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Synthesis, Growth And Characterization Nonlinear Optical Crystals: Glycine Ammonium Chloride (GAC) Single Crystals For Opto Electronic Materials.

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Abstract

A new semi-organic nonlinear optical crystal of Glycine Ammonium Chloride (GAC) has been grown by slow evaporation solution growth technique. The crystal system and lattice parameters were determined from the single crystal X-ray diffraction analysis. Fourier transform infrared (FTIR) studies confirm the various functional groups present in the grown crystal. The transmittance and absorbance of electromagnetic radiation is studied through UV-Visible spectrum.The thermal behavior of the grown crystals has been investigated by DTA and TGA analysis. The second harmonic generation test has been confirmed by the Kurtz powder test.

1. Introduction

Non-linear optical materials (NLO) exhibiting second harmonic generation have been in great demand over the last few decades due to technological importance in the fields of optical communication, signal processing and instrumentation [1-3]. Most of the organic NLO crystals usually have poor mechanical and thermal properties and are susceptible for damage during processing even though they have large NLO efficiency. Also it is difficult to grow larger size optical-quality crystals of these materials for device applications. Purely inorganic NLO materials have excellent mechanical and thermal properties but possess relatively moderate optical nonlinearity because of the lack of extended π-electron delocalization [4, 5]. Hence it may be useful to prepare semi-organic crystals which combine the positive aspects of organic and inorganic materials resulting in useful NLO properties. In semi-organic materials, the organic ligand is ionically bonded with inorganics. These crystals have higher mechanical strength, chemical stability, and large nonlinearity, high resistance to laser induced damage, low angular sensitivity and good mechanical hardness [6, 10].

2. MATERIALS AND METHODS

Analar Reagent (AR) grade Glycine and Ammonium Chloride were dissolved in deionized water in the molar ratio of 1: 1, and the solution was allowed to attain supersaturation state. The synthesized salt was again dissolved in triple distilled water and then re-crystallized by slow evaporation process. This process was repeated two times to improve the purity of the material. Good quality and defect-free seed crystals were used to grow bulk-size crystal. Highly transparent and full-faced crystals were obtained within 6 weeks. A good quality of Glycine Ammonium Chloride crystals are found is shown in fig .1.

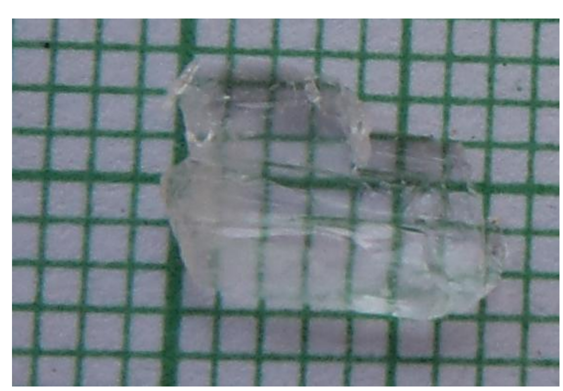

Fig 1. GAC single crystal

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3. RESULTS AND DISCUSSIONS

3.1. Single crystal X-ray diffraction analysis

The grown crystals were subjected to single crystal X-ray diffraction analysis to confirm the crystallinity and also to estimate the lattice parameters by employing Enraf Nonis CAD4 diffractometer. From the single crystal X-ray diffraction data, it is observed that the GAC crystal is hexagonal in structure. The lattice parameters were observed to be a = 6.941 Å, b = 6.941 Å, c = 5.419 Å, and space group Hexagonal P.

3.2. Fourier transforms infrared analysis

The FTIR spectrum of Glycine Ammonium Chloride was recorded in the range 400–4000 cm^{-1} using Perkin Elmer spectrometer by KBr pel-let technique. The resulting spectrum is presented in Fig. 2. The absorption peaks observed at 505.35 and 686.66 cm^{-1} are assigned to carboxylate groups, while the peaks observed at 2601.97, 1496.76 and 1126.43 cm^{-1} are attributed to $NH3^{+}$ group. Thus, the carboxyl group is present as carboxylate ion and amino group exists as ammonium ion in glycine. The C- C- N asymmetric and C- C- N symmetric stretching vibration are observed at 1043.49 and 891.11 cm^{-1}. The absorption at 1325.10 cm^{-1} is due to CH_2 twisting mode. The COO− symmetric stretching and COO− asymmetric stretching vibration are observed at 1390.68 cm^{-1} and 1585.49 cm^{-1}.

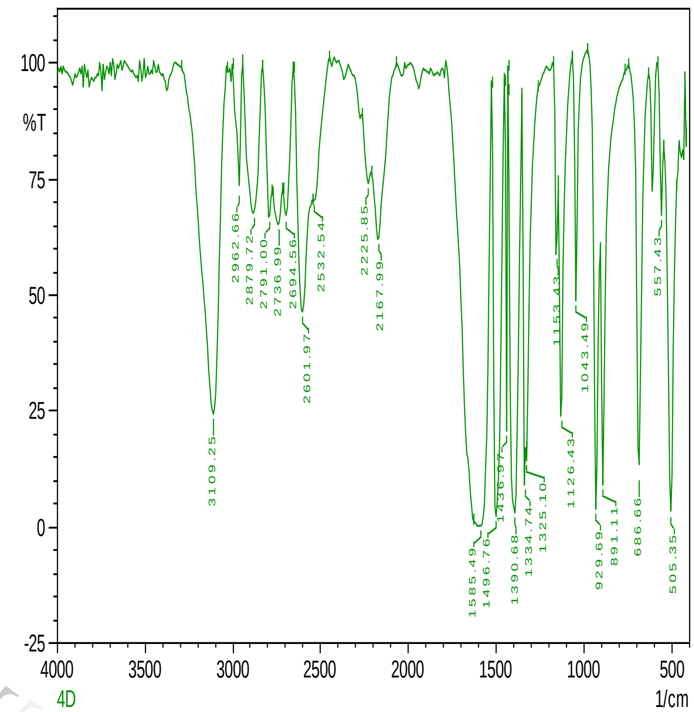

Fig 2. FTIR spectrum of GAC

3.3. Optical transmission studies

The optical absorption spectrum for the GAC grown crystals was recorded in the range 200 – 800 nm using VARIAN CARY 5E SECTROPHOTOMETER and is shown in the fig. 3. The resultant spectrum shows that the crystal has very low absorbance crystal in the entire in the entire visible and IR region. The UV cut-off wavelength is found to be at 250 nm. This very low absorption property of [the grown visible region suggests its suitability for second harmonic generation.

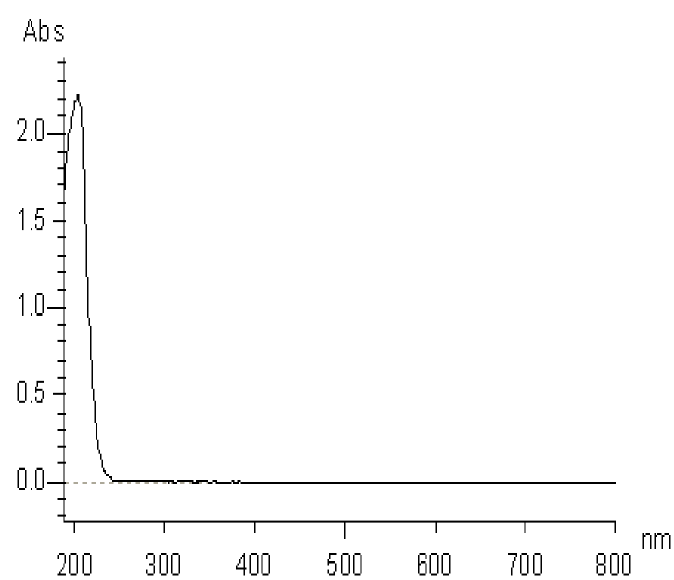

Fig 3. UV-Vis spectrum of GAC

4. THERMAL ANALYSIS

The thermo gravimetric analysis of Glycine Ammonium Chloride crystals was carried out for the sample weight of 2.635 mg between 30 to 300˚ C at a heating rate of 20˚ C min^{-1} in nitrogen atmosphere using alumina thermal analyzer and the obtained thermogram is shown in the fig. 4. There is a small weight loss at 190˚ C to 255˚ C. There is no loss of water below 190˚ C illustrating the absence of absorbed water in the crystal lattice. There is a sharp weight loss at 255˚ C without any intermediate stages and this is assigned as the melting point of the crystal. This study indicates that the compound could be used for device fabrication below its melting point of the crystal. The DTA curve recorded for the grown crystal implies that sharp exothermic peak at 190˚ C shows the melting point of the crystal. The DTA thermogram also reveals that the sharp exothermic peak coincides with that of TG confirms the thermal stability of the crystal.

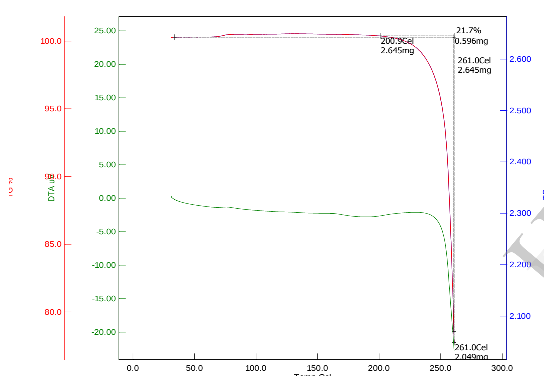

fig. 4 TG/DTA for GAC

5. SECOND HARMONIC GENERATION STUDIES

The second harmonic generation test was carried out by classical powder method developed by Kurtz and Perry [11]. It is an important and popular tool to evaluate the conversion efficiency of NLO materials. The fundamental beam of 1064 nm from Q switched Nd: YAG laser was used to test the second harmonic generation (SHG) property of GAC crystals. The input laser beam was passed through an IR detector and then directed on the microcrystalline powdered sample packed in a capillary tube. The SHG signal generated in the sample was confirmed from emission of green radiation from the sample. The SHG efficiency of the grown GAC crystal was 0.8timesw greater than the KDP crystals. Owing to all these properties GAC could be a promising material for NLO applications.

6. CONCLUSION

The potential semiorganic NLO crystals of Glycine Ammonium chloride were grown by slow evaporation method. The grown crystals were characterized by single crystal XRD analysis, FTIR analysis, UV-Vis-NIR analysis, TG/DTA analysis and SHG studies. The XRD analysis confirms the crystalline nature of the materials and lattice parameters. The presence of various functional groups present in the GAC crystals have been confirmed by FTIR analysis. The UV-Vis-NIR spectrum of grown crystals shows that the crystals are transparent in the wavelength region from 250nm to 800nm. The SHG efficiency of the grown GAC crystal was 0.8timesw greater than the KDP crystals. Owing to all these properties GAC could be a promising material for NLO applications.

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