CHAPTER VII

SUMMARY AND SUGGESTIONS FOR FUTUREWORK

7.1 INTRODUCTION

Aminoacid based nonlinear optical (NLO) materials have been under extensive investigations due to their promising applications including telecommunication, optical computing, optical data storage and optical information processing. Aminoacid family single crystals have gained importance as highly feasible second order NLO materials. In the present investigations, single crystals of L-Histidine acetate (LHA), L-Alanine acetate (LAlA), L-Threonine acetate (LTA) and L- Arginine acetate (LAA) were grown by SR method and characterized. The results of the findings are summarized below.

7.2 SUMMARY

Unidirectional <100> L-Histidine acetate (LHA) single crystal was grown for the first time and reported. The grown crystal was characterized by powder X-ray diffraction (XRD) studies to confirm the crystal structure. The mechanical properties of the grown crystals have been studied using Vickers microhardness tester. The Second Harmonic Generation (SHG) in the sample was confirmed and estimated by Nd: YAG laser employing the Kurtz and Perry powder technique. Thermal stability of the grown crystal was determined by Thermogravimetic (TG) and Differential theromogravimetric

(DTG) analyses. Dielectric and photoconductivity studies were also carried out for the grown LHA crystals.

Unidirectional <100> L-alanine acetate (LAlA) single crystal was grown for the first time and reported. The grown crystal was characterized by powder X-ray diffraction (XRD) studies to confirm the crystal structure. Investigation has been carried out to assign the vibrational frequencies of the grown crystal by Fourier Transform infrared (FT-IR) and Fourier Transform Raman (FT-Raman) spectroscopy technique. The mechanical property of the grown crystal has been studied using Vickers microhardness tester. The Second Harmonic Generation (SHG) in the sample was confirmed and estimated by Nd: YAG laser employing the Kurtz and Perry powder technique. The laser damage threshold of the grown crystal was also found. Thermal stability of the grown crystal was determined by Thermogravimetic (TG) and Differential theromogravimetric (DTG) analyses. Dielectric and photoconductivity studies were also carried out for the grown LAlA crystals.

Unidirectional <110> bulk L-Threonine acetate (LTA) single crystal was successfully grown for the first time by Sankaranarayan–Ramasamy (SR) method. The <110> oriented plane have been placed as seed at the bottom of the ampoule and a transparent single crystal of LTA of 10 mm diameter and 50 mm length have been grown. The crystal system and lattice parameters were analyzed from the powder X-ray diffraction study. FT-IR and FT-Raman analyses were done to confirm the presence of the functional groups. The grown crystal was also characterized by UV-Vis-NIR absorption and micro hardness. The second harmonic generation (SHG) in the sample was confirmed by Kurtz and Perry powder technique. The laser damage threshold was also found.

Unidirectional L-Arginine acetate (LAA) single crystal was successfully grown by Sankaranarayanan and Ramasamy (SR) method for the first time and reported. The grown crystal was characterized by powder X-ray diffraction (XRD) studies to confirm the crystal structure. Investigation has been carried out to assign the vibrational frequencies of the grown crystal by Fourier Transform infrared (FT-IR) and Fourier Transform Raman (FT-Raman) spectroscopy techniques.The Second Harmonic Generation (SHG) in the sample was confirmed and estimated using Nd: YAG laser by employing the Kurtz and Perry powder techniqueThe results of the grown crystals are summarized and presented in Table 7.1.

7.3 SUGGESTIONS FOR FUTURE WORK

Nucleation studies for these samples are not carried out, attempts can be made in future to investigate the nucleation parameters such as metastable zone width, induction period, interfacial tension etc., to improve and investigate the optimized growth parameters. A systematic study of pH of solution will throw more light on the growth rate of the crystals. It is well known that by bringing out changes such as deuteration and compositional variation, the physical properties as well as the nonlinear properties of this class of crystals can be improved.

Table 7.1 Comparison of physico-chemical and optical properties of grown crystal

	LHA	LAlA	LTA	LAA
Size	Length 28 mm Diameter 10 mm	Length 44 mm Diameter 10 mm	Length 40 mm Diameter 10 mm	Length 52 mm Diameter 10 mm
Crystal System	Triclinic P1	Orthorhombic $P2_12_12_1$	Orthorhombic $P2_12_12_1$	Monoclinic $P2_1$
SHG efficiency (KDP=1)	3.8	2.6	3.0	3.5
Laser damage threshold (GW/cm^2)	8.7	7.9	8.2	7.5
UV cut-off (nm)	250	254	248	243
Vickers hardness number for 10 g	230	102	112	71
Decomp-osition temp(˚C)	115.5	299.9	260	200

Attempts can be made to identify suitable dopants which could provide better optical properties and enhance the NLO property of these crystals. In the present study, only the second harmonic generation of the samples is confirmed. Hence more work can be done to investigate the nonlinear optical properties such as phase matching, higher harmonic generation, etc., to make this class of materials into a reality to replace the conventional materials used in laser applications. Studies such as ESCA/AUGER near the phase transition temperature will be very much useful in understanding the mechanism involved during the phase transition. Structure and defect mechanism of the crystals can be visualized by using scanning electron microscope (SEM) and Atomic force microscope (AFM). The etching behaviour of different crystallographic faces of the crystals can be examined with different organic solvents, in order to identify dislocation, lattice inhomogenties and then to compute crystallinity.

Thermomechanical analysis (TMA) can be carried out in future to evaluate the coefficients of thermal expansions (linear and bulk expansion coefficients) to find the thermal stress produced on the crystal. Henceforth, photoacoustic studies namely, thermal conductivity, thermal diffusivity and thermal effusivity measurements could be made. Efforts can be made to study the effect of irradiation on the physical properties of the samples. Temperature dependent conductivity experiments can be done in future and the results can be correlated with thermal studies.

Amino acids are interesting materials not only for NLO applications but also for several biomedical applications. Hence, attempts could be made in future to synthesis the crystals in nanocrystalline form, possibly by sol gel or CVD techniques. The physicochemical properties of the nanocrystalline material of amino acids can be investigated and the influence of size in particular can be studied for optical and NLO characterizations. The optical and mechanical properties strongly favour the usage of these crystals in photonics technology.