GROWTH AND CHARACTERIZATIONS OF L-ASPARAGINE SINGLE CRYSTALS

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Abstract: NLO crystal of L-Asparagine was grown by low evaporation solution growth technique at room temperature. The presence of various functional groups has been identified by using FT-IR spectral analysis ranging between 4000 cm^{-1} and 450 cm^{-1}. The UV-vis-NIR spectroscopic study shows that the grown crystal has good optical quality and belongs to insulating category. The dielectric constant has been carried out over a frequency range from 50Hz to 5MHz. Microhardness study reveals that the grown crystals belong to soft materials.

Keywords: Crystal growth; Optical properties; Dielectric; Microhardness

1. Introduction

Organic nonlinear optical materials are attracting all the researchers due to their applications in communications, data storage, high speed information, optical computing, telecommunication, sensors, imaging and optical devices [1-3]. It has been attracting many industry peoples due to versatile properties like low dielectric constant at high frequency, low laser damage threshold, high transparency, high refractive index, more chemical stability and good thermal stability [4-5]. Organic materials quality only based on π electron bond system. The π bond system with appropriate electron acceptor and donor groups can enhance the optical nonlinearity [6-7]. Yogam et al. reported on Growth, thermal, and optical properties of L-asparagine monohydrate NLO single crystal [8]. Growth and Characterization of L-Asparagine (LAS) Crystal Admixture of Paranitrophenol (PNP): A NLO Material was reported by Grace Sahaya Sheba et al. [9]. Ricardo et al. was described on the effect of Cu^{II} ions in l-asparagine single crystals [10]. In this present work, we report on synthesis and growth of L-Asparagine single crystals was grown using slow evaporation method. The grown crystals were analysed by UV-Visible, FT-IR, Dielectric and microhardness studies and reported their detailed results in this article.

2. EXPERIMENTAL WORK

The calculated amount of L-Asparagine (analar grade) was dissolved in de ionized (DI) water at room temperature and stirred continuously to get saturated homogeneous solution for two hours with the help of magnetic stirrer [11]. Then, the saturated homogeneous solution was filtered twice with whattman filter paper before it was subjected to evaporation. The solution was covered with perforated polythene paper to avoid dust and kept undisturbed place for evaporation. Crystal of appreciable size was obtained at the end of 22nd day. The as grown L-Asparagine crystal as shown in fig.1. Then, the as grown crystals were subjected to UV-Visible, FT-IR, Dielectric and microhardness studies.

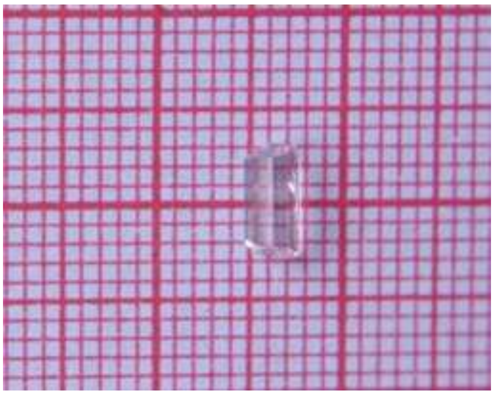

Fig. 1 As grown L-Asparagine crystal

3. Results and Discussion

3.1 Dielectric Studies

The dielectric studies of L-Asparagine single crystal was carried out using LCR HIOKI 3532 HI tester with the frequency range between 50 Hz and 5 MHz at the temperature 323 K and 373 K. The dielectric constant of the grown L-Asparagine was calculated by varying the frequencies. The graph was plotted between log f and dielectric constant and shown in fig. 2. The obtained results indicate that the dielectric constant of material decreases with increasing of frequencies. The variation of dielectric constant is due to attribution of electronic and ionic orientation of polarization. The low dielectric constant at high frequencies reveals that the grown material is well suitable for optoelectronic device applications.

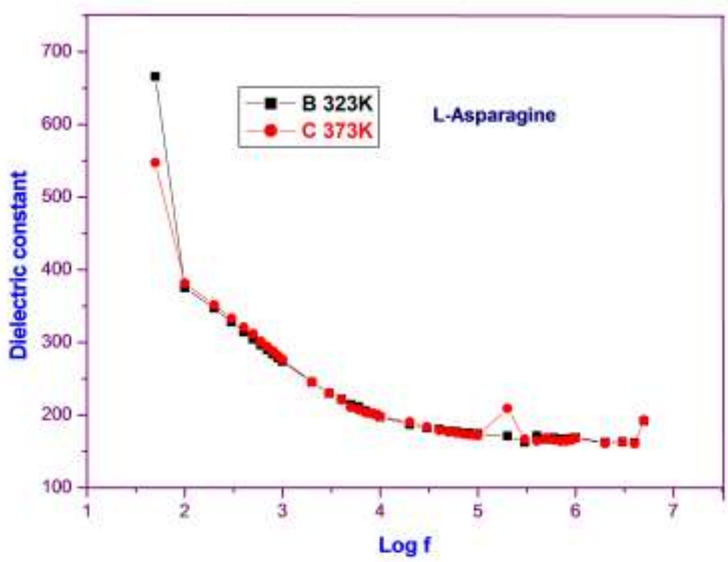

Fig.2 Log f Vs dielectric constant of L-Asparagine

3.2 FTIR ANALYSIS

FTIR spectrum of grown L-Asparagine single crystal was recorded using Perkin Elmer spectrometer by using FTIR/ATR technique in the range of 4000 cm^{-1} to 450 cm^{-1}. The peak observed at 3380 cm^{-1} is assigned to the NH symmetric stretching vibration. The peak around 681.77 cm^{-1} can be assigned to C=N stretching vibration. The peak around 1074.68 cm^{-1} can be assigned C=O stretching vibration. The peak at 665.74 cm^{-1} can be assigned to COO^- bending vibration [12-13]. The obtained FTIR spectrum of L-Asparagine is shown in fig.3.

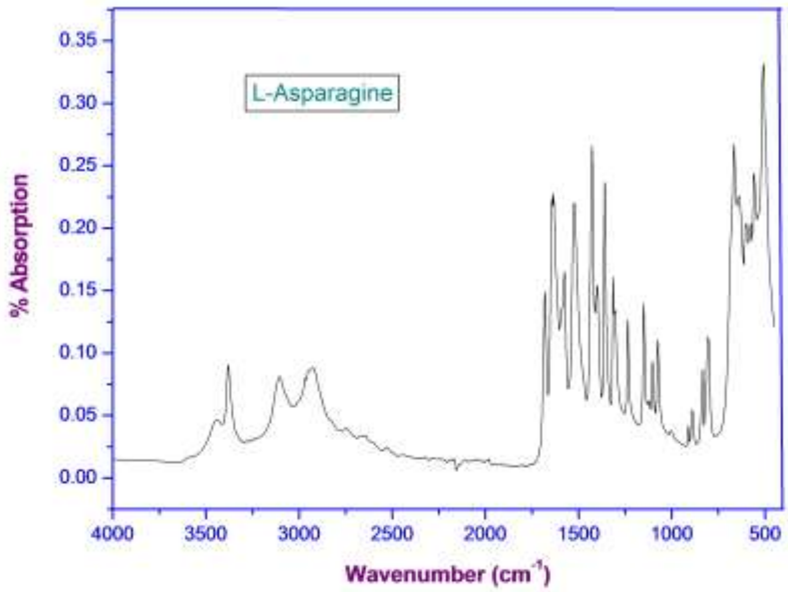

Fig.3 FTIT spectrum of L-Asparagine

3.3 UV VISIBLE SPECTRAL STUDIES

UV visible spectral studies of grown L-Asparagine crystal was carried out using LS45 model UV-visible spectrometer in the spectral range 190 - 800 nm. The absorption spectrum of L-Asparagine crystal is shown in fig. 4. The observed lower cut off wavelength of L-Asparagine crystal is 385 nm. The forbidden band gap for the grown crystal was calculated by using the below relation. $E_g = hc/\lambda$ Where, h is the Planck's constant, c is the velocity of the light and λ is the lower cutoff wave length. The calculated forbidden energy band gap of pure L-Asparagine crystal is 3.22 eV. This result suggests that the grown material belong to the typical insulating material and is suitable for fabricating optoelectronic devices.

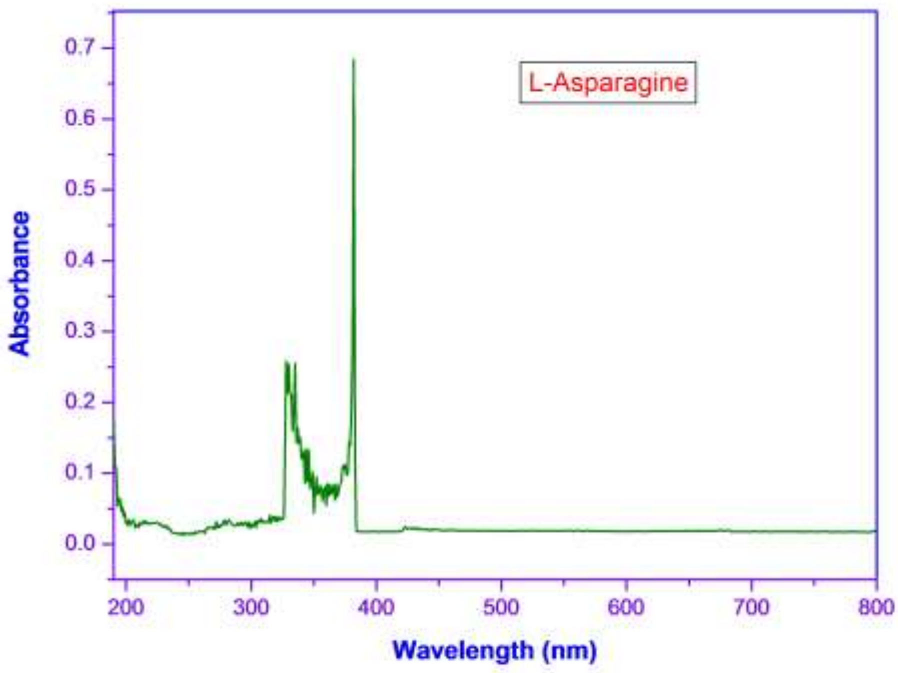

Fig. 4 Absorption spectrum of L-Asparagine single crystal

3.4 MICHRO HARDNESS STUDIES

The grown L-Asparagine single crystal was subjected to Vicker micro hardness test using HMV-2T microhardness tester. The indentations were made on the grown crystal L-Asparagine by varying load 25, 50, 100 gm at room temperature with constant indentation in steps of 5 sec to determine the hardness number. The graph was plotted between load p and hardness number (HV) and is shown in fig.5. Also the graph was plotted between log P and log d and depicted in fig.6. From the graph 7, the work hardening coefficient (n) was calculated by taking the slope. The obtained work hardening coefficient of the material is 1.95 which confirms that the grown material is belonging to the category of soft in nature. Hence, the grown L-Asparagine is used for optoelectronic device applications below 100 gm applied load.

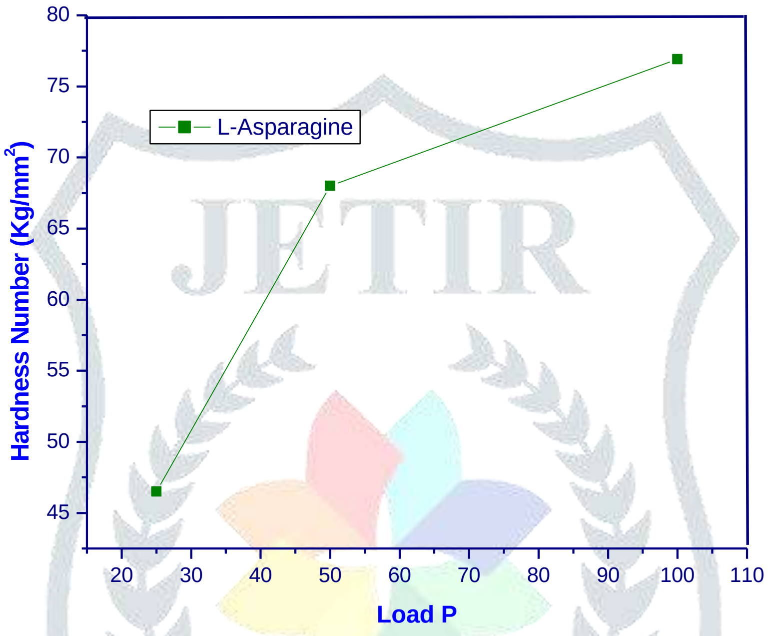

Fig. 5 Load P Vs Hardness number

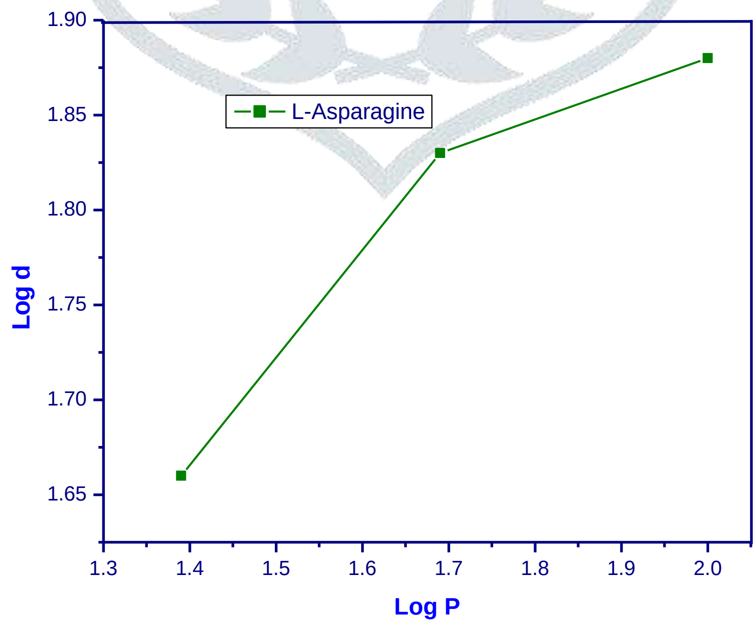

Fig. 6 Log P Vs Log d

4. CONCLUSION

The L-Asparagine crystal was grown by slow evaporation solution growth technique at ambient temperature. The estimated energy band gap of the L-Asparagine single crystals is 3.22 eV. The presence of functional groups and modes vibration of the single crystals was analyzed by Fourier transform infrared spectrometer. The work hardening co-efficient of the L-Asparagine single crystal is about 1.95. A dielectric study shows that the dielectric constant decreases with increase in frequency for L-Asparagine crystals. Thus, the grown L-Asparagine crystal is exhibiting good optical quality and used for optoelectronic device applications.

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