Journal of Advances in Applied Sciences and Technology
ISSN : 2393-8188 (print)
2393-8196 (online)
www.milliyasrcollege.org.journal.php

ANALYSIS OF OPTICAL COEFFICIENTS IN L-CYSTEINE DOPED ADP CRYSTALS FOR NLO APPLICATIONS

R.N Shaikh
Crystal Growth Research Laboratory, Milliya Arts Science and Management Science College, Beed, (M.S.) India.
* email:raisshaikh9@gmail.com

Abstract: In present investigation, L-Cysteine doped ammonium dihydrogen phosphate (ADP) crystal has been grown by slow evaporation technique. The functional groups of grown crystal were identified using the Fourier transform infrared (FT-IR) spectral analysis. The UV-visible studies were carried to assess the high optical transparency and wide range of transmission of doped L-Cysteine crystal in the range of 200-900 nm. The imperative optical constants like refractive index and optical conductivity has also been evaluated in the visible region.

KEYWORDS: Crystal Growth, UV-visible, optical properties

1. INTRODUCTION

The ammonium dihydrogen phosphate (ADP) is an inorganic material widely used as second, third and forth harmonic generator for Nd: YAG and Nd: YLF lasers. Studies of ADP crystals are gaining more interest because of their unique nonlinear optical, dielectric, piezoelectric and anti ferroelectric properties [1-3]. Many researchers have investigated pure and doped ADP crystals to study the enhancement in electrical, nonlinear and ferroelectric properties. The improved optical transmission and electrical conductivity of ADP doped with L-alanine crystals has been reported by Ferdousi et al [4]. Effect of L-lysine on growth and various properties of ADP has been reported by Rajesh et al [5]. Effect of L-arginine and glycine on growth and various properties of ADP have been reported by Pattanaboonmee et al [6]. Structural, optical, dielectric and mechanical study of L-proline doped ADP has been reported by Hasmuddin et al [7]. Brahim et al [8] has reported growth and detailed analysis of MAS NMR, FT-IR and Raman spectroscopic studies of different mole% LC doped ADP crystal and also reported its tetragonal structure by powder XRD. However, to the best of our knowledge no report is available in the literature on the linear- nonlinear optical, electrical, mechanical and thermal properties of 1wt. % LC doped ADP crystal. Therefore, in the present communication we have reported the effect of LC on optical coefficient of ADP crystal.

2. SYNTHESIS AND CRYSTAL GROWTH:

The amino acid LC was added in three different mole percent in the super saturated solution of AR grade ADP. The homogeneous solutions were prepared by constant stirring for 6 hours. The solutions were then filtered and kept for slow evaporation at room temperature. The good quality transparent seed crystals were harvested within 7-8 days.

3. RESULTS AND DISCUSSION

The FT-IR spectrum of LC doped ADP crystal was recorded using the Bruker α-ATR spectrophotometer in the range of 600-4000 cm-1 to confirm the incorporation of LC in ADP crystal. The recorded transmittance FT-IR spectrum of grown crystal is depicted in Fig. 1. In the spectrum the broad band around 3610 cm-1to 2530 cm-1 was due to the O-H vibrations of P-O-H group and N-H vibrations of NH4.The band at 2302 cm-1 was observed due to hydrogen bond. The peak at 1502 cm-1 was due to N-H vibrations. The strong band at 1260 cm-1 was observed due to the combination of the asymmetric stretching vibration of PO4 with lattice. The peaks at 1095 cm-1 and 967 cm-1 represents P-O-H vibrations. These peaks are same as that of pure ADP with slight shift in wave numbers from lower to higher, due to the presence of LC in ADP [4, 7]. The additional peaks at 1743 cm-1 was observed due to C=O stretching and the peak at 650 cm-1 was observed due to C-S stretching [8].

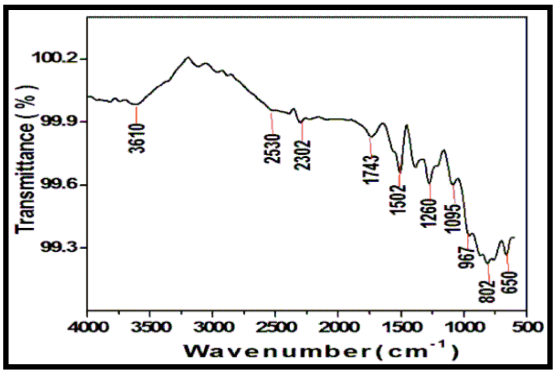
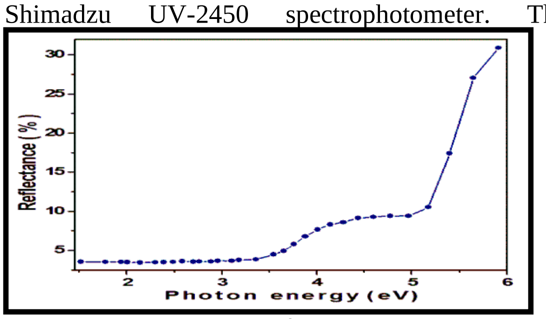


Fig.1. *FT-IR spectrum of LC doped ADP crystal*

3.1 UV-Vis Spectrophotometry

The UV-visible study of LC doped ADP crystal was undertaken in the range of 200-900 nm using Shimadzu UV-2450 spectrophotometer. The



transmittance spectrum of grown crystal shown in Fig.7.4 reveals the large transmission range of doped ADP crystal which is extending to the UV region. This might be due to prominent n to π* transitions offered by nitrogen and hydrogen bonds in organic compound LC [11]. The transparency of LC doped ADP crystal is more than 89% in entire visible region which confirms its suitability for SHG transmission devices [12].The dependence of absorption coefficient on incident photon energy helps to evaluate the band gap of material using the relation (αhν)2= A (hν-Eg) [12].

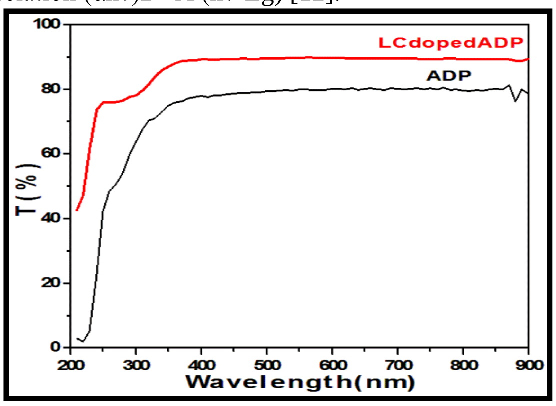


Fig.2 *UV- vis. Transmittance spectrum*

From the recorded transmission spectra, the linear optical constants of LC doped ADP crystal as a function of photon energy is plotted (Figs. 3-9). For understanding the interaction of light with matter, it is very essential to study the refractive index and the

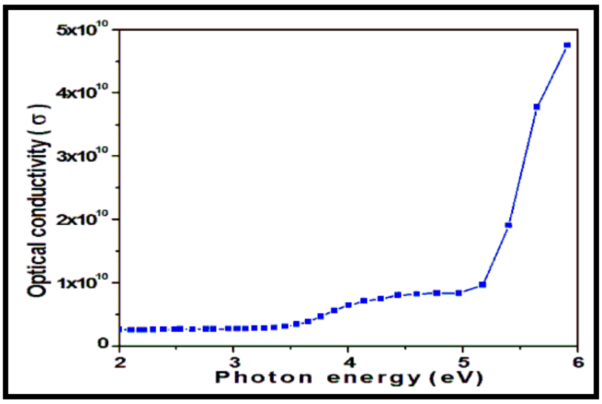


Fig.3 *Reflectance as a function of photon energy*.

extinction coefficient. The refractive index of the material at 900 nm is 1.46. Also the extinction coefficient shows exponential decay as the photon energy decreases**.** Refractive index being the measure of percentage of intensity of light reflected, the reflectance shows an increasing value along the photon energy.

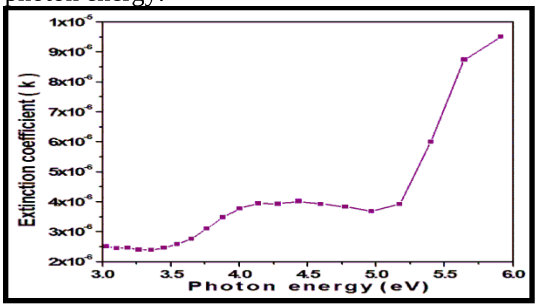


Fig. 4 *Plot of extinction coefficient vs. hυ*

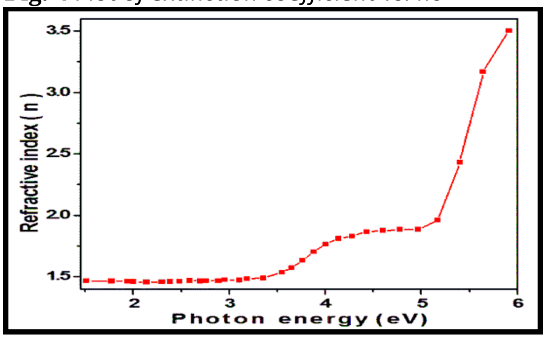


Fig. 5 *Refractive index as a function of photon energy.*

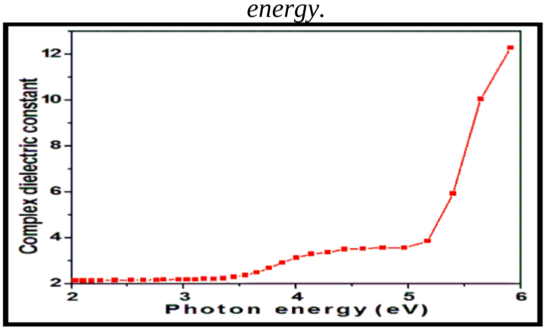


Fig. 6. *Dielectric constant as a function of photon energy.*

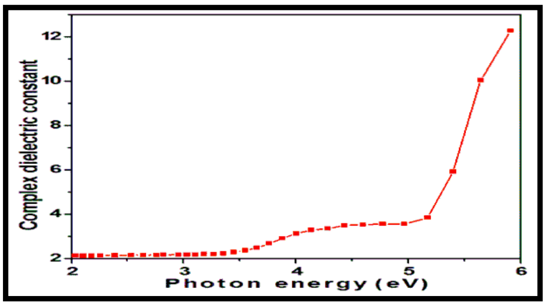


Fig. 7.*Dielectric constant as a function of photon energy.*

Fig. 8.*Optical conductivity as a function of vs. hυphoton energy.*

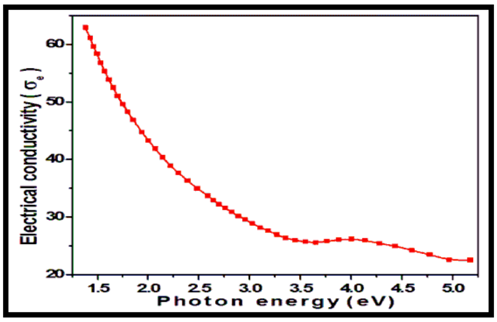


Fig. 9. Electrical conductivity as a function of photon energy.

From figures 36 and 4, it is clear that the reflectance and the extinction coefficient depend upon the absorption coefficient. The internal energy of the device depends on this absorption coefficient. The high transmission, low absorbance and low reflectance in the UV-vis. region make the material a prominent one for antireflection coating in solar thermal devices and NLO applications [15]. The low extinction value and electrical conductivity show the semiconducting nature of the material. The high magnitude of optical conductivity (1010s-1) confirms the presence of very high photo response nature of the material [15]. This makes the material more prominent for device applications in information processing and computing.

4. CONCLUSION

The amino acid LC doped ADP was grown by slow evaporation technique. The dopant LC promoted the transmittance of ADP up to 89%, and has appreciable changes in optical coefficients which indicate that LC doped ADP crystal is suitable for optical applications.

REFERENCES

[1] Dhumane NR, Hussaini SS, Dongre VG, Shirsat MD. Influence of glycine on the nonlinear optical (NLO) properties of zinc (tris) thiourea sulfate (ZTS) single crystal. Optic Mater 2008; 31:328-32.

[2] Dhanaraj PV, Bhagavannarayana G, Rajesh NP. Effect of Amino Acid Additives on Crystal Growth Parameters and Properties of Ammonium Dihydrogen Orthophosphate Crystals. Mater Chem. and Phys 2008; 112: 490-95.

[3] Rajesh P, Ramasamy P. Growth of DL-malic acid-doped ammonium dihydrogen phosphate crystal and its Characterization. J Cryst Growth 2009; 311:3491-97.

[4] Ferdousi Akhtar, Jiban Podder. Structural, Optical, Electrical and Thermal Characterizations of Pure and L-alanine Doped Ammonium Dihydrogen Phosphate Crystals. Cryst Proc Technol 2011; 1:18-5.

[5] Rajesh P, Ramasamy P, Mahadevan CK. Effect of L-lysine monohydrochloride dihydrate on the growth and properties of ammonium dihydrogen orthophosphate single crystals. J Cryst Growth 2009; 311: 1156-60.

[6]Pattanaboonmee N, Ramasamy P, Yimnirun R, Manyum P. A comparative study on pure, L-arginine and glycine doped ammonium dihydrogen orthophosphate single crystals grown by slow solvent evaporation and temperature-gradient method. J Cryst Growth 2011; 314:196-01.

[7] Mohd. Hasmuddin, Preeti Singh, Mohd. Shkir, Abdullah MM, Vijayan N, Bhagavannarayana G, Wahab MA. Structural, spectroscopic, optical, dielectric and mechanical study of pure and L-Proline doped ammonium dihydrogen phosphate single crystals. Spectrochim Acta A 2014; 123: 376–384.

[8] Brahim FB, Bulou A. Growth and spectroscopy studies of ADP single crystals with l-glutamine and l-cysteine amino acids. Vibrational Spectroscopy 2013;65:176-85.

[9]Kurtz SK, Perry TT. A Powder technique for the evaluation of Nonlinear Optical Materials. J Appl Phys 1968; 39: 3798-13.

[10]Parthasarathy M, Anantharaja M, Gopalakrishnan R.Growth and characterizationoflargesinglecrystalsof L-serine methyl ester hydrochloride. J Cryst Growth 2012;340: 118–22.

[11] Subhashini V, Ponnusamy S, Muthamizhchelvan C. Synthesis, growth, spectral, thermal, mechanical and optical properties of piperazinium (meso) tartrate crystal: A third order nonlinear optical material. J Cryst Growth 2013; 363:211-19.

[12] Rajalakshmi M, Indrajith R, Ramasamy P, Gopalkrishnan R. Synthesis, Growth and Characterization of 1H-Benzimidazolium Hydrogen L-Tartrate Dihydrate Single Crystals. Mol Cryst Liq Cryst 2011; 548: 126-41.

[13] Mohd Anis, Shirsat MD, Muley G, Hussaini SS. Influence of formic acid on electrical, linear and nonlinear optical properties of potassium dihydrogen phosphate (KDP) crystals. Physica B 2014; 449: 61-6.

[14] Shaikh RN, Mohd. Anis, Shirsat MD, Hussaini SS. Investigation on the Linear and Nonlinear Optical Properties of L-Lysine Doped Ammonium Dihydrogen Phosphate Crystal for NLO Applications. J Appl. Phys 2014; 6: 42-6.

[15] T. C. Sabari Girisun, S. Dhanuskodi, Cryst. Res.Technol., 44 (2009) 1297.