CHAPTER 6

SUMMARY AND SUGGESTIONS FOR FUTURE WORK

6.1 SUMMARY

The present investigation is divided into three parts. The first priority is the growth of good quality nonlinear optical single crystals by low temperature solution growth techniques. In the second part, the grown single crystals have been subjected to fundamental characterization studies such as crystallinity, functional group confirmation, optical behaviour, and Thermal behaviour. Finally fabrication of Vertical Bringman system and growth experiments have been performed.

There are many areas where nonlinear optics has not yet reached its full potential and much of the fundamental experimental and theoretical work needs still to be done. For instance all-optical switches would be very attractive in the communication technologies. There is a lot of excitement for photonic technologies in which photons are used for information transmission and manipulation, without resorting to conventional electronics. Based on the above said requirement in the field of nonlinear optics, concentrated on the growth of device quality organic NLO materials in bulk size by slow cooling solution growth and Vertical Bridgman techniques. First chapter elaborately outlines the nonlinear optics, organic NLO materials, growth methods and their salient features.
Single crystals of L-alanine were successfully grown by slow cooling solution growth technique. From single crystal X-ray diffraction studies it is confirmed that L-alanine crystallizes in the orthorhombic crystal system with the lattice parameters a = 6.012 Å, b = 12.140 Å, c = 5.241 Å and space group P2₁2₁2₁. The structural perfection of the grown crystal was analysed by high-resolution X-ray diffraction. A very sharp and single peak obtained in the rocking curve confirms that the LA crystal does not contain any grain boundaries and its crystalline perfection is excellent. The theoretical factor group analysis of L-alanine crystal predicts that there are 156 vibrational optical modes that decompose into \( \Gamma_{156} = 39A + 38B_1 + 38B_2 + 38B_3 \) modes among which three acoustic modes \( B_1 + B_2 + B_3 \) are included that correspond to the block transitions of the crystal. From powder SHG efficiency studies, it is clearly ascertained that LA relatively ostentates high efficiency with KDP and Urea. From UV-Vis studies of L-alanine, the absorption was confirmed below 240 nm. It may be due to electronic excitation in the COO⁻ group of L-alanine. The photoluminescence emission spectrum of LA shows the high intensity peaks in the region of 515 to 620 nm. Thus it is found that LA is material for applications in nonlinear optical devices.

By using L-alanine as the parent material, single crystals of L-alanine alaninium nitrate were grown successfully by slow cooling solution growth technique. The lattice parameters of LAAN were identified by single crystal XRD analysis. Factor group analysis was carried out and hence the possible vibrational degrees of freedom were calculated. The FTIR and FT-Raman studies confirm the functional groups. UV-Vis studies reveal that the title compound is transparent between 510 nm and 800 nm. The SHG studies show that the relative SHG efficiency of LAAN is 7.01 times higher than that of KDP and 1.3 times lesser than that of urea and 12.89 times greater than its parent material (L-alanine). The thermal analyses reveal the good
A potential organic NLO material L-alaninium tartrate (LAT) was synthesized from the amino acid L-alanine and tartaric acid and grown successfully by slow cooling solution growth technique. The lattice parameters of LAT were determined by single crystal XRD analysis. The functional groups were identified by FTIR analysis. A satisfactory factor group analysis was also carried out and hence the possible vibrational degrees of freedom were calculated. The UV-Vis. studies reveal that the title compound is transparent between 257 nm and 800 nm. The SHG studies show that LAT is highly efficient SHG material compared to its parent material L-alanine. The thermal analyses reveal the good thermal stability of the material thereby proving its suitability for NLO applications.

The device quality bulk size single crystal of 1,3-dinitrobenzene (1,3-DNB) was grown successfully using newly designed and fabricated Vertical Bridgman setup. From the single crystal XRD analysis, the lattice parameters of 1,3-DNB were identified. The FTIR studies confirm the functional groups. UV-Vis studies reveal that 1,3-DNB is transparent between 400 and 900 nm. The SHG studies show that the relative SHG efficiency of the material is greater than KDP. The thermal analyses reveal the good thermal stability of the material thereby proving its suitability for NLO applications. Based on all these results, this molecular organic material is identified as a new organic material for NLO applications.
6.2 SUGGESTIONS FOR FUTURE WORK

In the present investigation a preliminary report on growth and characterizations of organic nonlinear optical crystals from solution and melt techniques has been presented. Further analysis on effect of pH on the growth morphology can be made. The irradiation with the swift heavy ions like lithium, silver and silicon can be done. The possibility of wave guide like propagation in the irradiated crystals can be performed. New class of compounds of nitrates and tartrate can be synthesized by reacting nitric acid and tartaric acid with various aminoacids like L-Glutamine, L-Valine etc. The effect of dopants on the properties of the crystals can be studied.