In recent years the study of amino acids has received renewed attention because of industrial interest in these products. The importance of amino acid for nonlinear optics (NLO) application lies in the fact that almost all amino acids except glycine contain asymmetric carbon atom and crystallize in non-centrosymmetric space group. In solid state, amino acid exists as zwitterions. This dipolar nature exhibits peculiar physical and chemical properties in amino acids, thus making them ideal candidates for NLO application. NLO processes in organic systems led to new phenomena, new theoretical insights, and new materials and devices, thus the technical advances in laser applied fields are ensured with the emergence of new organic NLO materials. Organic NLO crystals have poor mechanical and thermal properties and are susceptible to damage during processing. In this context new class of hybrid crystals of amino acids are interesting materials for NLO application. It is believed that these sorts of amino acid materials inherit favourable thermal and mechanical properties of inorganic compounds.

The thesis consists of twelve chapters. Chapter 1 presents a brief introduction to nucleation kinetics, low temperature solution growth techniques, nonlinear optics, organic, inorganic and semiorganic materials and crystal growth techniques.

Chapter 2 describes briefly on the experimental techniques such as single crystal X-ray diffraction (XRD), powder XRD, high resolution X-ray diffraction (HRXRD), Fourier Transform Infrared (FT-IR), Ultra violet, visible and near infrared (UV-vis-NIR) spectroscopy, thermal analysis (TG/DTA, DSC), Vickers microhardness test, dielectric measurement and second harmonic generation (SHG) measurement employed in this work to characterize the synthesized materials and the grown crystals.
Chapter 3 consists of crystal growth and characterization of semiorganic nonlinear optical material of glycine zinc chloride (GZC). GZC single crystal was grown using double distilled water as the solvent. Slow evaporation and slow cooling methods were employed to grow single crystal of size 16mm×10mm×6 mm. Solubility of GZC was measured at various temperatures using water as the solvent. Metastable zonewidth of GZC was determined by conventional polythermal method. The cell parameters were obtained from single crystal X-ray diffraction study. Powder X-ray diffraction study was carried out and the various peaks were indexed. Perfection of the grown crystal was evaluated by HRXRD. FT-IR and FT-Raman spectra were recorded and various functional groups were identified. The mechanical hardness of the grown crystal was tested on (100) plane using Vickers microhardness Tester. Thermal properties were investigated by differential thermal analysis (DTA) and Thermogravimetric analysis (TGA). Percentage of optical transmittance and optical window were ascertained by recording UV-vis-NIR spectrum. Second harmonic generation efficiency was measured by Kurtz and Perry powder technique using Nd: YAG laser and was observed to be 0.5 times that of potassium dihydrogen orthophosphate (KDP). Dielectric studies have been carried out for the sample at different frequencies from 40 Hz to 100 kHz at two different temperatures.

Chapter 4 presents the growth and characterization of glycine zinc sulphate (GZS). Slow evaporation was employed to grow single crystals of GZS from aqueous solution. Single crystal of size 19mm×16mm×15 mm was grown using double distilled water as the solvent. The solubility and metastable zonewidth measurements were carried out for GZS at five different temperatures. Cell dimensions were obtained from single crystal X-ray diffraction study. FTIR spectrum confirms the presence of various functional groups. UV-vis-NIR spectral analysis was carried out to measure the range and percentage of optical transmittance of the GZS single crystal. TGA and differential scanning calorimetry (DSC) studies were carried out to study the thermal properties of GZS single crystal.
Mechanical strength of the grown crystal was estimated using Vickers microhardness tester on the prominent (011) face. Kurtz and Perry powder SHG test was performed to estimate the NLO property of GZS single crystal and the relative SHG efficiency is 0.7 times that of potassium dihydrogen orthophosphate. Dielectric studies have been carried out for the GZS crystal at different frequencies from 40 Hz to 100 kHz at different temperatures.

Chapter 5 consists of the growth and characterization of nonlinear optical γ-glycine single crystal. γ-Glycine single crystals were grown from a mixture of glycine, water and lithium bromide. Slow evaporation and slow cooling methods were employed to grow single crystals of γ-glycine. Solubility and metastable zonewidth were estimated from aqueous solution. Single crystal XRD results confirmed the growth of γ-glycine phase. Presence of various functional groups of γ-glycine was identified by FT-IR spectrum. Optical absorbance spectrum recorded in the wavelength range (250-2500 nm) of UV-vis-NIR revealed that this crystal has good optical transparency in the range 250-1500 nm. Vickers microhardness test was carried out to study the mechanical strength of γ-glycine on the prominent (100) plane. TG and DSC analyses were carried out to study the thermal properties of γ-glycine. The relative SHG efficiency of the crystal measured by Kurtz and Perry powder SHG method using Nd: YAG laser is about 3 times that of KDP.

Chapter 6 deals with the growth of single crystal of glycine lithium sulphate (GLS), a nonlinear optical material, from aqua solution by temperature reduction method. The solubility of GLS was estimated using water as the solvent. Metastable zonewidth of glycine lithium sulphate was estimated by conventional polythermal method. The single crystal of size 11mm×10mm×5 mm was grown following the slow cooling method. The cell parameters of the grown crystal were obtained by single crystal XRD. Powder X-ray diffraction study was carried out and the various peaks were indexed. Presence of functional groups was identified
from FT-IR spectrum. Thermal analysis (TG/DTA, DSC) was performed to study the thermal stability of the grown crystal. The transmission and absorption spectra of this crystal show that the lower cut off wavelength lies at 330 nm. The relative powder SHG efficiency of the grown crystal measured by Kurtz and Perry technique is 0.75 times that of KDP. Vickers microhardness study was carried out on the well developed (011) face of the grown crystal.

**Chapter 7** deals with the synthesis, crystal growth and characterization of glycine lithium bromide (GLB). Well developed transparent single crystals of glycine lithium bromide were grown by solvent evaporation method. Single crystal X-ray structure solution analysis reveals that the hydrated form of glycine lithium bromide crystallizes in monoclinic system of space group $P2_1/c$ with unit cell dimensions $a = 7.5396(6)$ Å, $b = 17.4173(14)$ Å, $c = 8.1518(7)$ Å, $\beta = 116.507(9)^\circ$, $V = 957.96(16)$ Å³ and $\rho = 1.768$ g/cm³. The grown crystals were characterized by powder XRD, FT-IR, UV-vis-NIR, TG and DSC analyses, mechanical and dielectric studies. The novel Li coordination pattern and crystal packing are discussed.

**Chapter 8** presents the growth and characterization of glycine lithium chloride (GLC) single crystal. GLC salt was synthesized and its solubility and metastable zonewidth were estimated. A comparison between the solubility of glycine lithium chloride and that of glycine lithium bromide, glycine lithium sulphate and glycine shows that the solubility of glycine lithium chloride is relatively higher. Single crystal of GLC of 15mm x14mm x 8 mm size was grown employing temperature reduction method. Single crystal XRD analysis confirmed the growth of GLC crystal. Presence of various functional groups of GLC identified from the FT-IR spectrum. Optical absorbance spectrum recorded in the wavelength range of UV-vis-NIR shows that this crystal has good optical transparency in the range 230 – 1500 nm. Vickers microhardness values were estimated on the prominent (011) face. SHG efficiency tested by high intensity Nd: YAG laser as a source is about 3 times that of KDP.
Thermogravimetric analysis was carried out to study the thermal properties of GLC. Dielectric studies have been carried out for the sample at different frequencies from 40 Hz to 100 kHz at room temperatures.

**Chapter 9** discusses on the growth and characterization of a new organic single crystal of glycinium phthalic acid (GPA). Optically transparent, GPA crystal with dimension of about 14mm ×8mm ×6mm was grown by temperature reduction method. Solubility of GPA was estimated, which indicates water as a suitable solvent for growing single crystal of this material. Single crystal XRD data reveals that the GPA belongs to orthorhombic system with Pbcn space group. In the crystal structure, antiparallel linear arrays of glycinium ions are sandwiched between phthalic acid layers via N-H...O and O-H...O intermolecular hydrogen bonds. Grown crystals were characterized by powder XRD and FT-IR spectral analyses. Thermal properties were investigated by TG-DTA and DSC analysis. Mechanical hardness of GPA single crystal was estimated by Vickers microhardness test. Dielectric studies have been carried out for the sample at different frequencies from 40 Hz to 100 kHz.

**Chapter 10** presents the preparation and characterization of the nonlinear optical single crystals of ammonium pentaborate (APB). Single crystal of APB was grown by the slow cooling method from aqueous solution. Grown crystal was characterized by single crystal and powder XRD and FTIR spectral analyses. Perfection of the grown crystal was evaluated by HRXRD. The effect of nylon threading on the perfection of the grown bigger crystal was also studied by HRXRD. The range and percentage of optical transmission was ascertained by recording UV - vis - NIR spectrum. Relative powder SHG efficiency tested using Nd: YAG laser for APB powders is about 0.75 times that of KDP. Thermal properties were investigated by TGA, DTA and DSC analysis. Its mechanical hardness was estimated by Vickers microhardness tester.

**Chapter 11** discusses a new nonlinear optical material L-ornithine monohydrochloride (LOMHC1) single crystal. LOMHCl, belongs to the
amino acid group, was grown by the slow evaporation solution growth technique at room temperature. The grown crystals were characterized by single and powder XRD analyses, FTIR spectroscopy, TGA, DTA, and DSC analysis. UV-vis-NIR spectrum shows excellent transmission in the wavelength range of 300-1600 nm. Mechanical properties of grown crystals were studied using Vickers microhardness tester. Dielectric studies were carried out for the grown crystal at different frequencies from 40 Hz to 100 kHz at different temperatures. Its relative powder SHG efficiency tested using Nd: YAG laser is about 1.25 times that of KDP.

Chapter 12 gives the summary of work done and suggestions for future work.