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Synthesis, Optical, Thermal and Microhardness Studies of L-Alanine Potassium Penta Borate Octa Hydrate (LAPPB)

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Abstract: The aim of the work is to synthesise a new semiorganic crystal of L-Alanine Potassium Penta Borate Octa Hydrate [LAPPB]. The LAPPB crystals were synthesised by adopting slow evaporation method. The Size of the materials obtained are a = 9.04 Å, b = 11.5Å, c = 11.03Å. The characterization for the obtained materials were done using UV-VIS, FTIR, Microhardness, SHG and Thermal anaysis methods. The structure of the synthesised crystals were found to be orthorhombic. The FTIR spectrum of the synthesized compound reveals the functional groups present in it. The UV-VIS Spectrum shows the optical transmission of the crystal. The SHG of APPB was tested by Kurtz-Perry technique using Nd:YAG laser. TG/DTA analysis shows the thermal stability of the crystal. The mechanical strength was analysed by measuring microhardness of the grown LAPPB crystals.

Key words: Alanine potassium penta borate, single crystal, FTIR, microhardness, TG-DTA

INTRODUCTION

Nowadays, various applications are attributed in the field of NLO crystals and plays an important role in Science and Technology (Muncheryan, 1991; Shen, 1984; Meystrey and Sargent, 1991; Sakai, 1992; Raghavan and Ramasamy, 1999; Ragavan and Ramasamy, 2002). Nowadays, semiorganic nonlinear materials have attracted great attention due to their importance in areas such as efficient signal processing, optical data storage, frequency shifting, optical switching and modulation (Janarthanam *et al*., 2009). Semiorganic materials combines the important characteristics such as efficient SHG, better mechanical and thermal stability etc., L-Alanine is one of the chiral amino acid. The growth and studies of L-alanine have also been reported (Razzetti *et al*., 2002; Misoguti *et al*., 1996; Vijayan *et al*., 2006). Similarly, the characterizations of L-Alanine Maleate (Balasubramanian *et al*., 2009; Urit, 2010), Lalanine Tetra Fluro Borate (Rajan Babu *et al*., 2002), LalanineAcetate (Kumar *et al*., 2005), L-Alanine sodium chloride (Prabha and Palaniswamy, 2010) Alanine Barium Chlorie (Chitra and Palaniswamy, 2010), Alaninium Oxalate (Devaprasad and Madhavan, 2010) have also been investigated. Research articles shows that borate compounds have better non linear response. In this series, potassium penta borate octa hydrate is successfully used for frequency conversion process (Ambujam *et al*., 2006; Vimalan *et al*., 2007). The growth and the characterization of potassium penta borate were reported in the literature (Justin Raj *et al*., 2009; Raja *et al*., 1993; Rajasekar *et al*., 2003; Thamizharasan *et al*., 2000). In this work, the characterization of L-Alanine Potassium Penta Borate Octa Hydrate is discussed.

SYNTHESIS

The LAPPB was prepared by mixing L-Alanine and potassium penta borate octa hydrate in 2:1 ratio. Using de-ionized water and stirred continuously about two hours. After the complete dissolution of the materials, the solution was filtered and poured in a Petri dish and it was covered by multi holed paper so as to enhance slow evaporation. After 6-7 days the crystals of LAPPB were grown. The obtained crystals were subjected to the following methods.

RESULTS AND DISCUSSION

Single crystal study: Using ENRAF NONIUS X-Ray Diffractometer, the structure of the crystals were calculated. The obtained crystal belongs to Orthorhombic System. The three lattice parameters are a = 9.04Å, b = 11.5Å, c = 11.03Å and V = 1111Å The axial angles are $\alpha = \beta = \gamma = 90°$.

Ftir analysis: IFS BRUKKER 66V Spectrophotometer was used to determine the functional groups present in the compound by KBr pellet techinique. The strong band at 3416 cm^{-1} is due to OH stretching vibration. Symmetric

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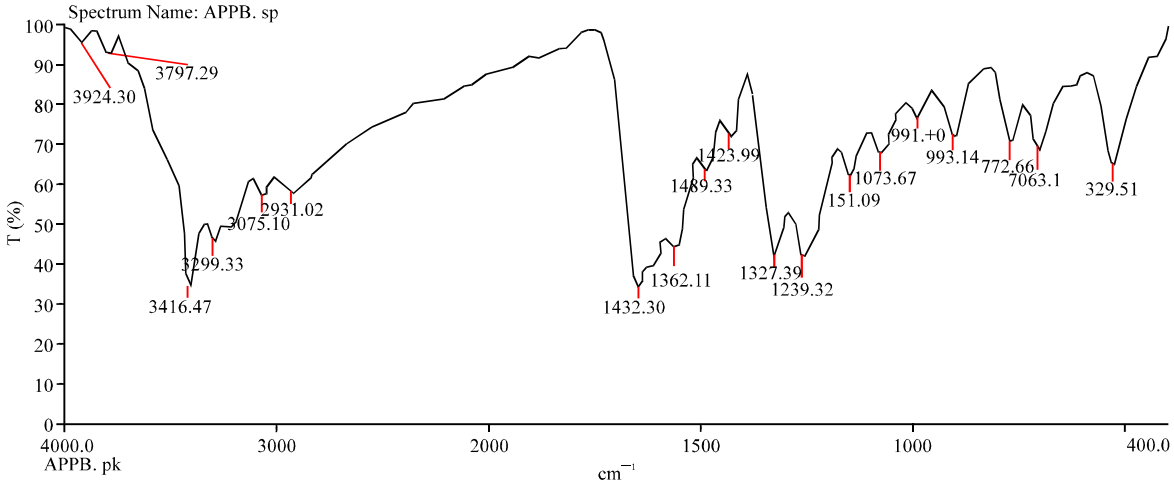

Fig. 1: FTIR-spectrum of LAPPB

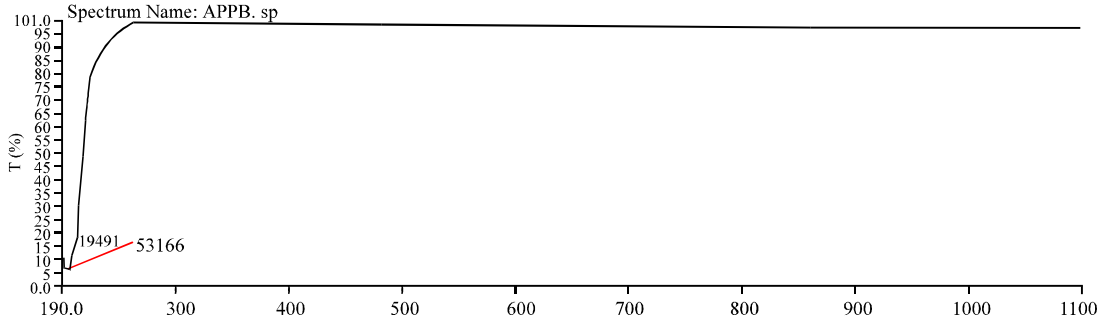

Fig. 2: UV-Vis spectrum of LAPPB

Table 1: FTIR spectral band assignments of LAPPB

Wave No. (cm^{-1})	Band assignments
3416	OH stretching vibration
3075	Symmetric and asymmetric stretching vibrations of N-H
2931	Symmetric and asymmetric stretching vibrations of N-H
1562	CH_3 bending
1489	O-H symmetric stretching
1372	CH_3 bending
1259	O-H bending of COOH
1151	C-O stretching
905	B-O symmetric stretching
772	B-O symmetric stretching
529	COO^- rocking

and asymmetric stretching vibrations of N-H were assigned at 3075 and 2931 cm^{-1}. The B-O vibrations of Borate group is identified by the absorption bands at 772 and 1428 cm^{-1} (Justin Raj *et al*., 2009). The Spectral band assignments of LAPPB is shown in Table 1. The FTIR-spectrum of LAPPB is shown in Fig. 1.

UV-Visible spectrometer analysis: The Optical Transmission of LAPPB crystal was taken in the range 190-1100 nm and it is shown in Fig. 2. The transparency is around 95% within the range of 230-1100 nm. This is the main requirement for the materials possessing NLO property. This high transmission of the LAPPB is due to the electronic transitions associated within the sample. The synthesised crystal shows equal transmission as that of the conventional grown crystals (Justin Raj *et al*., 2009). The UV-Vis spectrum of LAPPB is shown in Fig. 2.

Microhardness study: LAPPB crystal was subjected to the load variation from 25 to 100 g (Ambujam *et al*., 2006) in the Vickers Micro hardness test. The Micro hardness number was calculated using the relation:

$$Hv = 1.8544\ P/d^2\ kg\ mm^{-2}$$

Vickers micro hardness number vs applied load graph is illustrated in the Fig. 3.

It shows that the hardness of the crystal increases with the increase of load. The work hardening coefficient

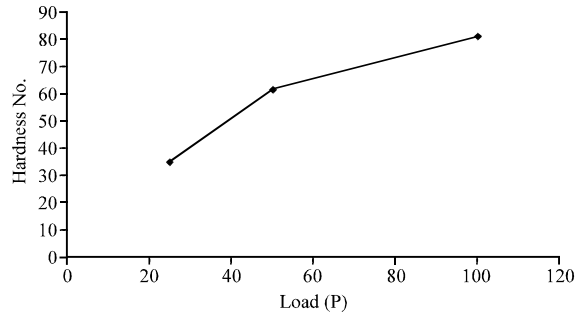

Fig. 3: Micro hardness No. versus load

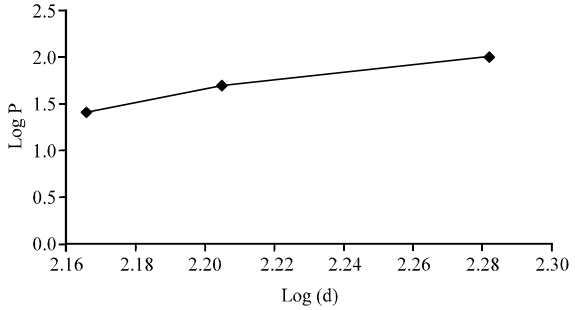

Fig. 4: Microhardening coefficient log P verses log d

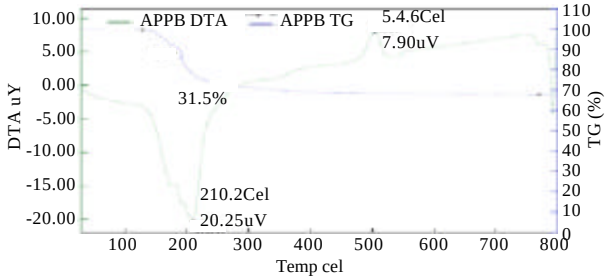

Fig. 5: Thermal studies

n is determined from the plot of log P Vs log d. It is shown in Fig. 4. It is observed that the Vickers hardness profile of the crystal increases with the increase of load (Vimalan *et al*., 2007). The work hardening coefficient is found to be 5.7. This shows that the synthesized material is a soft material (Lucia Rose *et al*., 2011).

Second harmonic generation testing (SHG)

Using the Nd: YAG laser beam at 1064 nm, the SHG conversion efficiency of the crystal was carried by Kurtz powder method. An input of 4.1 mJ was used. The SHG was confirmed by the emission of green signal of wavelength at 532 nm. The efficiency is confirmed with KDP and it is 0.27 times that of KDP.

Thermal studies: From the TG/DTA studies, we can find out the thermal stability of the sample. The TG/DTA Spectrum of LAPPB was taken using the instrument" SII EXSTAR 6000" Sample initially weighing 7.387 mg was taken in an alumina crucible and it was heated at a rate of 20°C min^{-1} from 30 to 800°C. The TGA curve shows that there is no weight loss upto 156°C and there is weight loss of about 31.6% of the initial mass after 156°C. From the DTA curve, it is observed that there is one endothermic peak at 210.2°C. From this it is concluded that the crystal is decomposed at 210.2°C. This is shown in Fig. 5.

CONCLUSION

Single crystals of L-Alanine Potassium Penta Borate are successfully grown by slow evaporation technique. The above crystal belongs to orthorhombic system that was characterized by single crystal XRD. The UV-VIS spectrum confirmed the device fabrication property of the crystal. The FTIR spectrum confirmed the presence of both Alanine and Potassium penta borate molecules for LAPPB. The NLO test using the Nd-YAG laser proved the NLO property of the crystal. The Vickers Micro hardness study revealed the soft category of the grown crystal. The TG/DTA Analyses explained that the stability of the crystal was upto 153°C and it started melting at 210.2°C.

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REFERENCES

Ambujam, K., S. Selvakumar, D.P. Anand, G. Mohamed and P. Sagayaraj, 2006. Crystal growth, optical, mechanical and electrical properties of organic NLO material γ-glycine. Cryst. Res. Technol., 41: 671-677.

Balasubramanian, D., R. Jayavel and P. Murugakoothan, 2009. Studies on the growth aspects of organic L-alanine maleate: A promising nonlinear optical crystal. Nat. Sci., 1: 216-221.

Chitra, M. and S. Palaniswamy, 2010. Growth and characterization of nonlinear optical material: Alanine barium chloride. Rasayan J. Chem., 3: 145-150.

Devaprasad, S.A. and J. Madhavan, 2010. Synthesis, growth and characterization of L-alaninium oxalate a promising nonlinear optical single crystal. Arch. Applied Sci. Res., 2: 26-32.

Janarthanam, S., T. Kishore Kumar, S. Pandi and D. Prem Anand, 2009. Growth and spectroscopic studies of L-argininum formate NLO single crystals. Indian J. Pure Applied Phys., 47: 332-336.

Justin Raj, C., S. Krishnan, S. Dinakaran, J. Mary Linet, R. Uthrakumar, R. Robert and S. Jerome Das, 2009. Growth, optical, mechanical, dielectric and theoretical studies on potassium pentaborate tetrahydrate ($KB_5O_8 \bullet 4H_2O$) single crystal by modified Sankaranarayanan-Ramasamy method. J. Mater. Sci. Technol., 25: 745-748.

Kumar, R.M., D.R. Babu, D. Jayaraman, R. Jayavel and K. Kitamura, 2005. Studies on the growth aspects of semi-organic L-alanine acetate: A promising NLO crystal. J. Cryst. Growth, 275: e1935-e1939.

Lucia Rose, A.S.J., P. Selvarajan and S. Perumal, 2011. Studies on growth and characterization of an NLO crystal: L-Alanine Hydrogen Chloride (LAHC). Mater. Chem. Phys., 130: 950-955.

Meystrey, P. and M. Sargent, 1991. Elements of Quantum Optics. Springe-Verlag, Berlin, Germany, ISBN-13: 9783662116548.

Misoguti, L., A.T. Varela, F.D. Nunes, V.S. Bagnato, F.E.A. Melo, J.M. Filho and S.C. Zilio, 1996. Optical properties of L-alanine organic crystals. Opt. Mater., 6: 147-152.

Muncheryan, H.M., 1991. Lasers and Opto-Electronic Devices. Hemisphere Publ. Co., New York, USA.

Prabha, D. and S. Palaniswamy, 2010. Growth and characterization of NLO material: L-alanine sodium chloride. Int. J. Chem. Environ. Pharm. Res., 1: 40-46.

Ragavan, P.S. and P. Ramasamy, 2002. Recent trends in crystal growth technology. PINSA, 68: 235-249.

Raghavan, P.S. and P. Ramasamy, 1999. Crystal Growth: Process and Methods. KRU Publications, Kumbakonam, India, Pages: 404.

Raja, C.R., R. Gobinathan and F.D. Gnanam, 1993. Growth and characterisation of potassium pentaborate single crystals. Crystal Res. Technol., 28: 453-456.

Rajan Babu, D., D. Jayaraman, R.M. Kumar and R. Jayavel, 2002. Growth and characterization of non-linear optical L-alanine tetrafluoroborate (L-AlFB) single crystals. J. Crystal Growth, 245: 121-125.

Rajasekar, S.A., K. Thamizharasan, S.J.A. Pragasam, J.P. Julius and P. Sagayaraj, 2003. Growth and characterization of pure and doped potassium pentaborate (KB5) single crystals. J. Cryst. Growth, 247: 199-206.

Razzetti, C., M. Ardoino, L. Zanotti, M. Zha and C. Paorici, 2002. Solutions Growth and characterisation of L-alanine single crystals. Cryst. Res. Technol., 37: 456-465.

Sakai, J., 1992. Phase Conjugate Optics. McGraw Hill Inc., New York and London, ISBN-13: 9780070543157, Pages: 206.

Shen, Y.R., 1984. The Principles of Nonlinear Optics. John Wiley and Sons, New York, USA., ISBN-13: 9780471889984, Pages: 563.

Thamizharasan, K., S.X. Jesu Raja, F.P. Xavier and P. Sagayaraj, 2000. Growth, thermal and microhardness studies of single crystals of potassium penta borate (KB5). J. Cryst. Growth, 218: 323-326.

Urit, C.I., 2010. Growth of some inorganic, organic and semi-organic nonlinear optical crystals By sankaranarayanan-Ramasamy method and their characterization. Ph.D. Thesis, The Suranaree University of Technology, Nakhon Ratchasima, Thailand.

Vijayan, N., S. Rajasekaran, G. Bhagavannarayana, R.R. Babu, R. Gopalakrishnan, M. Palanichamy and P. Ramasamy, 2006. Growth and characterization of nonlinear optical amino acid single crystal: L-Alanine. Cryst. Growth Design, 6: 2441-2445.

Vimalan, M., A. Ramanand and P. Sagayaraj, 2007. Synthesis, growth and characterization of L-alaninium oxalate: A novel organic NLO crystal. Cryst. Res. Technol., 42: 1091-1096.