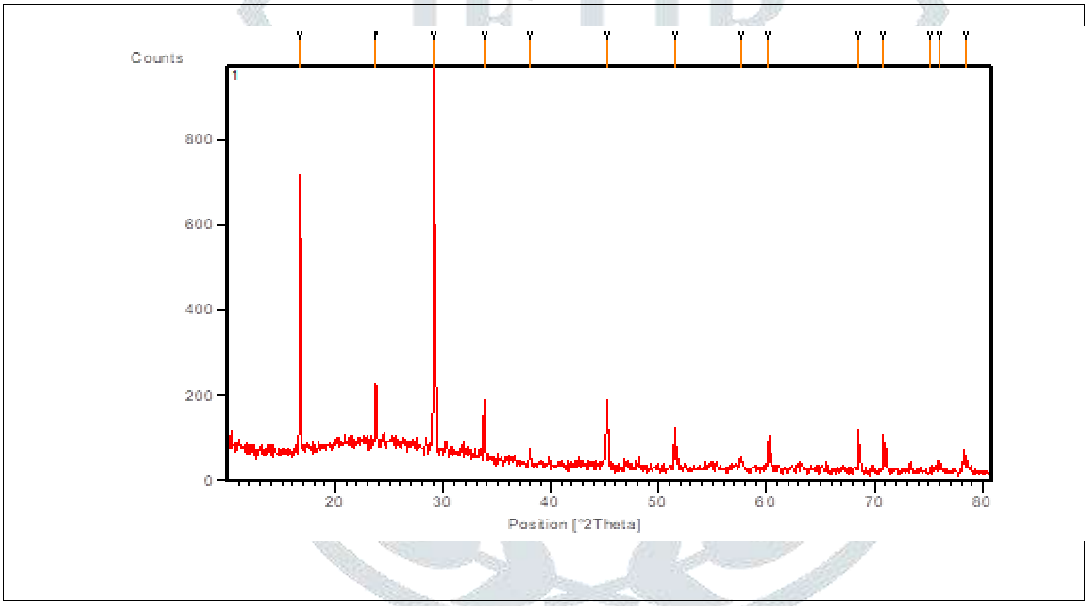

Figure 2. Powder x-ray spectrum of btzb.

3.2 Fourier Transform Infrared spectral Analysis

FTIR spectrum of BTZB crystal recorded in the frequency region 400- 4000 cm^{-1} using Perkin Elmer spectrometer is shown in figure 3. The broad band at 3783 cm^{-1} is due to OH bending of watermolecules in the grown crystal. The band at 1649 cm^{-1} is due to NH_2 bending. The C=N symmetric and asymmetric stretching vibrations are observed at 1189 and 1400 cm^{-1} respectively. The C=S asymmetric stretching vibration is observed at 973 cm^{-1}[6-8]. The broad envelop positioned between 2000 and 3700 cm^{-1}corresponds to the symmetric and asymmetric stretching of NH_2 grouping of BTZB crystals. The observations suggest that the metals coordinate with thiourea through sulphur.

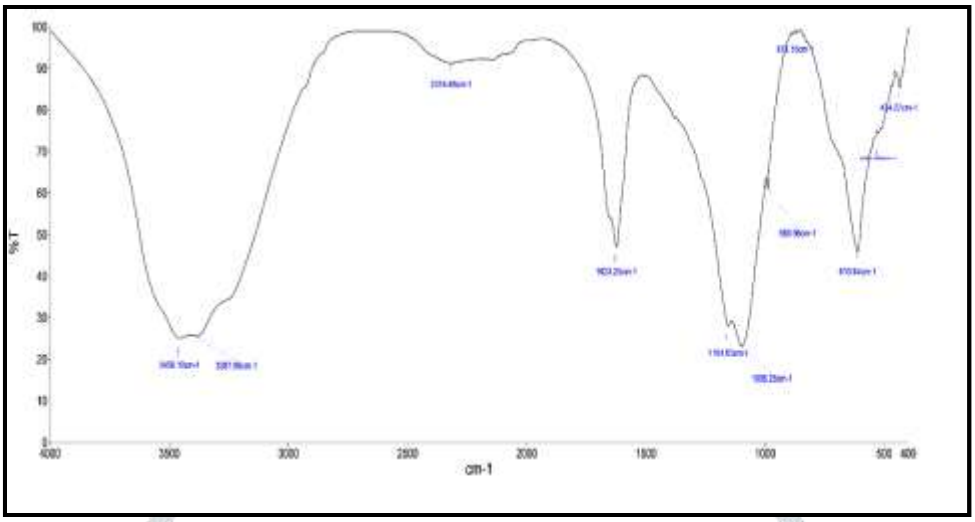

Figure 3. FTIR spectrum of btzb crystal.

3.3 UV – VIS – NIR Spectral analysis

The UV visible transmission spectrum of BTZB crystal was recorded by Perkin Elmer Lamda 35 UV – visible spectrometer in the range of 190 nm – 1100 nm and the observed spectrum of BTZB crystal is shown in figure4. The material BTBZ is highly transparent in the entire visible and near IR region and it has a cut off wavelength at 230nm. Single crystals are mainly used in optical applications and hence optical transmittance is 87 % for light in the visible region of the electromagnetic spectrum which is an important for the realization of SHG output in this range using lasers.

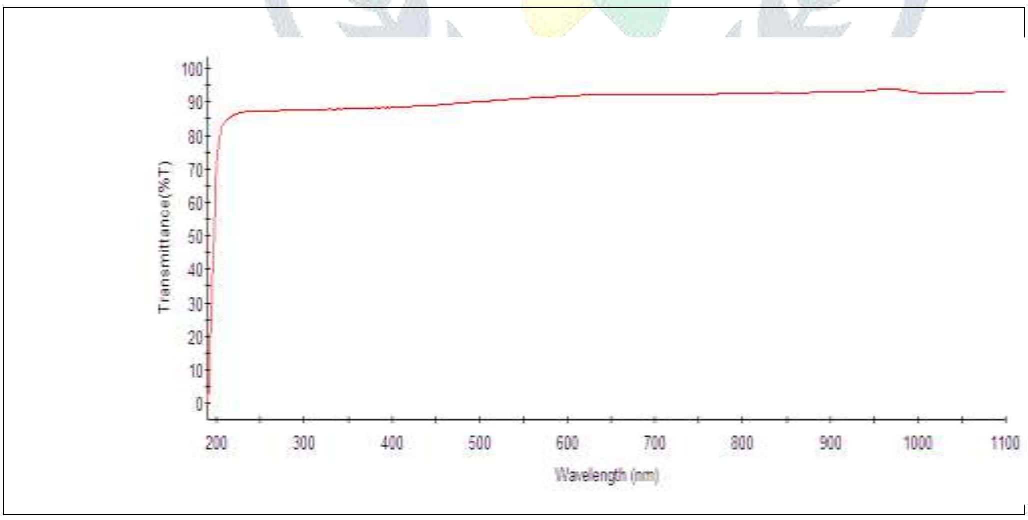

Figure 4. UV-visible transmittance spectrum of btzb

This transparent nature in the visible region is a desirous property for the material used for NLO applications [9-10]. The absence of absorption in the region 210 nm and 1100 nm shows that this crystal could be used for optoelectronic applications.

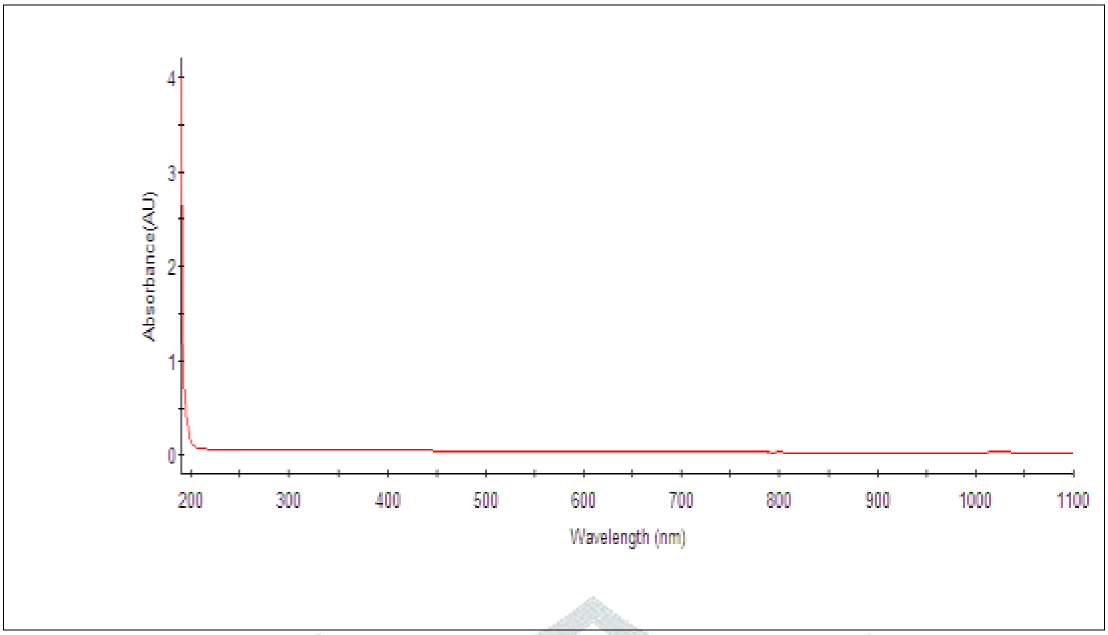

Figure 5. UV-visible absorbancespectrum of btzb

3.4 Fluorescence Studies

The emission of light which ceases after the cause of excitation in cut off is known as fluorescence and this is generally observed in those organic molecules which have rigid framework and no many loosely coupled substituent through which vibronic energy can flow out.The fluorescence emission spectrum was measured in the range 280 – 795 nm and is depicted in figure 6. A peak at 513nm was observed in the emission spectrum. The results indicate that BTZB crystal have a green fluorescence emission.

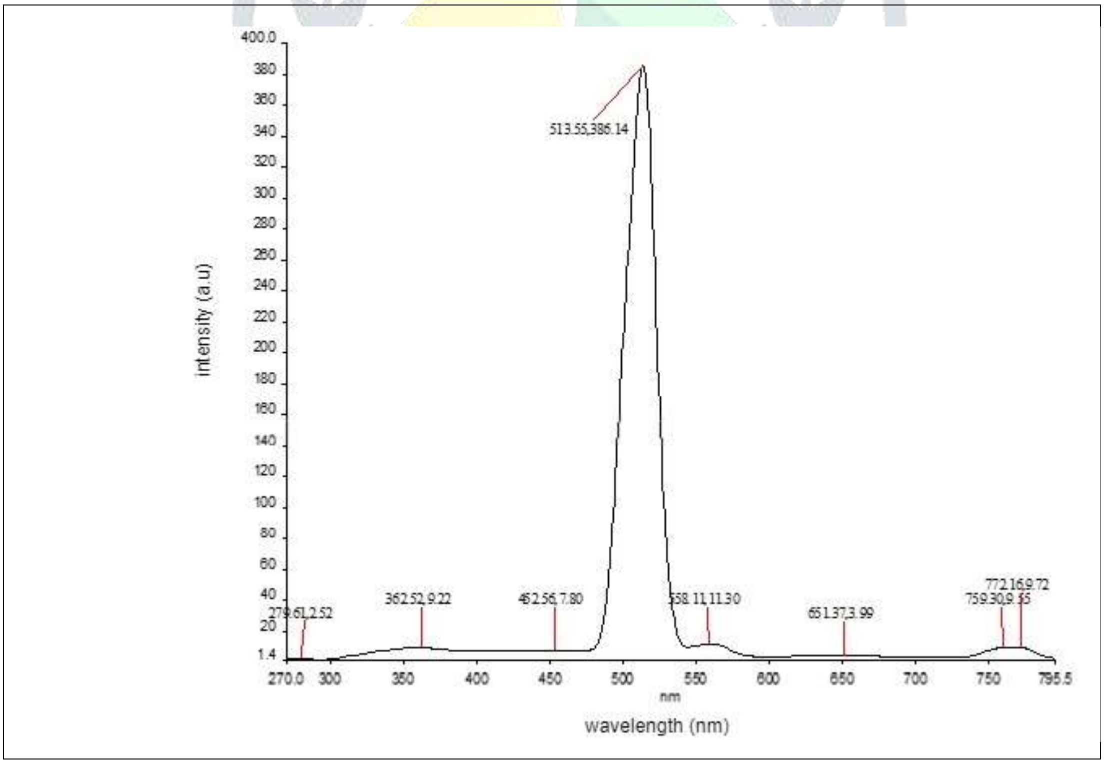

Figure 6. Fluorescence spectrum of btzb.

3.5 SHG Efficiency Measurement

The grown crystals were subjected to the NLO study to measure the SHG efficiency. The SHG property of the grown crystal was tested by the Kurtz Perry powder method. The crystalline powder is illuminated using Q switched Nd:YAG laser with the wavelength 1044 nm of pulse width 6 ns with the frequency rate 10Hz . The SHG is confirmed by the emission of green radiation at 513 nm and the SHG efficiency is found to be 1.1 times that of the reference material KDP.

4. CONCLUSION

Bisthiourea Zinc Borate crystals are grown by slow evaporation technique. The crystalline nature and purity of grown crystal is confirmed by power XRD technique. The recorded FTIR spectrum of the grown crystal BTZB confirms the presence of functional groups in the compound. UV-VIS-NIR spectrum of BTBZ shows non-linear optical property which is the essential requirements for any non-linear optical material.The fluorescence of the grown sample is confirmed by nonlinear optical property. The SHG efficiency of BTZB crystal is nearly 1.1 times that of standard KDP material.

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