CHAPTER 9

SUMMARY AND SUGGESTION FOR FUTURE WORK

9.1 SUMMARY

In the present study Imidazolium L – Tartrate (IMLT), Ammonium L –Tartrate (AMT), Benzimidazole (BMZ) and Potassium sodium tartrate Tetrahydrate (PST), Zinc Guanidinium Sulphate (ZnGuS), L – Histidine Nitrate (LHN) and 1 mole %, 4 mole % and 5 mole % MgO doped Lithium Niobate were taken for investigation of crystal structure, morphology, dielectric behaviour, laser damage threshold, third order nonlinearity and optical limiting behaviour.

The grown IMLT seed crystal was confirmed by single crystal XRD analysis and further it was grown by SR method in <010> direction in bulk size. UV - Visible transmittance and absorbance, mechanical property, dielectric behaviour, second harmonic conversion efficiency were studied. Refractive Index of orthogonally cut IMLT single crystal was measured using the Brewster angle method and the values are 0.9801, 1.0034 and 1.0563, respectively for n_x, n_y and n_z with their sequence $n_x<n_y<n_z$. Electro-optical effect was studied and the half wave voltage (V_π) and electro-optical coefficient (r_{12}) of IMLT were estimated to be V_π = 3.1 kV and r_{12} = 66.19 pm/V for the wavelength of 532 nm using diode laser. The third-order nonlinear optical property of the IMLT crystal was studied by the Z-scan technique using an Nd–YAG diode-pumped laser at 532 nm.

Third-order susceptibility was measured to be (χ^3) = 6.6596 × 10^{-6} esu. Optical limiting behaviour of IMLT was also examined.

Good quality AMT single crystal was grown by conventional slow evaporation solution growth technique. The single crystal X-ray diffraction analysis revealed the orthorhombic structure of AMT with space group $P2_12_12_1$. The HRXRD study enumerated the structural perfection of AMT is reasonably good. Optical studies reveal the grown crystal has maximum transmittance of about 78% from 234 to 1100 nm with the lower cut-off wavelength at 234 nm. Mechanical, dielectric, laser damage threshold, SHG, third order nonlinearity and optical limiting property studies were carried out for AMT crystal. The second order NLO efficiency of AMT is 1.3 times larger than that of the standard KDP.

The good quality BMZ and PST single crystals have been grown successfully from unidirectional solution growth method. Single crystal XRD confirms that the BMZ crystallizes in the orthorhombic crystal system with space group $Pna2_1$ whereas PST crystal belongs to orthorhombic crystal system with space group $P2_12_12$. The HRXRD study reveals that both the compounds have good crystalline perfection. The optical cut-off wavelength of the BMZ and PST crystal is found to be 300 and 230 nm, respectively. The low dielectric loss was found in the higher frequencies which indicate both the crystals are significant for NLO applications. The laser damage threshold value of BMZ and PST crystals, is 1.091 GW/cm^2 and 1.464 GW/cm^2, respectively. SHG efficiency of the BMZ crystal is 2.1 times that of KDP. The nonlinear absorption coefficient of BMZ, PST and KDP crystals, was calculated by employing the Z – Scan technique and the values are 159.99 × 10^{-12} m/W, 100 × 10^{-12} m/W, 37.5 × 10^{-12} m/W . The crystals studied here exhibit optical power limiting behaviour of nanosecond laser pulses at 532 nm wavelength.

ZnGuS single was grown by slow evaporation solution growth technique. Single crystal X - ray diffraction analysis confirmed that ZnGuS crystal belongs to tetragonal crystal system. From transmittance spectra, ZnGuS crystal has a lower cut - off wavelength of 230 nm. The variation of dielectric constant with temperature at various frequencies of the sample was analyzed. From the mechanical studies it was observed that the hardness increases with increasing load. The SHG efficiency of ZnGuS samples was confirmed as 1.94 times that of standard KDP. Laser damage threshold property, third order nonlinearity and optical limiting behaviour were analyzed.

Good quality of <011> orientational LHN single crystal was grown by unidirectional solution growth method. The single crystal X-ray diffraction analysis revealed the orthorhombic structure of LHN with space group $P2_12_12_1$. Optical studies reveal the grown crystal has maximum transmittance of about 60 % with the lower cut-off wavelength at 320 nm. The dielectric constant of the crystal was found to be high in the low frequency region and decreased with increase in applied frequency. The second order NLO efficiency of LHN is 1.94 times larger than that of the standard KDP and enhanced SHG efficiency with different particle size reveals that LHN is phase - matchable NLO material. Third order nonlinearity and optical limiting behaviour were also assessed to identify the suitability of the material for the nonlinear optical applications and device fabrication.

Czochralski method grown 1 mole %, 4 mole % and 5 mole % MgO doped Lithium Niobate crystals were used for optical, mechanical, dielectric, laser damage threshold, piezo electric charge coefficient, third nonlinearity and optical limiting behaviour studies and the results were compared. HRXRD study reveals that the structural perfection of 4 mole % MgO doped $LiNbO_3$ is superior to the 1 mole % and 5 mole % concentration.

UV – Visible transmittance and absorption study indicates that MgO dopant concentration enhance the blue shift in absorption edge. The dielectric behaviour, mechanical stability, laser damage threshold, third order nonlinearity and optical limiting property of 1 mole %, 4 mole % and 5 mole % MgO doped Lithium Niobate crystals were analyzed and the obtained data are compared.

9.2 SUGGESTION FOR FUTURE WORK

In the present investigation IMLT, AMT, BMZ, PST, ZnGUS and LHN single crystal were grown by conventional solution growth method and SR method and their optical, electrical, mechanical and nonlinear optical properties are compared. Dopants can be added to this crystalline material and the properties can be compared. The properties of 1 mole %, 4 mole % and 5 mole % MgO doped lithium niobate crystals were analysed in this present investigation. By varying the dopant concentration between 4 to 5 mole %, of optical properties of $LiNbO_3$ can be optimized for suitable applications.