

## CONTENTS

<b><i>ABSTRACT</i></b>	i - iii
<b><i>DECLARATION</i></b>	v
<b><i>CERTIFICATES</i></b>	vi - vii
<b><i>ACKNOWLEDGEMENTS</i></b>	viii - x
<b><i>CONTENTS</i></b>	xi - xiii
<b><i>LIST OF TABLES</i></b>	xiv-xv
<b><i>LIST OF FIGURES</i></b>	xvi - xxiii
<b><i>LIST OF ABBREVIATIONS</i></b>	xxiv - xxv

### CHAPTER 1: Introduction

1.1 Current status of the global energy infrastructure	1
1.2 Integration of renewable energy into the grid	1
1.3 Energy storage – A global solution to restore grid infrastructure	2
1.4 Electrochemical energy storage systems	3
1.5 Batteries	4
1.5.1 Lithium-ion batteries (LIBs)	5
1.5.2 The design and operational principle of Lithium-ion batteries (LIBs)	6
1.5.3 Concerns associated with LIBs	7
1.6 Aqueous monovalent and multivalent energy storage systems	8
1.6.1 Aqueous Potassium ion batteries (APIBs)	10
1.6.2 Aqueous Aluminium ion batteries (AAIBs)	12
1.6.3 Challenges ahead with aqueous batteries	13
1.7 Scope and Structure of the Thesis	14
1.8 Objective of the thesis	14
1.9 Choosing electrodes for aqueous batteries	15
1.9.1 Carbon based materials	15
1.9.2 Bismuth based Chalcogenides	16
1.9.3 Molybdenum based materials	17
1.10 References	19

## CHAPTER 2:

### **Aqueous electrolyte mediated reversible $K^+$ ion insertion in graphite**

2.1 Introduction	35
2.2 Experimental Section	36
2.2.1 Materials	36
2.2.2 Characterization	36
2.2.3 Electrochemical analysis	37
2.3 Results and discussion	38
2.4 Conclusion	49
2.5 References	

## CHAPTER 3:

### **The Active-Inactive Interface for $K^+$ Ion Storage- A Case Study with $Bi_5Nb_3O_{15}$**

3.1 Introduction	56
3.2 Experimental Section	57
3.2.1 Materials	57
3.2.2 Synthesis	57
3.2.3 Characterization	57
3.2.4 Electrochemical analysis	57
3.4 Results and discussion	58
3.5 Conclusion	76
3.6 References	77

## CHAPTER 4:

### **Investigation on $Al^{3+}$ ion storage in $Bi_2MoO_6$ and $Bi_2WO_6$ for rechargeable aqueous aluminum-ion battery**

4.1 Introduction	81
4.2 Experimental Section	81
4.2.1 Materials	81
4.2.2 Synthesis	81
4.2.3 Characterization	82
4.2.4 Electrochemical analysis	82
4.3 Results and discussion	83
4.4 Conclusion	98
4.5 References	99

**CHAPTER 5:****High-rate performance of  $H_xMoO_3$  for aqueous aluminum-ion battery**

5.1 Introduction	103
5.2 Experimental Section	104
5.2.1 Materials	104
5.2.2 Synthesis	104
5.2.3 Characterization	104
5.2.4 Electrochemical analysis	105
5.3 Results and discussion	106
5.4 Conclusion	125
5.5 References	126

**CHAPTER 6: Conclusions**

6.1 Conclusion	131-135
List of Publications	136