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Growth and Characterization of a Novel Organic NLO Crystal: Acridine Orange

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Abstract: Now days there are significant interest shown by the researchers in the fields of Nano science and nano technology especially with the synthesis of novel materials because of their potential for use in wide varieties of applications in the fields of telecommunication, computer technology, bio informatics. It has received remarkable attention in view of the size,structure, shape ,potential applications in advanced levels.In the present study, a single crystal of Acridine Orange possessing excellent nonlinear optical properties were grown by the slow solvent evaporation technique at 25^{o}C using a constant temperature bath.An organic compound generally used for production of dyes and drugs is selected and the crystal system is studied. Flower shaped Acridine orange micro structures were synthesized in a large quantity via solution growth method using aqueous mixtures of Acridine orange and acetone. The morphological characteristics were done by field emission scanning electron microscopy which revealed that the synthesized product possesses flower shaped microstructures. The detailed structural characterization performed by x ray diffraction confirmed that the synthesized micro structures are well crystalline Acridine orange.

Keywords: Acridine orange microstructures ,nucleation, growth from solutions, organic compounds, non linear optical materials.

1. Introduction

The organic material Acridine orange is a new NLO material. Acridine orange C17H_{13}N3is an organic compound and a nitrogen heterocyclic. It is a raw material used for the production of dyes and some valuable drugs. Acridine is structurally related to Anthracene with one of the central CH group is replaced by nitrogen.Acridine Orange (3, 6-dimethylaminoacridine) is a nucleic acid .It is a selective metachromatic stain useful for cell cycle determination. By slow evaporation method, we have grown the Acridine Orange crystal. Powder XRD confirms the crystalline property, the lattice parameters are calculated from single crystal XRD data and the molecular structure also revealed. The crystalline perfection is assessed by the high resolution X ray diffractometry.

2. Experimental Set-Up

Crystal growth plays a vital role in the development of many solid state devices for technological applications. In the recent part, there have been extensive effort to develop new inorganic, organic and semi organic nonlinear optical crystals. This paper, describes our efforts of growing Acridine orange crystals. Crystal growth is the basis for various technological advancements. The studies on the nucleation kinetics, growth and characterization of different organic nonlinear optical single crystals are vital for device applications. Acridine orange can be grown by slow evaporation method. Single crystals of these materials were obtained by slow evaporation solution growth using constant temperature bath (CTB) at room temperature. These materials possesses large non linearity, high resistance laser induced damage and low angular sensitivity. Semi organic NLO materials gain importance over organic and inorganic NLO materials because of their large polarizibility and wide transmission window. Single crystals of Acridine orange were grown by slow evaporation at room temperature using Acetone as solvent. Crystals grown by slow evaporation solution growth is ensured with high crystalline perfection. Crystallization from the solution is an important process and the driving force for crystallization is the degree of super saturation which has been commonly expressed as the difference in concentration between the supersaturated and saturated solutions. Slow solvent evaporation technique has been widely used to grow several types of crystals at ambient temperature. Acetone is the solvent generally used for growing Acridine orange crystals.

Single crystals of Acridineorange were grown by slow cooling technique in constant temperature bath at an accuracy of +0.01^{o}C. Before stating the growth process the material was purified by repeated recrystallization process by using Acetone as the solvent.

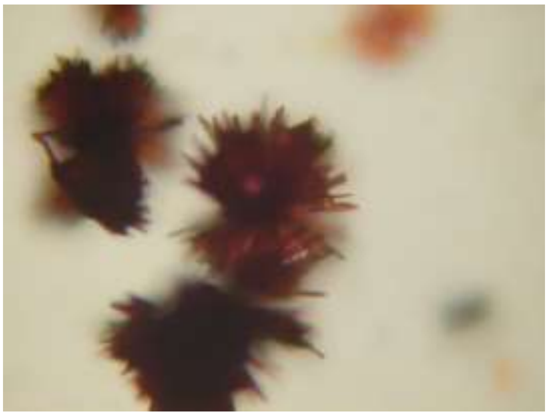
Then the recrystallized salt was dried and makes it as a powder for further growth process. The concentrated solution was prepared and then the solution was stirred continuously and warmed up slightly in order to complete the chemical reaction using a magnetic stirrer attached with hot plate. Then the solution was filtered and covered with a plastic sheet with holes for controlled evaporation. After a period of three weeks, highly transparent optical good quality single crystals have been harvested from the mother solution. The grown single crystal was subjected to single crystal X ray diffraction studies and the lattice parameters were obtained.

3. Results and Discussion

3.1 Crystal Growth

Before conducting the actual crystal growth experiments, solubility experiments were carried out for the following solvents; acetone, methanol and xylene at room temperature. According to the solubility data, saturated solutions of Acridine orange were prepared and transferred to conventional growth vessels (beaker) for collecting the seed crystal by the slow solvent evaporation technique. Based on the quality of the grown crystals from acetone, methanol and xylene, suitable seed crystal having a microscopic size was selected for single crystal growth with specific orientation. Based on the observations related to induction period, growth rate and the solvent properties, Acetone was selected as the solvent for conducting the single growth experiment with specific orientation. Prior to growth, care has been taken to avoid any contamination from the growth vessel which can lead to spurious nucleation. Also special care was taken for the preparation of the solution. The seed crystal was chemically polished and a specific orientation was selected. In the present study (1 1 0) plane of the Acridine orange crystal was selected to impose the orientation in the growing crystal.

Once the system attains equilibrium, the growth was initiated with a suitable temperature provided by the ring heater at the top of the supersaturated solution. The effective zone width of the solution and the maximum temperature of the ring heater determine the effective evaporation rate of the supersaturated solution. The entire quantity of solute was converted in to crystal thus achieving solute-crystal conversion efficiency of hundred percent. The crystalline quality of the crystal was justified by the X-ray rocking curve study and the FTIR confirms the presence of fundamental functional groups. The TG and DTA study was used to analyze the thermal properties of the grown crystal. The optical transmission study and powder SHG measurements were carried out in order to analyze the suitability of the grown crystals for nonlinear applications.



X- ray diffraction analysis

The powder XRD was taken and compared to JCPDS data. The grown single crystal of Acridine Orange was subjected to X-ray diffraction analysis. The recorded powder XRD spectrum (Fig) confirms the growth orientation to the < 1 1 0 >direction. The high resolution diffraction curve was recorded with the multi crystal X-ray diffractometer in symmetrical Bragg geometry. The specimen crystal is aligned in the (+,-,-,+) configuration. Due to dispersive configuration, though the lattice constant of the monocromator crystal and the Acridine Orange crystal are different the unwanted dispersion broadening in the diffraction curve of the specimen crystal is considerably less. The diffraction curve is considerably sharp and contains single peak. The half width of the peak is 40 arcsec. The data collected from the FWHM value exhibited by the rocking curve are compared .From the results one can infer that the Acridine Orange grown in the present study has a reasonable good crystalline quality. No additional peak is found and this reveals the fact that no possible plastic deformation occurred in the crystal.

Conclusion

Flower shaped Acridine Orange microstructures were synthesized in a large quantity via simple solution method using mixtures of Acridine Orange and Acetone.This method confirms the faster growth of nitrogen heterocyclic crystal. The crystal is micro flower shaped with maximum growth rate of 0.5 mm perday. The crystalline properties and the lattice parameters are

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studied by using XRD data and thus the molecular structure is studied. Large non linearity and low angular sensitivity are the special features of Acridine Orange crystal.

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