

Contents

Contents		Page No.
Title of Thesis		i
Certificate		ii
Declaration by the Candidate & Certificate by the Supervisor		lii-iv
Copyright Transfer Certificate		v
Dedication		vi
Acknowledgements		vii-viii
Contents		ix-xii
List of Figures		xiii-xviii
List of Tables		xix
List of symbols/ Abbreviation		xx-xxi
Preface		xxii-xxviii
CHAPTER – 1 Introduction		1-65
1.1 Materials science		1
1.2 Classifications of nanostructured materials		2
1.3 Metal oxides and mixed metal oxides nanoparticles		4
1.4 Applications of metal oxides and mixed metal oxides nanoparticles		8
1.5 Perovskite oxides: A General Introduction		12
1.6 Classification of Perovskite		18
1.7 Type and Structures of Perovskite		18-24
(a)	ABO ₃ Perovskite	18
(b)	A ⁺¹ B ⁺⁵ O ₃ Perovskite	19
(c)	A ⁺² B ⁺⁴ O ₃ Perovskite	20
(d)	A ⁺³ B ⁺³ O ₃ Perovskite	20
(e)	(ABO ₃) _n AO Perovskite	21
(f)	A ₂ B ₂ O ₅ Perovskite	21
1.8 Complex perovskites		25
1.9 Substitutions in perovskite		26
1.10 Chemical synthesis routes for ceramic material		29
1.11 Dielectric properties of metal oxide		31-35
1.11.1	Capacitors	31
1.11.2	Dielectric materials	33

Contents

1.12 Electrical Polarization		35-38
1.12.1	Orientation Polarization	35
1.12.2	Space Charge Polarization	36
1.12.3	Atomic or Ionic Polarization	36
1.13 Dielectric constant		38
1.14 Dielectric loss		39
1.15 Impedance		40
1.16 Electrical conductivity		43
1.17 Aim of study		44
References		47
CHAPTER–2 Materials Synthesis and Characterizations		66-76
2.1	Experimental procedure	66
2.2	Synthesis of materials	67-68
(a)	Semi wet route	67
(b)	Preparation of ceramic material	67
2.3	Calcination process	69
2.4	Sintering process	69
2.5	X-Ray Diffraction analysis	69
2.6	Transmission Electron Microscopy (TEM) analysis	71
2.7	Scanning Electron Microscopy (SEM) analysis	72
2.8	Energy Dispersive X-ray analysis (EDX)	73
2.9	Electric and Dielectric measurement	74
2.10	Electrochemical characterization	76
CHAPTER – 3 Investigation of microstructure and dielectric behavior of $\text{Bi}_{2/3}\text{Cu}_{3-x}\text{Mg}_x\text{Ti}_4\text{O}_{12}$ ($x=0, 0.05, 0.1$ and 0.2) ceramics synthesized by semi-wet route		77-99
3.1	Introduction	77
3.2	Material synthesis and characterization	79
3.3	Results and discussion	80-92
3.3.1	X-Ray diffraction (XRD) analysis	80
3.3.2	Scanning Electron Microscopy (SEM) analysis	81
3.3.3	Transmission Electron Microscopy (TEM) analysis	82
3.3.4	X-ray photoelectron spectroscopic (XPS) studies	83

Contents

3.3.5	Dielectric studies	86
3.3.6	Impedance spectroscopic studies	88
3.3.7	Conductivity measurements	90
3.4	Conclusions	92
	References	93
CHAPTER –4 Low temperature Synthesis, dielectric and electrical characteristics of $\text{Bi}_{2/3}\text{Cu}_{3-x}\text{Ni}_x\text{Ti}_4\text{O}_{12}$ (where $x=0.05, 0.1, \text{ and } 0.2$) ceramics		100-123
4.1	Introduction	100
4.2	Material synthesis and characterization	102
4.3	Results and discussion	104-118
4.3.1	X-Ray diffraction (XRD) analysis	104
4.3.2	Microstructural studies	106-109
4.3.2.1	Scanning Electron Microscopy (SEM) Studies	106
4.3.2.2	Transmission Electron Microscopy (TEM) Studies	108
4.3.3	X-Ray Photoelectron Spectroscopic (XPS) Studies	109
4.3.4	Dielectric studies	111
4.3.5	Conductivity measurement	112
4.3.6	Electrochemical studies	114
4.4	Conclusions	117
	References	119
CHAPTER – 5 Influence of Zn doping on microstructure, dielectric and electrical properties in $\text{Bi}_{2/3}\text{Cu}_3\text{Ti}_4\text{O}_{12}$ ceramic synthesized by the semi wet method		124-152
5.1	Introduction	124
5.2	Materials synthesis and characterizations	125
5.3	Results and discussion	127-144
5.3.1	X-Ray diffraction (XRD) analysis	127
5.3.2	Microstructural studies	128-133
5.3.2.1	Scanning Electron Microscopic (SEM) studies	128
5.3.2.2	Transmission Electron Microscopic (TEM) studies	131
5.3.3	X-Ray Photoelectron Spectroscopic (XPS) studies	133
5.3.4	Dielectric studies	135
5.3.5	Impedance spectroscopic studies	137

Contents

5.3.6	Electrical conductivity	140
5.3.7	Cyclic Voltammetry	143
5.4 Conclusions		144
References		145
CHAPTER – 6 Emergence of dielectric properties by doping of semi-transition metal in semi-conductor complex perovskite oxide		153-177
6.1 Introduction		153
6.2 Materials synthesis and characterization		155
6.3. Results and discussion		157-172
6.3.1	X-ray Diffraction (XRD)	157
6.3.2	Scanning Electron Microscopic (SEM) studies	158
6.3.3	Transmission Electron Microscopic (TEM) studies	160
6.3.4	X-Ray Photoelectron Spectroscopic (XPS) studies	162
6.3.5	Dielectric studies	164
6.3.6	Impedance spectroscopic studies	167
6.3.7	Electrical conductivity	168
6.3.8	Cyclic Voltammetry	170
6.4 Conclusions		172
References		173
CHAPTER – 7 Summary and Future Scope		178-179
7.1 Summary		178
7.2 Future scope		179
List of Publications		180-182