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Comparison of Mechanical and Dielectric Properties of Pure and L-Cystein Doped Bis Thiourea Zinc Acetate (L-Btza)

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ABSTRACT
The nonlinear optical single crystal of L-cystein doped bisthiourea zinc acetate (BTZA) was grown successfully by slow evaporation technique using water as solvent at room temperature. Elemental Composition percentages were analysed for both pure and doped crystals by using CHN study. An elemental confirmation was performed by using energy dispersive X-ray analysis(EDAX).The Vicker's microhardness studies were performed to understand the mechanical strength of both pure and doped BTZA. The dielectric studies were carried on both the crystals to study the electric behavior of these crystals.

Keywords - Dielectric constant, Dielectric loss, BTZA, L-BTZA, Micro hardness

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I. INTRODUCTION

Non linear optical features of transparent samples are of great importance since their applications considerably improve the characteristics of different optoelectronic devices[1]. Thiourea molecules are an interesting inorganic matrix modifier due to its large dipolemoment and its ability to form an extensive network of hydrogen bonds [2]. The structural and the optical, mechanical,and thermal properties of thiourea based complexes have been reported in detail in the literature (Jayalakshmi and Kumar 2006; Kannan et al 2004; Lydia Caroline and Vasudevan 2009; Thomas Joseph Prakash and Ruby Nirmala 2010). The growth and characterization of pure BTZA is reported by Niji Abraham and V S John et al, IOSR Journal of Applied Physics[3]. Growth and characterization of lithium chloride,cd2+,L-Proline doped BTZA crystals had also been reported by J.Thomas Joseph Prakash, L.Ruby Nirmala Spectrochimica Acta Part A:Molecular and Biomolecular Spectroscopy 97(2012) 673-677,M.Lydia Caroline ,S.Vasudevan Current Applied Physics 9(2009)1054-1061,J.Felicita Vimala,J.Thomas Joseph Prakash Spectrochimica Acta Part A. :Molecular and Biomolecular Spectroscopy 107(2013) 371-376.

Spectral, Optical and Thermal properties in Grown L-cystein doped Bis Thiourea Zinc Acetate is reported by Niji Abraham and V S John et al[4]. The present work deals with the effect of L-cystein on the mechanical and dielectric properties of Bis Thiourea Zinc Acetate.

II. EXPERIMENTAL

Pure BTZA salt was synthesized by mixing zinc acetate and thiourea in the stiometric ratio 1:2 in double distilled water. The dopant L-cystein was added to the supersaturated solution of BTZA in the concentration of 2 wt% and stirred at a constant speed for six hours to attain homogeneity throughout the volume. The solution was filtered and kept for evaporation at room temperature. A good quality transparent crystals were harvested within a period of 20 days as shown in Figure 1.

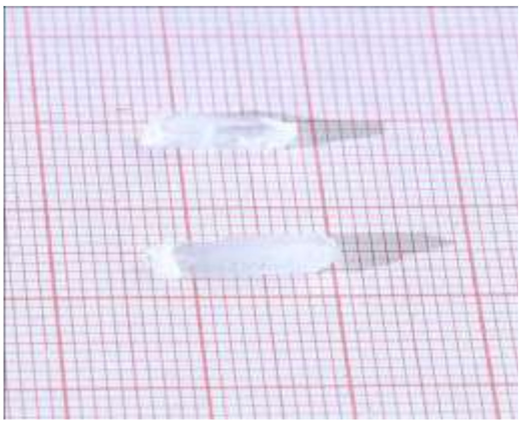

Fig 1: Photograph of L- BTZA single crystal

III. RESULTS AND DISCUSSION

3.1 CHN Analysis

The elemental composition percentage of pure and L-cystein doped BTZA crystals were analysed using Elementar Vario EL III elemental analyser. The result of the analysis is presented in Table 1.

Elements	Pure BTZA(%)	Doped BTZA(%)
Carbon	21.19	21.37
Hydrogen	4.41	4.51
Nitrogen	17.04	17.50

Table 1: CHN analysis of pure and doped BTZA

The experimental C, H and N percentages were compared with pure BTZA and confirms the presence of the dopant.

3.2 EDAX Analysis

Energy-dispersive X-ray spectroscopy is an analytical technique used for the elemental analysis or chemical characterization of a sample. The recorded spectrums of pure and doped BTZA are shown in figure 2.

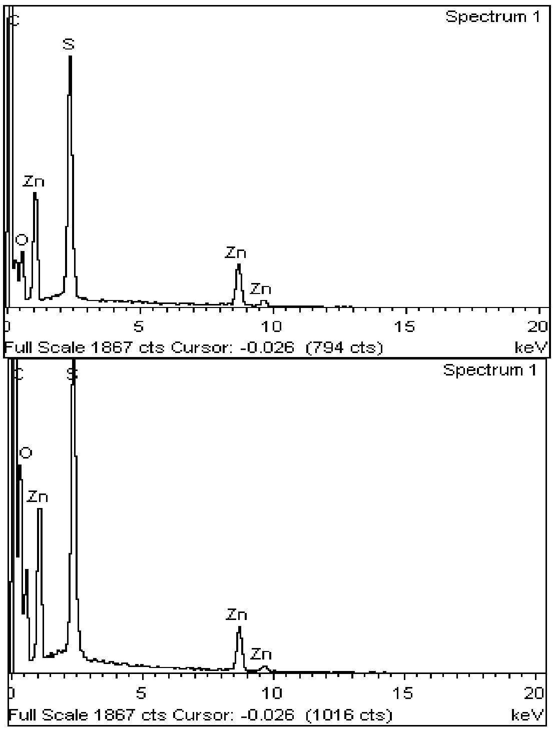

Fig 2: EDAX spectrum of pure and L-cystein doped BTZA

The elevation in the peak of oxygen, sulphur and zinc elements show the incorporation of L-Cystein in the grown crystal.

3.3 Microhardness Measurement

Vickers microhardness indentation test is used to characterize the hardness of the material.The hardness number was calculated using Hv = 1.8544 xP/d2 Kg/mm2, where Hv is the Vickers microhardness number, P is the applied load in Kg, d is the mean diagonal length of the indentation impression in mm and 1.8544 is a constant of a geometrical fraction for the diamond pyramid.

The hardness values have been taken for various applied loads over a fixed interval of time. A graph has been plotted between hardness number (Hv) and applied load (P) as shown in the Figure 3.

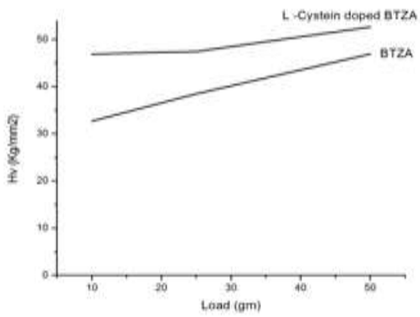

Fig 3: Hardness Vs load graph of pure and doped BTZA

At lower loads there is an increase in the hardness with load, which can be attributed to the work hardening of the surface layers[5]. Hardness study concluded that the doped crystal is harder than pure crystal.

3.4 Dielectric Properties

Dielectric measurement characterize the materials response towards applied field.The dielectric behavior of doped and pure BTZA crystal were carried out at room temperature using Agilent 16451B impedence analyser in parallel mode at frequency ranging from 40Hz to 1 MHz.
Dielectric constant and loss expressed by the following equations.

$$\varepsilon' = (C_p\, d) / (\varepsilon_0 A)$$

$$\varepsilon'' = \varepsilon' \tan\delta$$

where, d is the thickness of the sample, A is the area of the sample, ε0 is the permittivity of free space (=8.854×10–12 F/m), Cp is the parallel capacitance across the sample and tan δ is the loss tangent or the dissipation factor.

The variation of dielectric constant and dielectric loss with frequency for pure and doped BTZA is shown in figure 4 .The dielectric constant decreases with increase in frequency.The high value of dielectric constant at lower frequencies may be due to the presence of space, charge, orientation, electronic and ionic polarization mechanism [6]. The low values of dielectric constant at high frequencies indicate high crystal perfection and low space charge polarization[7].From the figure, it is observed that dielectric constant decreases slightly for the doped sample. The dielectric loss is also depend on the frequency of the applied field. Dielectric loss is almost same for both pure and doped BTZA. The lower dielectric characteristics indicate the grown crystal is efficient for NLO, optoelectronic, laser and SHG device applications[8].

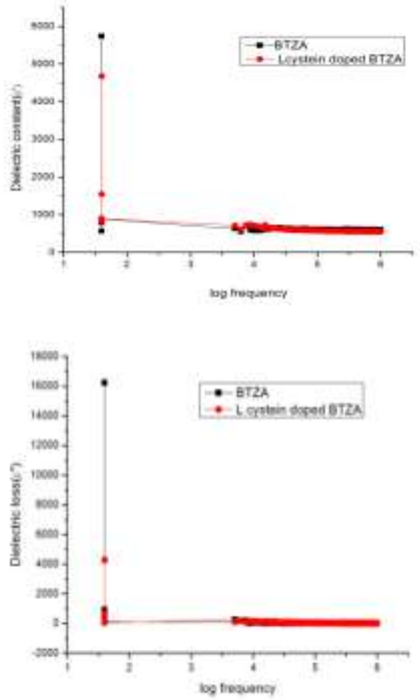

Fig 4: Variation of dielectric constant and dielectric loss with frequency of pure and doped BTZA

The ac conductivity of the pure and doped BTZA crystal is shown in the figure 5.It is evident from the figure that ac conductivity increases with the increase in frequency.

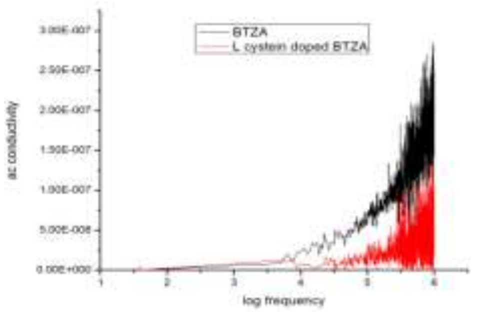

Fig 5: AC conductivity of pure and doped BTZA

IV. CONCLUSION

Good quality single crystal of L-cystein doped BTZA was grown by slow evaporation technique under room temperature. Grown crystals were characterized and compared with pure BTZA.

The CHN analysis reveals the presence of dopant in the grown crystal. Presence of all the elements and doping of L-cystein were confirmed by EDAX test. The mechanical property of both crystals were evaluated by Vickers micro hardness test and it is concluded that doped crystal is harder than pure one. Dielectric studies ascertained that the grown crystals possess low values of dielectric constant and dielectric loss with high frequency which is highly demanded for NLO applications.

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