

CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
I	INTRODUCTION	
	1.1 Introduction	2
	1.2 Aim of the study	4
	1.3 Strategy	5
	References	8
II	SOLID ELECTROLYTES WITH OXYGEN ION CONDUCTION	
	2.1 Introduction	10
	2.2 Ionic conductors	10
	2.3 Quality Criteria for oxide ion conductors	14
	2.4 Conduction Mechanism in ionic conductors	17
	2.5 Ionic conductivity	18
	2.6 Oxide ion electrolytes	21
	2.6.1. Oxides with fluorite-related structures	22
	2.6.1.1 Stabilized zirconia	24
	2.6.1.2 Doped ceria	29
	2.6.1.3 Stabilized δ -Bi ₂ O ₃	32
	2.6.1.4 Pyrochlores	33
	2.6.2. Oxide deficient perovskites	35
	2.6.3. Other oxide ion conductors	38
	2.7 Mixed ionic electronic Conductors (MIECs)	39
	References	40

III	BICUVOX AS SOLID ELECTROLYTE	
	3.1 Introduction	49
	3.2 Crystal structure of $\text{Bi}_4\text{V}_2\text{O}_{11}$	49
	3.3 Metal ion substituted bismuth vanadates (BIMEVOXes)	54
	3.4 Conduction mechanism in BIMEVOXes	56
	3.5 Copper substituted bismuth vanadate (BICUVOX)	60
	3.6 Literature review on BICUVOX	61
	References	66
IV	SYNTHESIS OF BICUVOX ELECTROLYTE FILMS	
	4.1 Introduction	70
	4.2 Thin film deposition techniques	70
	4.3 Spray Pyrolysis Technique (SPT)	74
	4.4 Scheme of pyrolysis and formation of thin films	78
	4.5 Thermo Gravimetric Analysis (TGA)	83
	4.6 Differential Thermal analysis (DTA)	83
	4.7 Experimental procedure	84
	4.7.1. Substrate cleaning	84
	4.7.2. Preparation of the solution	85
	4.7.3. Thickness measurement	86
	4.8 Optimization of preparative parameters	86
	4.8.1. Substrate temperature	86
	4.8.2. Quantity of spraying solution	87
	4.8.3. Spray rate	87
	4.8.4. Concentration of spraying solution	88
	4.8.5. Post deposition heat treatment	88
	4.9 Results and Discussion	88

	4.9.1. Thermo gravimetric and differential thermal analysis of BICUVOX	88
	4.9.2. Effect of preparative parameters on film thickness	89
	4.10 Conclusions	93
	References	94
V	STRUCTURAL CHARACTERIZATION OF BICUVOX FILMS	
	5.1. Introduction	98
	5.2. Theoretical Background	98
	5.2.1 X-ray Diffraction technique (XRD)	99
	5.2.1.1. Determination of crystallite size	100
	5.2.1.2. Measurement of total intensities	101
	5.2.2 Scanning Electron Microscopy (SEM)	103
	5.2.3 Energy Dispersive X-ray Analysis (EDAX)	105
	5.2.4 Atomic Force Microscopy (AFM)	107
	5.3. Experimental	109
	5.4. Results and Discussion	110
	5.4.1 Effect of annealing on XRD of BICUVOX films formed on:	110
	a) Glass substrate	110
	b) Alumina substrate	114
	c) Effect of substrate on the annealing of BICUVOX films	119
	5.4.2 Effect of annealing on the surface morphology of BICUVOX films formed on:	120
	a) Glass substrate	120
	b) Alumina substrate	121

	5.4.3 EDAX studies of BICUVOX films	122
	5.4.4 AFM studies of BICUVOX films	124
	5.4. Conclusions	127
	References	129
VI	ELECTRICAL CHARACTERIZATION OF BICUVOX FILMS	
	6.1 Introduction	131
	6.2 Theoretical Background	131
	6.2.1 Dielectric constant	132
	6.2.2 Permittivity	133
	6.2.3 Dielectric polarization	134
	6.2.4 Dielectric mechanisms	135
	6.2.5 Effect of frequency and temperature on dielectric properties	138
	6.3 Experimental	140
	6.3.1 D.C. electrical conductivity	141
	6.3.2 Dielectric constant and dielectric loss	142
	6.3.3 A.C. conductivity	143
	6.4 Results and Discussion	144
	6.4.1 D.C. electrical conductivity of BICUVOX films formed on:	144
	a) Glass substrate	144
	b) Alumina substrate	146
	6.4.2 Dielectric constant and dielectric loss of BICUVOX films formed on:	149
	a) Glass substrate	149
	b) Alumina substrate	153
	6.4.3 A.C. conductivity of BICUVOX films formed On:	156

	<ul style="list-style-type: none"> a) Glass substrate 156 b) Alumina substrate 158 6.5 Conclusions 160 References 162 	
VII	IMPEDANCE STUDY OF BICUVOX FILMS	
	7.1 Introduction	165
	7.2 Theoretical Background	165
	7.2.1 Basics of impedance measurements	165
	7.2.2 Choosing an equivalent circuit	169
	7.3 Experimental	171
	7.4 Results and Discussion	172
	7.4.1 Room temperature impedance study of BICUVOX films formed on FTO coated glass substrates	172
	7.4.2 Temperature dependant impedance and ionic conductivity of BICUVOX films formed on:	176
	a) Glass substrate	176
	b) Alumina substrate	178
	7.5 Conclusions	181
	References	182
VIII	FORMATION OF PLANAR THIN FILM SOFC USING BICUVOX THIN FILMS	
	8.1 Introduction	184
	8.2 Theoretical Background	184
	8.2.1 Working principle of fuel Cells	184
	8.2.2 Types of fuel cells	185
	8.2.3 Solid Oxide Fuel Cell (SOFC)	186

	8.3 Brief review of development of SOFC	189
	8.4 Experimental	190
	8.4.1 Design of planar fuel cell geometry	190
	8.4.2 Synthesis of planar thin film SOFC	192
	8.5 Results and Discussion	193
	8.5.1 Surface morphological studies of planar structure	193
	8.5.2 Measurement of open circuit voltage (OCV)	194
	8.6 Conclusions	196
	References	198
IX	SUMMARY AND CONCLUSIONS	200