St. Joseph's Journal of Humanities and Science
ISSN: 2347 - 5331
http://sjctnc.edu.in/6107-2/

Growth and Characterization of L-Arginine Ammonium Chloride Single Crystal Grown from Slow Evaporation Technique

M. Maria Julie*
C. Yogambal
H. Jude Leonard Hilary

ABSTRACT

Single crystals of the organic nonlinear material L-arginine ammonium chloride have been grown by slow-evaporation method. The crystal structure is confirmed by powder X-ray diffraction method. The transmittance spectrum of crystal shows that the cut-off wavelength at 247 nm. The modes of vibrations are present in L-arginine ammonium chloride has been identified by spectral analysis. Second harmonic generation (SHG) conversion ratio has been measured as input voltage is 8mV by the crystal was 2.94 times greater than that of potassium dihydrogen phosphate (KDP) crystal.

Keywords: Single crystal, PXRD, UV-Vis-NIR, SHG.

INTRODUCTION

Nowadays, there is a need to deviate our focus from electrons to photons for ultrafast technology. That's why extensive exploration has been made in various technological fields such as telecommunication, optical data storage, optical computing andoptical bistability [1]. Organic materials have vital physicochemical properties essential for optical switching, electro-optic modulation, and photonics application. The photonic field perform functions that fall in the domain of electronics, such as telecommunication and information processing. Amino acids come under the above classification as they exhibit excellent nonlinear optical properties. Generally, it has been found that these compounds crystallize in a non-centrosymmetric crystal system due to asymmetric structure which is a precondition for exhibiting second harmonic generation (SHG). Arginine is the most common amino acid with a proton acceptor carbonyl (-coo)group and the proton donor (-NH2) group. α – Amino acid compounds have some special features such as molecular chirality, high transparency in UV and visible region, and the zwitterionic nature of the molecule, which hardens the crystal [2]. The crystal structure of L-arginine adipate was first reported by Roy et al [3].L-arginine forms

PG and Research Department of Physics, St. Joseph's College of Arts and Science (Autonomous),
Cuddalore-607001, Tamil Nadu, India.
*E-mail: juliephysjc@gmail.com.

a number of hydrogen and ionic bonded crystalline salt with other compounds as it forms zwitterion having protonatedguanidyl group, alpha amino group and deprotonated carboxyl group. There are many authors L-arginine based material which shows SHG efficiency such as L-arginine p-nitrobenzoate monohydrate(LANB), L-arginine glutarate, L-arginine adipate, L-arginine phosphate monohydrate (LAP), L-arginine semi-oxalate (LASO) and L-arginine trifluoro acetate [4-9]. Hence, there is no report, to our knowledge that the growth of L-arginine ammonium chloride crystal was reported. Therefore in the present work, single crystals of L-arginine ammonium chloride were synthesized and characterized by using the techniques such as Powder X-ray diffraction (XRD) analysis, Fourier transform infrared spectroscopy (FT-IR), UV spectral analysis and nonlinear optical studies to analyse the suitability of the material in device fabrications.

EXPERIMENTAL

Materials and Methods

L- Arginine ammonium chloride single crystal was grown by slow evaporation method. Analytical grade chemicals of L-Arginine and ammonium chloride were mixed in the equimolar ratio 1:1 in double distilled water. The super saturated solution was filtered and allowed to evaporate at room temperature over a period of 25 days. The image of the grown crystal shown in figure.1.

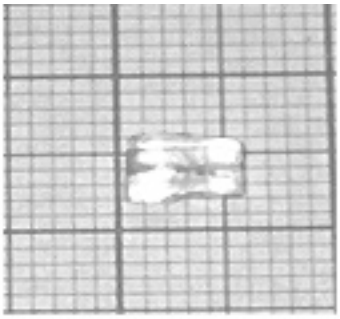

Figure.1 As grown crystal of L-arginine ammonium chloride

CHARACTERIZATION STUDIES

Powder X-ray diffraction analysis

PXRD technique was carried out using Bruker D8 Advance X-ray diffractometer with Cu Kα1 (λ=1.5406 Å) radiation. The powdered sample was scanned over a range 10˚– 80˚at the scan rate of 1˚per min as shown figure.2. The observed X-ray diffracted pattern was revealed the monoclinic system and crystalline nature of the grown crystal. From the PXRD data, the lattice parameters of the grown crystal are a = 9.468, b = 5.287 and c = 13.457. The calculated cell parameters of L-Arginine ammonium chloride crystal are in good agreement with literature [10].

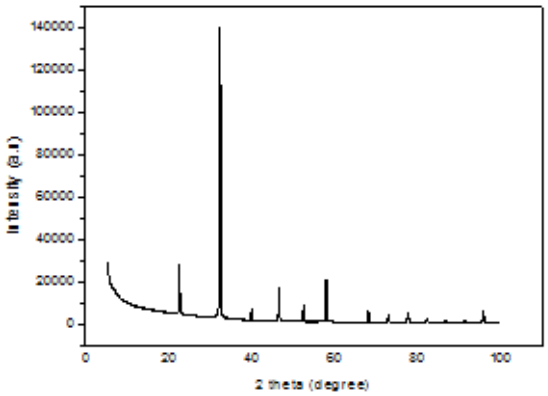

Figure.2 PXRD Pattern of L-arginine ammonium chloride

UV-Vis-NIR spectral analysis

The optical properties of L-Arginine ammonium chloride was studied by UV-V is spectrometer using Perkin Elmer lambda 35 model. The transmittance of the L-Arginine ammonium chloride powder was measured in the wavelength range from 200 – 1100 nm and the transmittance spectrum is shown in Figure.3. Using transmittance spectrum the transparency nature of the grown crystal revealed the cut off wavelength range of 247 nm. The material shows good optical transmittance over the UV and visible regions (247-1100 nm). This confirms the nature of the crystals is colourless. The optical transparency at lower cut-off wavelength between 200 to 400 nm suggests the well -known efficiency of the grown NLO crystal [11]

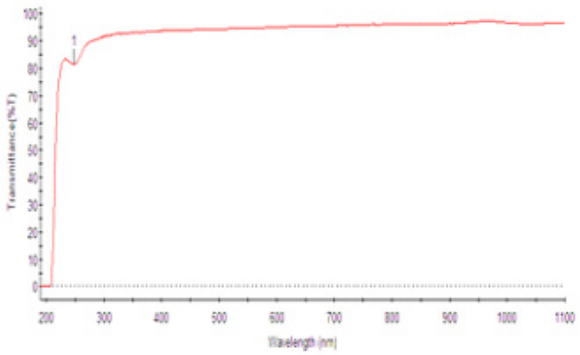

Figure.3 UV-V is spectrum of L-arginine ammonium chloride

FT-IR spectral analysis

The FT-IR spectrum of the grown L-Arginine ammonium chloride crystals were analysed from the frequency of range 400-4000 cm^{-1}using Perkin Elmer spectrometer by KBr pellet technique and is shown in figure. 4. The peaks observed at 527, 602, 643, 1403 and 1573 cm^{-1} attributed to the carboxylic group, while the transmission peaks observed at 1124 and 3030 cm^{-1} corresponds to the ammonium group (NH3+). Peaks observed at 849 and 1043 cm^{-1} are attributed to C-C-N symmetric and C-C-N asymmetric stretching vibrations. The occurrence of functional groups is in good agreement with the reported work [10].

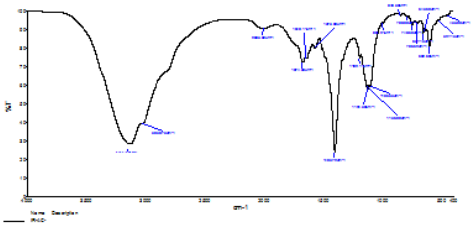

Figure.4 FT-IR spectrum of L-arginine ammonium chloride

Second Harmonic Generation test

The second harmonic generation (SHG) conversion efficiency of the grown crystal was measured by Kurtz and Perry powder technique [12]. The crystal was finely powdered into a homogenous mixture and it was made as a pellet. The Q-switched Nd:YAG laser emitting a wavelength (λ=1064 nm) of pulse width at 6 ns was admitted to strike on the sample cell. The emission of green radiation at 532 nm was detected by the photomultiplier tube acknowledging the material was potentially capable for frequency conversion. The grown L-Arginine ammonium chloride crystal exhibits the SHG efficiency of 2.94 times greater than that of KDP and it reveals that the crystal was suitable for fabrication of applications.

CONCLUSION

A nonlinear optical single crystal of L-arginine ammonium chloride was grown by slow evaporation method at room temperature. The unit cell parameters have been determined by powder XRD analysis and they agree with the reported values. The UV-Vis-NIR transmission spectrum of L-arginine ammonium chloride confirm transparent in the entire ultraviolet regions, making it a potential candidate for photonic and NLO applications. The presence of functional groups was identified by FT-IR studies. The SHG studies were confirmed.

REFERENCE

1. K. Thukral, N.Vijayan, M. Vij, C.M. Nagaraja,V. Jayaramakrishnan, M.S. Jayalakshmy, R. Kant, Mater. Chem.Phys. 194 (2017) 90-96.
2. Prince Thomas, S.D. Dhole, Ginson P. Joseph, Nuclear Inst, and Methods in physics Research B 426 (2018) 46-55.
3. Tapati Mallik, Tanusree Kar, Gabriele Bocelli, Amos Musatti, Cryst.Res.Technol. 41 (3) (2006) 280-284.
4. K. Ramya, N. T. Saraswathi, C. Ramachandra Raja, Optik 127 (2016) 2495-2499.
5. K. Ramya, C. Ramachandra Raja, Journal of Minerals and Materials Characterization and Engineering 4 (2016) 143-153.
6. G. H. Sun, G. H. Zhang, Z. H. Sun, X. Q. Wang, D. Xu, Materials Chemistry and Physics 127 (2011) 265-270.
7. P. Vasudevan, S. Gokul Raj, S. Sankar, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 106 (2013) 210-215.
8. Sonia, N. Vijayan, Mahak Vij, Kanika Thukral, Naghma Khan, D. Haranath, Rajnikant, M. S. Jayalakshmy, Chinese Journal of Chemical Engineering, (2018) doi: 10.1016/j.cjche.2018.06.029.

9. M. Meena, C.K. Mahadevan, Materials letters 62 (2008) 3742-3744.
10. Gajanan G. Muley, Prakash S. Ambhore, Anil B. Gambhire, Materials Today: Proceedings 4 (2017) 9491-9495.
11. H. Jude Leonard Hilary, P.C. JobePrabhakar, A. Christy Ferdinand, D. Manikandan,S. Thiyagaraj, 1179 (2019) 216-223.
12. Kurtz SK, Perry TT. Journal of Applied Physics,39, 3798 (1968).