Original Research Article

Journal of Functional Materials and Biomolecules

Journal homepage: www.shcpub.edu.in

ISSN: 2456-9429

# INVESTICATION ON GROWTH AND CHARACTERIZATION OF GLYCINE PARA NITROPHENOL CRYSTAL FOR NLO APPLICATION

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Received on 21 November 2023, accepted on 30 November 2023,
Published online on December 2023

**Abstract**

Single crystals of Glycine Para Nitrophenol (GPNP) for NLO applications aregrown from an aqueous solution by slow evaporation solution growth technique at ambient temperature.Characterization studies have been conducted to probe the nonlinear effects of the crystal. The crystalline nature and purity of GPNP crystal was confirmed by powder XRD pattern. The chemical composition is resolved by the Fourier transform infrared (FTIR) spectroscopy and energy dispersive X-ray analysis. The UV-Visible spectroscopic study showed that the lower cut-off wavelength was found to be 216nm it indicated the good transmission of crystal. Energy gap spectrum shows the band gap of the crystal is about 5.9eV. The fluorescence emission observed at 572nm. The nonlinear optical property was tested using Kurtz Perry powder technique and SHG efficiency was measured.

**Keywords:** Slow evaporation method, NLO, XRD, FTIR, UV-Visible, Fluorescence, SHG.

## 1. Introduction

Molecular NLO materials are greatly utilized in optoelectronic and photonic fields due to their significance and nonlinear effects [1]. The symmetrical or regular arrangement of atoms in crystalline lattice point is called crystal. The crystals are used in many of places in our everyday life, chemical industries, food industries, purification technique, etc. In recent year science association of nonlinear optics developed in many applications. The NLO crystals applications like optical electronics, signal processing, optical modulator, frequency shifting, organic transistor, organic LDE's [2,3]. The crystals it produced the nonlinear optical effect from electricity, magnetic field and strain field is called NLO crystals [4-7]. The NLO crystal is formed in any kind of materials like Organic, inorganic and semi-organic crystals are used in the nonlinear optics [8-13]. Organic Nonlinear optical materials had a variety of device application. It is using the photorefractive effect in real time holography and frequency doubling, electro-optic modulation and switching [14,15]. The organic NLO crystal of Glycine Para Nitro-phenol crystal is grown and its characterization investigations are single crystal XRD, Powder XRD, FTIR, UV-visible, SHC and absorption and fluorescence studies.

## 2.Experimental procedure

A high quality of glycine P nitro-phenol single crystal was prepared by slow evaporation method.The glycine is taken in 1M ratio and it is stirred in 50ml deionized or double distilled water. The para nitro-phenol is taken in 1M ratio and it stirred in 50ml deionized water with the 45℃ at 1 h. On the glycine solution and the para nitro-phenol solution is added and the mixed solution is stirred in 2 h. After the stirred mixed solution was filtered using A1 whatmann filter sheet. The filtered solution kept in room temperature without disturbance. The solution is nucleation after 45 days the single crystal is grown and it's shown in Fig 1. The crystal size is 12×10×3 $mm^3$.

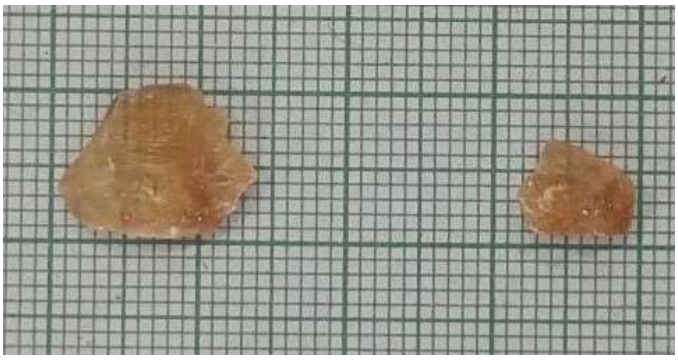

**Fig.1 Grown single crystal of Glycine 4 Nitro-phenol**

## 3. Characterization studies

### 3.1. Powder X-ray diffraction analysis

The powder X-ray diffraction is investigated and given crystallinity and analysis the lattice parameter. The powder X-ray diffraction pattern of glycine 4 nitro-phenol grown crystal was noted by using Bruker AXS D2 PHASER. In X-ray diffractometer Cu Kα (λ=1.5406Å) radiation [16]. The powder sample scan range is 3-90º. The powder XRD

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pattern was matched in JCPDS Card No. 06-0230 of glycine in some similar peaks is matched. The major peak was found in 25.207º. The powder XRD pattern is shown in Fig.2.

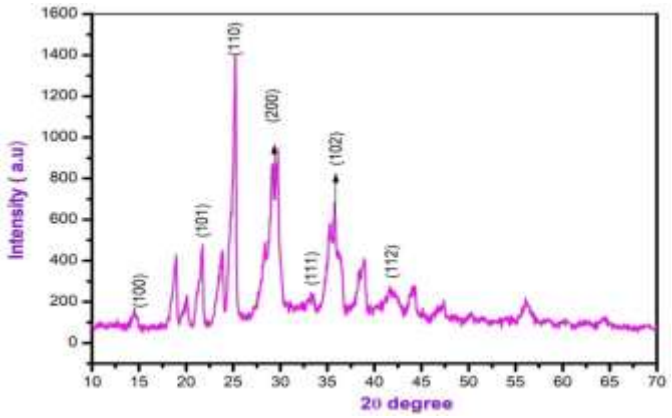


**Fig.2. Powder XRD pattern of glycine 4 nitro-phenol**

### 3.2. Fourier Transform Infrared (FT-IR) Analysis

The FT-IR is used in the analysis for the functional group, chemical bond strength of the compound. The powder sample was used in the Fourier Transform Infrared Analysis. It performed between 400-4000cm$^{-1}$ by used KBR pellet method[17,18]. The FTIR is analysis found the mixed nature of Glycine 4 nitro-phenol and it show in table.1. The Fig.3 shows the FT-IR spectral line pattern.

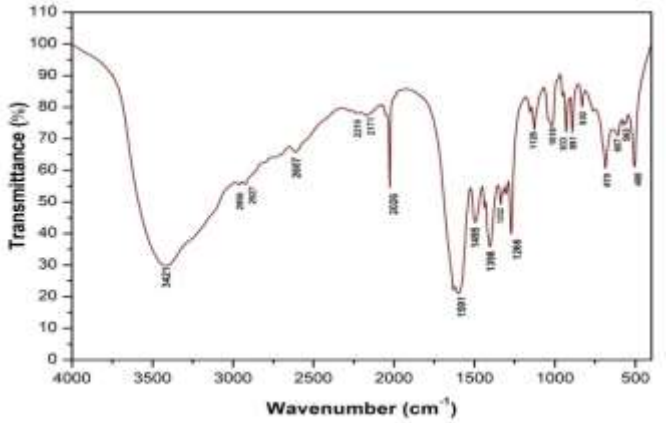


**Fig.3. FT-IR spectral pattern**

**Table.1. FT-IR analysis**

| Frequency in wavenumber(cm$^{-1}$) | Assignment of vibrating |
|---|---|
| 3421 | N-H Stretch |
| 2956 | C-H Stretch |
| 1495 | N=O nitro asymmetric stretch |
| 1332 | N=O nitro symmetric stretch |
| 1266 | C-O stretch |
| 2607 | O-H bond |
| 830 | Para-diethylbenzene |
| 1591 | C-C Stretch |
| 1398 | C-H Bending |
| 679 | C-C-H Bending |
| 498 | C-N Stretch |

### 3.3 UV Visible spectral analysis

UV spectral analysis is found the optical absorbance and transmittance of the material. The powder of glycine 4 nitro-phenol is used in this technique. The UV absorbance ranges 252-900 nm it indicated the good transmission of the crystal [19]. The absorbance is shown in Fig 4. The absorbance is inversely proportional to the transmittance. A=2-logT, Where A is the Absorbance and T is the Transmittance value

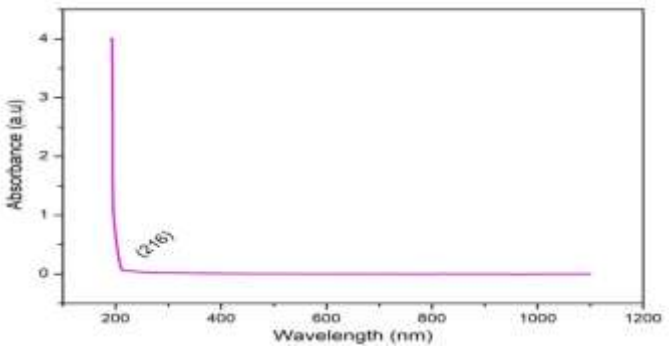


**Fig.4. UV Absorbance**

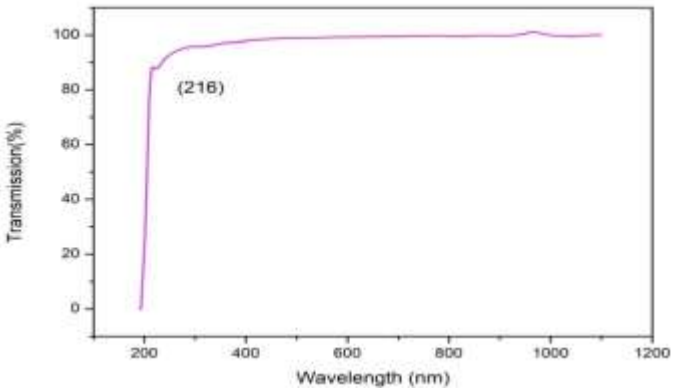


**Fig.5. UV Transmittance**

The transmittance graph is shown in Fig 5 and the transmittance is observed the cut off region is 216 nm and it is showing the good transmittance. Its resultant transmittance is maximum transmittance of glycine 4 Nitro-phenol crystal was used to nonlinear optical materials.

The UV- Visible band gap Fig 6 is used to measure the energy difference between valance bands to conduction band. The relation of band gap is,

$$Eg = (\alpha h\nu)^2 / h\nu$$

The glycine 4 Nitro-phenol is the band gap is Eg = 5.9eV, it is suitable for optoelectronic application.

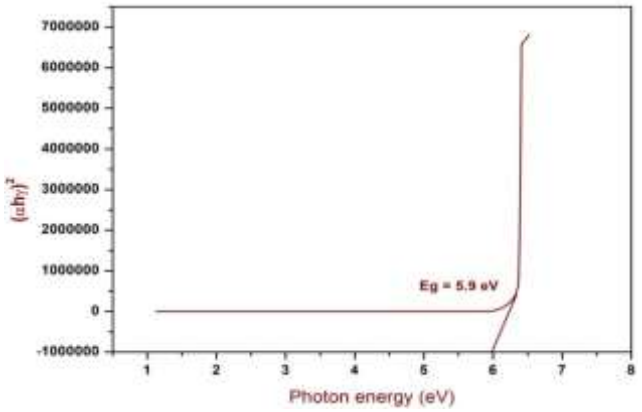


**Fig 6. UV-Visible spectrum band gap**

### 3.4. Fluorescence

Fluorescence is the material absorbs one color light and it emits an another color light is called fluorescence. The VARIAN CARY ECLIPSE fluorescence spectrometer, it is harmless process [20,21]. The fluorescence emission spectra measuring range is 380-740 nm. Glycine 4 nitro-phenol fluorescence spectral range is 570-590 nm. The peak is 572 nm and it is a YELLOW in color. The Fig. 7is shows the fluorescence spectra.

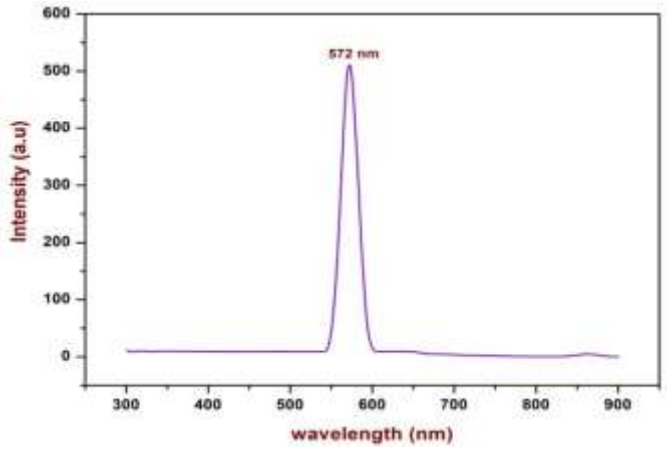


**Fig 7. Fluorescence spectra**

### 3.6 Second harmonic generation efficiency

The NLO efficiency of GPNP crystal was tested using Kurtz and Perry method. The sample was illuminated using Q-switched Nd: YAG laser with the first harmonic output of 1064 nm with a pulse width of 8 ns. The SHG was confirmed by the emission of green light (λ=532 nm). The second harmonic generation signal of 3.83 mJ for GPNP crystal was obtained for an input energy of 0.68 J. But the standard KDP crystal gave an SHG signal of 8.8 mJ for the same input energy. Thus it is notices that the SHG efficiency of the grown GPNP crystal is 0.43 times than that of KDP.

## 4. Conclusion

The glycine 4 Nitro-phenol is the new combination ofNon-linear optical organic crystal and it grown by using the slow evaporation method. The powder XRD pattern is plotted its hkl value. The FT-IR is analysis glycine 4 Nitro-phenol and foundfunctional group and molecular structure. The UV –Visible analysis of the glycine 4 Nitro-phenol crystal is determined the band gap is 5.9 eV. The fluorescence of emission spectra is 573 nm and it emits the yellow color emission. The measured relative value of the SHG efficiency of GPNP crystal is about 0.43 times than that of KDP.

## Conflicts of Interest

The authors declare that they have no known conflicts of interests.

## Acknowledgements

The authors thank Abdul Kalam Research Centre (AKRC)- Sacred Heart College (Autonomous) Tirupattur, SAIF-IIT Madras, Archbishop Casimir Instrumentation Centre (ACIC)- St. Joseph's College (Autonomous), Tiruchirappalli for providing their facilities for characterization facilities.

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