# Contents

**Chapter 1**  
**INTRODUCTION** 1-26

1.1 A brief history of crystal growth  1
1.2 Techniques of Crystals Growth  2
   1.2.1 Growth from Melt  4
   1.2.2 Growth from Solution  5
   1.2.2.1 Aqueous solution growth  7
   1.2.2.2 Flux Growth  7
   1.2.2.3 Metallic Solution Growth  8
   1.2.2.4 Hydrothermal growth  8
   1.2.3 Growth from Vapour  8
   1.2.4 Gel Growth  9
   1.2.4.1 Chemical reaction method  9
   1.2.4.2 Chemical reduction method  11
   1.2.4.3 Solubility reduction method  11
   1.2.4.4 Complex dilution method  11
1.3 Defects in Crystals  11
   1.3.1 Point Defects  14
   1.3.2 Line Defects  14
   1.3.3 Planar Defects  15
   1.3.4 Volume Defects  16
1.4 Detection of Defects in Crystals  16
1.5 Nonlinear Optics  19
1.6 Nonlinear Optical Materials  20
1.7 Organic NLO Materials  21
1.8 Objectives of the Present Work  22
1.9 References  23

**Chapter 2**  
**RELEVENT THEORETICAL ASPECTS** 27-48

2.1 Introduction  27
2.2 Kinetics of Crystal Growth  27
2.3 Theories of Crystal Growth  29
   2.3.1 Growth of ideal crystals  29
   2.3.2 Growth of real crystals  34
2.4 Growth of Crystals from Solutions
  2.4.1 Growth from Pure Solutions
  2.4.2 Growth from impure solutions

2.5 Basics of nonlinear optics
  2.5.1 Nonlinear Polarization
  2.5.2 Second Harmonic generation
  2.5.3 Self Action Effects
    (a) Self-Focusing
    (b) Self-defocusing
    (c) Self-Phase Modulation
    (d) Nonlinear Absorption
    (e) Saturable absorption

2.6 Physics of NLO Behaviour in Organic Molecules

2.7 References

Chapter 3
CHARACTERISATION TOOLS AND TECHNIQUES

3.1 Introduction
3.2 X-Ray Powder Diffraction
3.3 Elemental Analysis
  3.3.1 CHN Analysis
  3.3.2 Energy Dispersive X-Ray (EDX) Analysis

3.4 Thermal Characterisation
  3.4.1 TGA/DTA Analysis
  3.4.2 Differential Scanning Calorimetry

3.5 Optical Characterisation
  3.5.1 UV/Vis/NIR Absorption Spectroscopy
  3.5.2 Photoluminescence Studies

3.6 Surface Analysis
  3.6.1 Optical Microscopy
  3.6.2 Scanning Electron Microscope (SEM)

3.7 Vibrational Spectral Analysis
  3.7.1 Fourier Transform Infrared Spectroscopy
  3.7.2 Raman Spectroscopy

3.8 Micro Hardness Studies

3.9 Chemical Etching Studies

3.10 Dielectric Studies by Microwave Cavity Perturbation Method

3.11 Nonlinear Optical Characterisation
  3.11.1 Second Harmonic Generation (SHG)
  3.11.2 Laser Damage Threshold Studies
  3.11.3 Z Scan Measurement of Optical Nonlinearity

3.12 References
Chapter 4
GROWTH AND CHARACTERISATION OF GLYCINIUM OXALATE SINGLE CRYSTALS FOR NONLINEAR OPTICAL APPLICATIONS 90-124

4.1 Introduction 90
4.2 Experimental Methods 91
4.2.1 Synthesis and Seeded Growth 91
4.2.2 CHN Analysis 92
4.2.3 X-Ray Powder Diffraction Studies 92
4.2.4 UV/Vis/NIR Spectrum and Evaluation of Linear Optical Constants 93
4.2.5 FTIR and FT Raman Spectral Analysis 97
4.2.6 Thermal Analysis 103
4.2.7 Vickers’ Microhardness 105
4.2.8 Chemical Etching Studies 108
4.2.9 Microwave Dielectric Studies 111
4.2.10 Photoluminescence Studies 113
4.2.11 SHG in GLO Crystal 114
4.2.12 Laser Damage Threshold Studies 114
4.2.13 Z Scan Measurements of the Optical Nonlinearity 116

4.3 Conclusions 120
4.4 References 121

Chapter 5
GROWTH AND CHARACTERISATION OF NONLINEAR OPTICAL SINGLE CRYSTALS OF L-ALANINIUM OXALATE 125-163

5.1 Introduction 125
5.2 Synthesis and Growth 126
5.3 Characterisation Methods 127
5.3.1 Powder X Ray Diffraction Studies 127
5.3.2 Measurement of Density 129
5.3.3 CHN Analysis 129
5.3.4 UV/Vis/NIR Absorption Spectroscopy 130
5.3.5 Thermal Analysis 134
5.3.6 The Vibrational Spectra of L-Alaninium Oxalate 137
5.3.7 Vickers’ Microhardness Analysis 142
5.3.8 Chemical Etching Studies 146
5.3.9 Photoluminescence Studies 149
5.3.10 Dielectric Studies by Microwave Cavity Perturbation Technique 150
5.3.11 SHG Studies 152
5.3.12 Laser Damage Threshold Studies 152
5.3.13 Z Scan Measurement of the Optical Nonlinearity 154

5.4 Conclusions 158
5.5 References 159
**Chapter 6**

INVESTIGATIONS ON THE GROWTH AND CHARACTERISATION OF POTASSIUM HYDROGEN PHTHALATE SINGLE CRYSTALS FOR NONLINEAR OPTICAL APPLICATIONS.................................164-203

6.1 Introduction .............................. 164
6.2 Crystal Growth Techniques .......... 165
   6.2.1 Growth of KAP Crystals by Floating Seed Technique 165
   6.2.2 Growth of KAP Crystals by Gel Method ........ 166
6.3 Characterisation Methods .......... 168
   6.3.1 X-Ray Powder Diffraction Studies 168
   6.3.2 CHN Analysis ...................... 170
   6.3.3 EDX Analysis ...................... 170
   6.3.4 UV/Vis/NIR Spectrum and Determination of Linear Optical Constants 171
   6.3.5 The Vibrational Spectral Analysis of Potassium Hydrogen Phthalate Crystal 175
   6.3.6 Thermal Analysis ................. 179
   6.3.7 Vickers’s Microhardness Analysis .......... 181
   6.3.8 Microtopography and Chemical Etching Studies 185
   6.3.9 Microwave Dielectric Properties by Cavity Perturbation Technique 188
   6.3.10 Laser Damage Threshold Studies ........ 189
   6.3.11 SHG Studies ..................... 192
   6.3.12 Third Order NLO Properties by Z Scan Technique 193

6.4 Conclusions ......................... 197
6.5 References ......................... 198

**Chapter 7**

GENERAL CONCLUSION AND SCOPE FOR FUTURE WORK..............................204-210

List of publications

****

****

****