International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)
ISSN: 2456-236X
Vol. **05** Special Issue **01** | **2020**

Focusing Nonlinear Optical Traits of Parent & L-Tryptophan Doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal for NLO Applications

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ABSTRACT

Recent scenario deals with the requirement of good quality crystals for the nonlinear optical (NLO) device applications. Hence present manuscript explores the growth of parent & L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal by conventional slow evaporation solution growth method. Paper demonstrates the study of comparative nonlinear optical properties such as optical conductivity, extinction coefficient, reflectance and refractive index of parent & L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal. The evaluated nonlinear optical parameters confirmed the superiority of L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal over parent Bis Thiourea Cadmium Acetate (BTCA) crystal for application in laser assisted NLO applications.

Keywords: Crystal growth, Extinction coefficient, optical conductivity,Reflectance, Refractive index

1. INTRODUCTION

Nonlinear optical (NLO) crystals seek large demand for developing the cutting edge technological accessories utilized in data storage, digital communication systems, optical switching, laser fusion, photonics, optoelectronics and laser frequency conversion device applications **[1–3].** Designing, engineering and growth of perfect nonlinear optical crystals delivering extraordinary characteristics has become a challenging task for researchers in the current scenario. All optical device applications concurrently desire excellent optical (UV–visible), SHG efficiency, luminescence, third order nonlinear optical), crystalline perfection, thermal stability and electrical (dielectric) properties **[4].** Tremendous efforts have been taken since past few decades for designing a new class of organo-metallic nonlinear optical crystals. In organometallic crystals a large variety of thiourea metal complex crystals have been reported **[5,6]** amongst which the Bis thiourea Cadmium acetate (BTCA) deserves more attention due to its orthorhombic crystal structure, appreciable linear-nonlinear optical properties, hardness, electrical and thermal properties as evident in literature. With the aim of achieving improved quality CTA crystal; several researchers attempted a technique of doping additives Zn, Mn(II), NMU, Glycine, Alanine, Valine, Cystein **[7-16].**

L-tryptophan contains an α amino group, and α carboxylic acid group with 1five membered ring with a nitrogen atom bounded to a benzene ring called as in dole ring present in side chain of molecule making it an non polar aromatic amino acid . L tryptophan exhibits non exponential fluorescence decay in aqueous solution and this has been explained by the emission from non interconnecting rotamers which has different life times due to different rate of intermolecular charge transfer **[17]**.

Hence present study aimed to grow the parent bis thiourea cadmium acetate (BTCA) and L-tryptophan doped bis thiourea cadmium acetate (TR-BTCA) crystal by slow evaporation solution growth technique and thus to study the effect of amino acid L- tryptophan on nonlinear optical properties of BTCA.

2. EXPERIMENTAL PROCEDURE

Bis thiourea Cadmium acetate salt was synthesized by taking Merck brand cadmium acetate and thoiurea in 1:2 ratios in doubly deionized water. The obtained salt was purified by continual recrystallization for 3 times. This recrystallized salt was used for growth of crystal. In super saturated solution of purified BTCA salt, the precisely measured quantity of 0.3M% L-tryptophan was added with constant stirring speed for 5hrs, so as to achieve homogeneous doping. After filtering the both parent and doped solutions were kept for evaporation at ambient temperature. The high standard crystals were collected in duration of 20 days as indicated in **Fig. 1(a) and 1(b).**

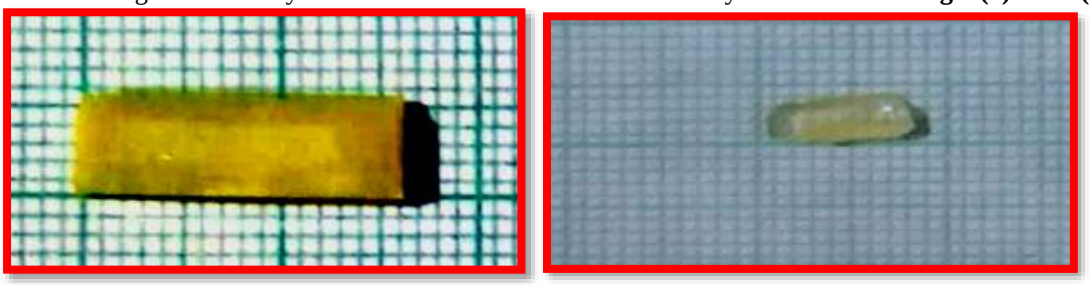

Fig. 1(a) Photograph of Pure BTCA **Fig. 1(b)** Photograph of 0.3M% TR-BTCA Crystal.

3. RESULTS AND DISCUSSION

The optical band gap (E_g) can be calculated from transmission spectrum [18] using the relation $\alpha=A(h\nu-E_g)^{1/2}$. Where α= linear absorption coefficient, A= constant, Eg= optical band gap, h = planck's constant and υ= frequency of incident photon. By using above formula, the optical band gap of TR-CTA crystal is found to be 4.26ev as shown in Fig.2(a) which indicates that doped crystal have wide application in photo electronics [19].

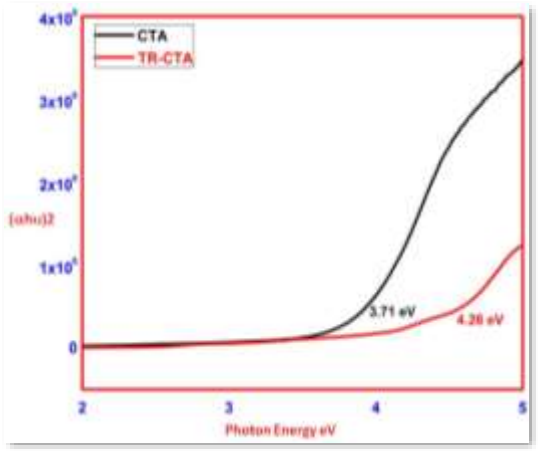

Fig.2(a) $(\alpha h\nu)^2$ Vs hν(eV)

The study of optical parameters helps to identify the most suitable crystal for processing and designing the various useful technological devices. Therefore the effect of L-tryptophan on optical conductivity, extinction coefficient, refractive index and reflectance of CTA crystal has been extensively investigated. The optical conductivity ($\sigma_{op}=\alpha nc/4\pi$) increases with increasing photon energy which shows grown crystal have application in information processing and computing **[20].** The graph of optical conductivity and extinction coefficient of TR-BTCA crystal is shown in figure and **Fig. 2(b) and 2(c)** respectively. The lower value of extinction coefficient and higher optical conductivity suggest suitability of doped crystal in conversing efficiency and integrated optical; application **[21]**.The difference of refractive index and reflectance with wavelength is shown in **Fig. 2(d) and 2(e)** respectively. From this graph it is evident that TR-CTA crystal exhibit lower refractive index and lower reflectance as compared to CTA in entire visible region which are the most desirable properties for antireflection coating in solar thermal devices **[22-23].**

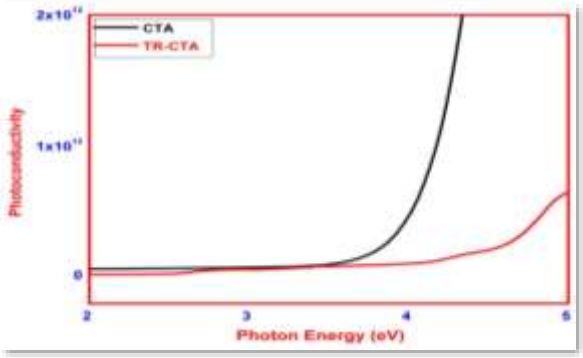

Fig.2(b) Optical Conductivity

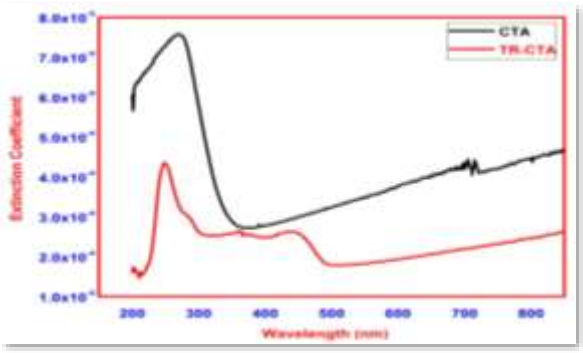

Fig .2(c) Extinction coefficient

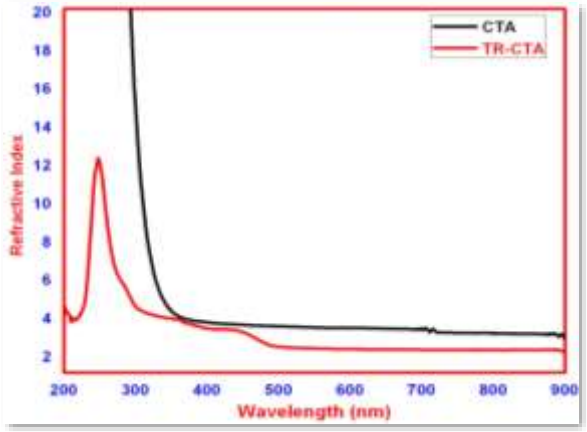

Fig.2(d) Refractive Index

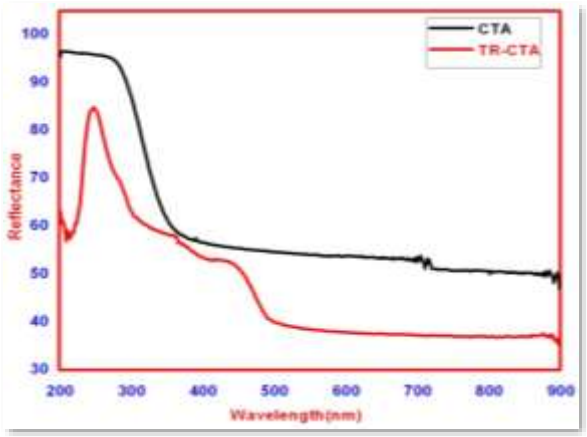

Fig.2(e) Reflectance

4. CONCLUSIONS

Parent Bis thiourea cadmium acetate (BTCA) & L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal was grown by conventional slow evaporation solution growth method . The direct optical band gap values of Parent Bis thiourea cadmium acetate (BTCA) & L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal has been calculated from Tauc's plot. Parent Bis thiourea cadmium acetate (BTCA) has narrow band gap (3.71 eV) than L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal (4.26 eV). The optical studies revealed the lower values of extinction coefficient, reflectance, photoconductivity and refractive index of L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal were also confirmed in the visible region of interest. The high optical quality of L-Tryptophan doped Bis Thiourea Cadmium Acetate (TR-BTCA) Crystal makes it suitable candidate for NLO assisted optoelectronic device applications.

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