

TABLE OF CONTENTS

CHAPTER - I		Page No.
GENERAL INTRODUCTION AND RESEARCH OBJECTIVES		1
1.1	Introduction	1
1.2	Types of crystals based on nature of bonding	3
1.3	Isomorphism and mixed crystals	3
1.4	Nonlinear optics and the relevant materials	5
1.5	Sodium chlorate (NaClO ₃) and sodium bromate (NaBrO ₃)	8
1.6	Research objectives	9
1.7	Chapterization	10
 CHAPTER-II		
GROWTH METHODS AND CHARACTERIZATION TECHNIQUES		11
2.1	Introduction	11
2.2	Crystal growth methods	11
2.3	Characterization techniques	27
2.3.1	X-ray Diffraction (XRD) technique	27
2.3.2	Fourier Transform Infrared Spectrometer (FTIR)	30
2.3.3	Scanning Electron Microcopy (SEM)	32
2.3.4	TG/DTA Analyzers	35
2.3.5	Dielectric measurement	38
2.3.6	UV-Vis Spectrophotometer	42
2.3.7	Microhardness test	45
2.3.8	Second harmonic powder test	48
 CHAPTER III		
CRYSTALLIZATION AND CHARACTERIZATION OF PURE AND DOPED SODIUM CHLORATE SINGLE CRYSTALS		51
3.1	Introduction	51
3.2	Reagents used	51
3.3	Solubility	52

3.4	Crystal Growth	55
3.4.1	Preparation of seed crystals and growth	55
3.5	Energy Dispersive X-ray Analysis (EDAX)	59
3.6	X-ray diffraction analysis	62
3.7	FTIR- spectral analysis	69
3.7.1	FTIR spectral analysis of pure sodium chlorate crystal	69
3.7.2	FTIR analysis of sodium chloride doped sodium chlorate crystal	70
3.7.3	FTIR analysis of ammonium chloride doped sodium chlorate crystal	72
3.7.4	FTIR analysis of nickel sulphate doped sodium chlorate crystal	74
3.7.5	FTIR analysis of lithium nitrate doped sodium chlorate crystal	75
3.8	Scanning Electron Microscope (SEM) Analysis	77
3.9	Mechanical studies	79
3.10	UV-Vis Spectroscopy	83
3.11	Second harmonic generation measurement (SHG)	96
3.12	Electrical Property	98
3.13	Thermal Analysis	128
3.13.1	The thermal analysis of pure sodium chlorate single crystal	129
3.13.2	Thermal analysis of ammonium chloride and sodium chloride doped sodium chlorate crystals	130
3.13.3	Thermal analysis of lithium nitrate and NiSO ₄ doped NaClO ₃ crystals	131

CHAPTER-IV

CRYSTALLIZATION AND CHARACTERIZATION OF PURE AND DOPED SODIUM BROMATE SINGLE CRYSTALS 133

4.1	Introduction	133
4.2	Growth of pure and doped sodium bromate crystals	136
4.3	Identification of elements by EDAX studies	140
4.4	Structural studies	143

4.5	Hardness studies	149
4.6	Fourier Transform Infrared (FTIR) spectral studies	156
4.7	Surface features by Scanning Electron Microscopic (SEM) studies	162
4.8	TG/DTA studies	164
4.9	Nonlinear optical (NLO) activity	169
4.10	Linear optical studies	170
4.11	Dielectric properties	177

CHAPTER - V

CHARACTERIZATION OF MIXED SODIUM CHLORATE, SODIUM BROMATE SINGLE CRYSTALS AND DOPED SODIUM CHLORATE, SODIUM BROMATE SINGLE CRYSTALS		207
5.1	Introduction	207
5.2	Synthesis, Solubility and Growth	207
5.3	EDAX spectra	212
5.4	XRD studies	214
5.5	Hardness, Yield stress and Stiffness constant	218
5.6	Identification of functional groups	222
5.6.1	FTIR analysis of the mixed Na (ClO ₃ , BrO ₃) crystal	222
5.6.2	FTIR analysis of lithium nitrate doped mixed crystal of Na (ClO ₃ , BrO ₃)	224
5.6.3	FTIR analysis of nickel sulphate doped mixed crystal of Na(ClO ₃ , BrO ₃)	225
5.7	SEM studies	227
5.8	Thermal analysis	228
5.8.1	Thermal analysis for mixed crystal of Na (ClO ₃ , BrO ₃)	228
5.8.2	Thermal analysis for lithium nitrate doped mixed crystal of Na (ClO ₃ , BrO ₃)	229
5.8.3	Thermal analysis of nickel sulphate doped mixed crystal of sodium chlorate and sodium bromate	230
5.9	UV-Vis spectral studies	231
5.10	NLO characterization	235
5.11	Dielectric characterization	236

CHAPTER - VI

SUMMARY, CONCLUSIONS AND FUTURE SCOPE 253

6.1 Summary and Conclusions 253

6.2 Suggestions for future work 258

REFERENCE 259

APPENDIXES 272

A.1 Resume of the candidate 272

A.2 List of publications by the candidate 272