DECLARATION

I declare that the thesis entitled **"UNIDIRECTIONAL GROWTH AND CHARACTERIZATION OF NONLINEAR OPTICAL AMINOACID BASED ACETATE SINGLE CRYSTALS"** submitted by me to the University of Madras for the degree of Doctor of Philosophy is the record of work carried out by me independently during the period 2010 - 2013 under the guidance of **Dr. J. MADHAVAN** and has not formed the basis for the award of any degree, diploma, associateship, fellowship, titles in this or any other University or other similar Institution of Higher Learning.

Signature of the candidate

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LIST OF SYMBOLS AND ABBREVIATIONS

$\vec{E}$	-	Electric Field Vector
$\vec{P}$	-	Polarization
ε_0	-	Permittivity of free space
ε_r	-	Dielectric constant
$\chi^{(1)}$	-	Linear susceptibility
$\chi^{(2)}$, $\chi^{(3)}$	-	Nonlinear susceptibilities
μV	-	microvolt
n	-	Work hardening coefficient
Hv, VHN	-	Vickers hardness number
nm	-	nanometer
μm	-	micrometer
μ_0	-	Permeability of free space
Å	-	Angstrom
θ	-	Theta
Δ	-	Delta
α	-	Alpha
β	-	Beta
γ	-	Gamma
ω	-	Omega
g	-	Gram

a,b,c	-	Unit cell parameters
Δk	-	Phase mismatching
η	-	Conversion efficiency
λ	-	Wavelength
TGA	-	Thermogravimetric Analysis
DTA	-	Differential Thermal Analysis
DTG	-	Derivative thermogram
DSC	-	Differential Scanning Calorimetry
PI	-	Isoelectric pH
IR	-	Infrared
FT-IR	-	Fourier Transform Infrared
FT-Raman	-	Fourier Transform Raman
NLO	-	Nonlinear optics
SHG	-	Second Harmonic Generation
SONLO	-	Second Order Nonlinear Optical
UV	-	ultraviolet
XRD	-	X-Ray Diffraction
ISE	-	Indentation size effect
LHA	-	L- Histidine Acetate
LAlA	-	L-Alanine Acetate
LTA	-	L-Threonine Acetate
LAA	-	L-Arginine Acetate

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ABSTRACT

Crystal growth has become an important area of research in physical sciences and material science. During the last three decades, much progress has been made in the development of new and better nonlinear optical (NLO) materials having large nonlinear optical coefficients. Nonlinear optical materials are of much importance because of its extended applications, especially to develop new laser sources. In recent years, researchers have identified aminoacid based nonlinear optical crystals with better linear and nonlinear optical properties. The wider choice of materials, improved high non-linearity, low transformation temperature, fast response and high transparency make these systems more demanding than any other systems. Nonlinear optical phenomena have got a tremendous interest after the advent of laser sources, and they play a vital role in the development of laser technology. Most of the NLO materials find applications in devices such as frequency multipliers and frequency mixtures, optical switches, fiber optics, ferroelectric, piezoelectric, infrared sensitive materials, detectors and sensors etc. They exhibit good thermal and chemical stability and have the appropriate phase-matching properties. Also, these materials are resistant to optical damage and have high mechanical hardness.

The thesis comprises of seven chapters. In the first chapter the fundamentals of the various methods along with SR method to grow good quality single crystals are outlined. The theoretical aspects of nonlinear optics,

the role of NLO materials in science and technology and the various applications of NLO materials are also explained.

The second chapter deals with the experimental techniques and tools used for characterizing the grown crystals. Characterization of crystal essentially consists of an evaluation of its chemical composition, structure, defects and the study of its optical, thermal, mechanical and electrical properties. Assessment techniques are essential in order to estimate the quality and character of the grown crystals. These studies help us to trigger rapid progress in the growth process and to improve the quality of the grown crystals.

The powder diffraction patterns of the grown samples were obtained using RICH SIEFERT X-ray diffractometer with Cu K_α (λ = 1.54056Å) radiation. The presence of functional groups was qualitatively assessed by FT-IR spectrum taken with BRUKER IFS 66V spectrometer. FT-Raman spectrum has been recorded in the frequency ranging from 3500 cm^{-1} to 50 cm^{-1} by using BRUKER FRA 106 FT-Raman spectrometer. The optical absorption for the crystal is an important parameter with respect to its NLO applications. In the present work, optical absorption studies were carried out using Varian Cary 5E spectrophotometer. TGA and DTG curves were recorded to identify the thermal stability, the decomposition temperature and the weight loss of the samples. The mechanical strength of the materials was measured using Vickers microhardness tester fitted with Vickers diamond pyramidal indenter. Dielectric measurement is one of the useful characterizations of electrical response of the materials. The study of the dielectric properties of the samples

gives information about the electric field distribution within the sample. The frequency dependence of dielectric properties gives insight into the possible applications of the materials in various fields. The dielectric behaviour of the crystal was studied using, HIOKI 3532 LCR Hitester. Photoconductivity measurements were done with a picoammeter (Keithley 485) and its accessories. In the present work, SHG efficiencies of the grown crystals were studied using Nd:YAG Q-switched laser.

Chapters III to VI explains the growth and characterization of LHA, LAlA, LTA and LAA single crystals grown by SR method. The results obtained were discussed in detail.

The results of the studies carried out in the investigations, along with the suggestions for future studies are given in Chapter VII. The results of the above investigations have been published/accepted in National / International Journals and have also been presented in various National seminars/conferences.