

Content

CERTIFICATE.....	i
DECLARATION BY THE CANDIDATE	iii
COPYRIGHT TRANSFER CERTIFICATE	v
Acknowledgments	vii
Content.....	xi
LIST OF FIGURES.....	xv
LIST OF TABLES	xxiii
PREFACE	xxv
Chapter-1	1
CHAPTER 1: Introduction and Literature Review.....	3
1.1 Motivation of the work.....	3
1.2 Fuel Cells.....	6
1.3 Types of Fuel Cell.....	7
1.4 Solid Oxide Fuel Cell (SOFC)	8
1.4.1 General Introduction.....	8
1.4.2 Operation of Solid Oxide Fuel Cells.....	9
1.4.3 High and Intermediate Temperature Solid Oxide Fuel Cells	11
1.5 Application Areas	13
1.6 Different Components of SOFCs	14
1.6.1 Electrodes (Cathode and Anode)	14
1.6.2 Electrolyte.....	16
1.6.3 Interconnect	16
1.7 Materials Selection for SOFCs	17
1.7.1 Factors influencing ionic conduction of the electrolyte	18

1.8 Present Scenario of electrolyte for Solid Oxide Fuel Cells	19
1.9 Apatite-type Materials	20
1.9.1 Conductivity Optimization.....	23
1.9.2 Conduction mechanism in Apatite germinate:	26
1.9.3 AO ₆ Metaprism Twist Angle in Apatite-type Materials	30
1.10 Objective of Present Investigation.....	32
Chapter-2	35
Chapter 2: Synthesis, Characterizations and Analysis Techniques	37
2.1 Overview	37
2.1.1 Specification of Raw Materials	38
2.2 Materials Synthesis.....	39
2.2.1 SSR (Solid-State Reaction Route)	40
2.2.2 Mechanism of Ball-Mill.....	41
2.2.3 Preparation of Materials using Ball Milling.....	43
2.2.4 Calcination of Materials.....	44
2.2.5 Granulation and pelletization	44
2.3 Pelletization for Conductivity and Dilatometry Measurements.....	45
2.3.1 Sintering.....	46
2.4 Characterization Techniques	46
2.4.1 TGA-DSC (Thermal Analysis).....	46
2.4.2 Measurement of Density and Porosity	48
2.4.3 X-Ray Diffraction Analysis (XRD)	49
2.4.4 XPS (X-Ray Photoelectron Spectroscopy)	63
2.4.5 Scanning Electron Microscopy (SEM)	65
2.4.6 Ultra – Violet Visible (UV-Vis) Spectroscopy	67
2.4.7 Photoluminescence Spectroscopy (PL).....	69

2.4.8 Fourier Transform Infrared Spectroscopy (FTIR)	71
2.5 Electrical Data Analysis	72
2.5.1 Impedance Spectroscopy Analysis	74
2.5.2 Conductivity Spectroscopy Technique	79
2.6 Analysis Techniques	81
2.6.1 Process of Analysing the Obtained Data	81
2.7 Theoretical Studies	82
2.7.1 Bond Valance Energy-Based Approach	82
Chapter-3	85
CHAPTER 3: Ion transport and one-dimensional ion migration in lanthanum silicate apatite (La_{9.67}Si₆O_{26.5})	87
3.1 Introduction	87
3.2 Materials and Methods	89
3.3 Results and discussion:	90
3.4 Conclusions:	101
Chapter-4	103
CHAPTER 4: Influence of ionic radii on the conduction mechanism in Lanthanum silicate oxyapatite.....	105
4.1 Introduction	105
4.2 Composition section	107
4.3 MATERIALS AND METHODS	109
4.3.1 Sample preparations	109
4.3.2 Characterization techniques.....	110
4.4 Results and Analysis	111
4.4.1 Structural Studies	111
4.4.2 SEM Analysis:	119
4.4.3 XPS and TGA Studies.....	121

4.4.4 Temperature dependence conduction behaviour	128
4.5 DISCUSSION AND CONCLUDING REMARK.....	143
Chapter-5	147
CHAPTER 5: Overlapping large polaron tunnelling in lanthanum silicate oxyapatite ..	149
5.1 INTRODUCTION	149
5.2 Materials and Methods	151
5.2.1 Sample preparation.....	151
5.3 Characterization techniques	152
5.4 RESULTS AND ANALYSIS.....	153
5.4.1 Structural Studies.....	154
5.5 Temperature dependence conduction behaviour.....	163
5.5.1 dc Conductivity	163
5.5.2 The universal exponent 'p'	164
5.6 Frequency dependent conductivity behaviour	165
5.6.1 The exponent parameter (s).....	165
5.7 Optical absorption.....	168
5.8 DISCUSSION	171
5.9 CONCLUDING REMARKS	175
Chapter-6	177
CHAPTER 6: Conclusions and Future Scopes	179
6.1 Conclusion of the Present Investigation.....	179
6.2 Scope for Future Work (New Directions and Future Perspectives).....	181
References	185
Publications.....	215