Growth, Structural, Functional, Optical and Thermal Properties of Nonlinear Optical Strontium Diformate (SDF) Crystals

S.Jeeva[1], K. Arulabaranam[1], P. Krishnan[1,2], G.Marudhu[3], G.Mani[1*]
[1]*P.G. and Research Department of Physics, Arignar Anna Govt. Arts College, Cheyyar-604 407, India.*
[2] *Dept. of Physics, St. Joseph's College of Engineering, Chennai-600 119, India.*
[3] *Dept. of Physics, Aksheyaa College of Engineering, Madhuranthagam-603 314, India.*

Abstract

SDF Single crystal was grown water solution by natural slow evaporation method. The present crystal need been to single X-ray beam diffraction analysis to identified the lattice cell parameters. Fourier Transform Infrared [FTIR] analysis was carried out on the grown sample to convey the essential functional groups. Optical transmittance studies investigate UV-Vis spectrum of SDF, it is noted that there is better transmittance in the UV and visible region. The crystal was carried to TGA/DTA analysis to find its warm Dependability. The NLO property of the grown crystal has been confirmed by the Kurtz powder Second Harmonic Generation [SHG] test.

Keywords: *strontium Diformate, single crystal, XRD, TGA/DTA, SHG.*

I. INTRODUCTION

Growth of nonlinear [NLO] materials initiate to improvement of many novel devices in the field claimed from optoelectronics and optical communication such that optical modulator, capacity of optical data and also optical switches [1, 2]. In this way, the form of inorganic NLO materials bring phenomenal mechanical and thermal properties at have moderately humble optical nonlinearity due to those absence of extended π-electron delocalization [3]. Although those having some drawbacks it suitable to apply fabricating many more devices. Now a day many researchers expelling inorganic NLO crystal like strontium derivatives with suitable organic acids [4]. So that the strontium Diformate single crystal was grown by very few exist in literature overview [5]. In this paper, illustrates that growth, functional, optical, and thermal properties were evaluated for the grown crystal.

II. MATERIALS AND METHODS

The Strontium Diformate single crystal was grown by slow evaporation method under the atmospheric conditions. The high purity of strontium chloride hexahydrate and sodium formate mixing in the solvent of water at stochiometric ratio of 2:1. The mixed solution was stirred for 6 hours and filtered with watt man filter paper then it placed on the dust free vibration fewer tables kept at room temperature. After few weeks, a better sized crystal was reaped from the mother solution. The grown crystal of SDF is exhibited in the **Fig.1.**

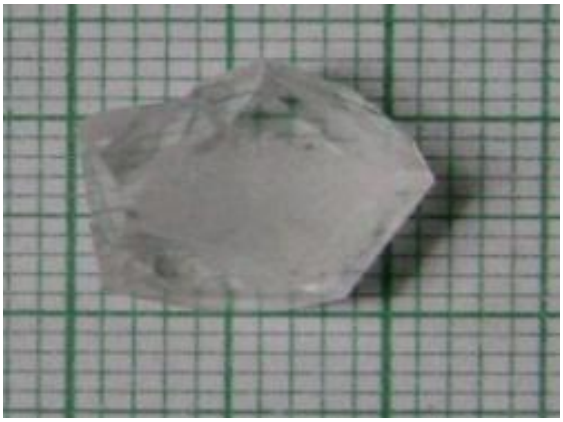

Fig. 1. As grown SDF Single Crystal

III. RESULT AND DISCUSSION

A. Single Crystal X-ray Diffraction Studies

In order to reveals the crystal system with lattice parameters of the grown crystals, the Strontium Diformate single crystal subjected to X-ray diffraction analysis using ENRAF NONIS CAD4/MAC4 X-ray diffractometer. It shown that the crystal having the class of monoclinic with $P2_12_12_1$ space group symmetry, with its observed values crystalline lattice cell parameters as a = 6.825 Å, b = 8.691 Å, c = 7.247 Å, and V^3 = 443.6 $Å^3$ were coincide the reference work [5].

B. FT-IR spectral studies

The FTIR analysis is qualitatively useful to shown the presence of functional groups in the synthesized material. The spectrum was recorded using the Perkin Elmer spectrum one FT-IR spectrometer in order to range between 400cm^{-1}-4000 cm^{-1}.

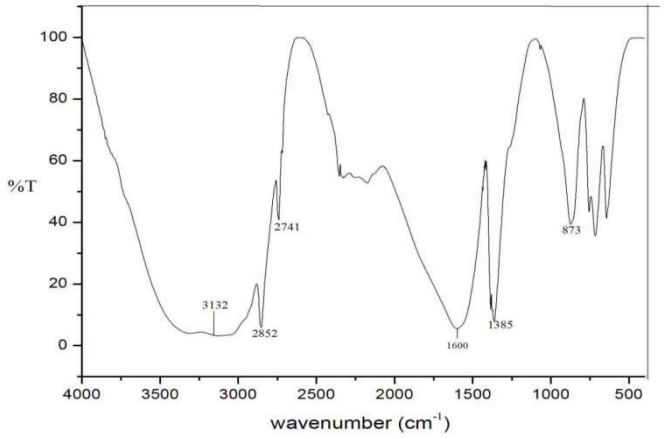

Fig.2.FTIR Spectrum of SDF Crystal

The recorded FTIR spectrum of strontium Diformatesingle crystal is shown in the **Fig.2.** The observed peak positions and their functional groups assignments for SDF single crystal are listed in the **Table.1.**

Table.1. Functional Groups Assignments for SDF Single Crystal.

WAVE NUMBER	ASSIGNMENT
3132	OH-Stretching of –COOH
2852 2741	CH- Stretching
1600	C=O Vibration of –COOH
1385	CH- Stretching
873	CH- Stretching

C. UV-Vis Spectral Analysis

In general, fine optical property in order to UV-Visible region enhanced NLO efficiency **[6]**. In these way, the UV-Vis spectrum is given information like electronic bands, and types of optical transitions to suitable optical device applications in order to SHG output. Optical transmittance spectrum might have recorded for the grown SDF single crystal in the wavelength from 200 to 700 nm using a Varian Cary 5E UV-Vis spectrophotometer. Starting with the UV-Vis range for SDF, it may be noted that there may be most extreme transmittance in the whole noticeable region, then the UV cut-off wavelength is around 225 nm and the optical band gap energy (E_g) of SDF was estimated from the relation ($E=h\nu/\lambda$), Then the Optical band gap like E_{g1} = 5.511 eV and E_{g2} = 4.461eV. Due to these observations, the present material given good optical linearity provides possibility of optoelectronic requisitions and the second and third-order harmonic generations.

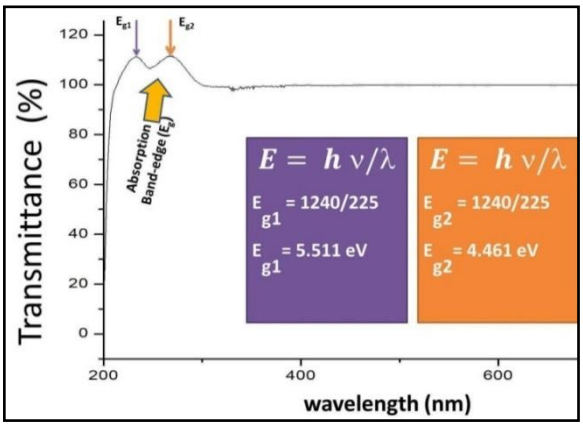

Fig.3. UV - Vis Spectrum of SDF Crystal

D. Thermogravimetric Analysis

The thermogravimetric analysis [TGA] for the grown SDF crystal might have been recorded using SDT Q 600 V8.3 Build 101thermogravimetric analyser. The sample was heated at a rate of 20°C/min for temperature range 10-1000°C in the protected nitrogen gas flow. The initial weight 5.26 mg of the powder sample subjected on analyses and its final 42.72% of residue is extracted due to decomposition at the temperature of 1000°C. In Fig.4, DTA analysis given the exothermic peak around 74.66°C is the melting point of the material due to weight loss is started the material. Also, further peaks [497.74°C, 947.92°C] shown either compounds were liberated to increase decomposition of the title crystal. Hence the material texture up to 74.66°C for preferable to device requirements.

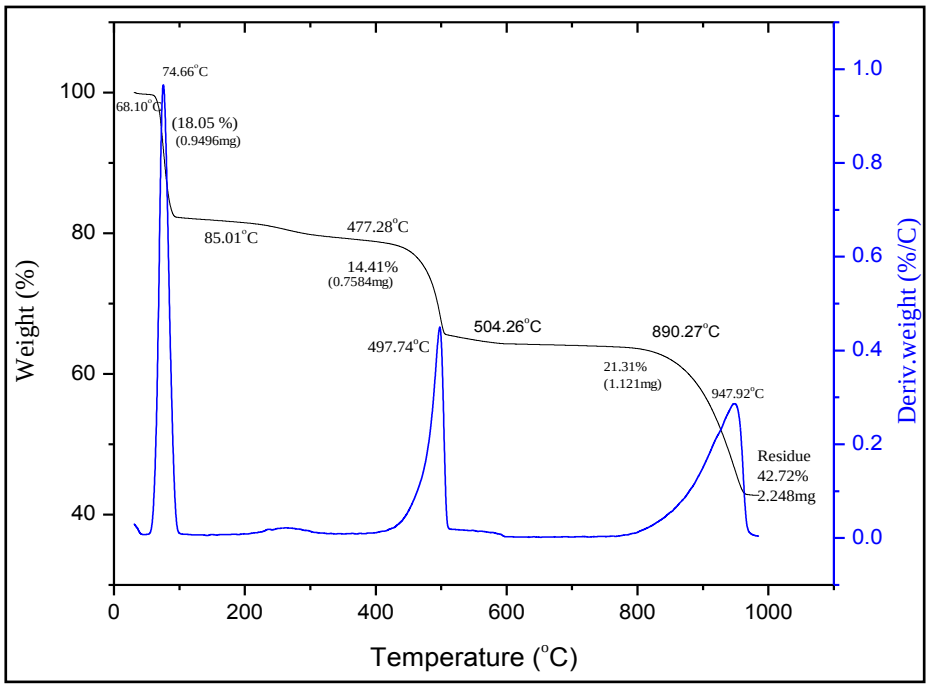

Fig.4. Thermogram of SDF Crystal

E. Powder SHG Measurement

The study of Nonlinear optics is an essential study to develop many more applications. In this scenario the powdered SDF sample carried out to SHG measurement using a Q-switched Nd: YAG laser under Kurtz and Perry power test [7]. 1064 nm wavelength of fundamental beam emitted by Nd:YAG laser its invisible light form appeared to the sample, then the emission of green colour detected by the detector through the sample. Further KDP was used as a reference powder sample, hence it suitable to further optoelectronic requirements.

IV. CONCLUSIONS

The Strontium Diformate single crystal was grown using slow evaporation method. It belongs to monoclinic crystal system confirmed by single crystal XRD. The presence of functional groups was revealed by FTIR studies. The opticaltransmission spectrum gives the cut-offwavelength around 225 nm. The material is stable up to 74.66°C for electro-optic applications. The efficiency of NLO is support to prepare the industrial applications in future.

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