
Contents

Contents.....	I
List of Abbreviations.....	V
Zusammenfassung.....	XI
Abstract	XII
Chapter 1 Introduction.....	1
1.1 Background.....	1
1.2 Motivation.....	3
Chapter 2 Theoretical Foundation	5
2.1 Overview of ASSB based on different electrolytes.....	5
2.1.1 Polymer-based solid-state electrolyte.....	6
2.1.2 Oxide-based solid-state electrolyte	8
2.1.3 Sulfide-based solid-state electrolyte.....	9
2.1.4 Other solid-state electrolytes	10
2.1.5 Application of different solid-state electrolytes	10
2.2 Anode development for ASSB	12
2.2.1 Silicon anode	12
2.2.2 Lithium metal	13
2.2.3 Anode-free and anode-less	16
2.3 Challenges to achieve anode-free	18
2.4 Literature approaches and discussion	23
2.4.1 Solid electrolyte fine-tuning.....	23
2.4.2 Design an interfacial layer.....	24
2.4.3 Cell testing condition optimization	25
2.5 Scaling up of solid-state batteries	28

2.5.1	Scalability of solid-state electrolytes.....	29
2.5.2	Fabrication of sheet-like solid electrolyte	30
2.5.3	Scalability of cathode	32
2.5.4	Scalability of anode	34
Chapter 3 Experimental methods		35
3.1	Preparation of metal-carbon composite layer with varying conductive carbons.....	35
3.2	Preparation of metal-carbon composite layer with eutectic alloys	36
3.2.1	Eutectic alloy particle size optimization	36
3.2.2	Slurry preparation with eutectic alloys.....	38
3.3	Preparation of dual-layered anode	39
3.3.1	Preparation of primary zinc layer via PVD	39
3.3.2	Preparation of conductive carbon layer	40
3.3.3	Preparation of dual-layered structure	40
3.4	Preparation of other battery components	41
3.4.1	Preparation of cathode.....	41
3.4.2	Preparation of free-standing solid separator.....	42
3.5	Torque cell assembly	44
3.6	Single-layer pouch cell assembly	45
3.7	Post-mortem analysis.....	47
3.8	Electrochemical characterization.....	48
3.9	Other characterization.....	49
Chapter 4 Determination of testing cell format.....		51
Chapter 5 Results of silver-conductive carbon approach		55
5.1	Anode coating optimization of Ag-CB baseline.....	55
5.2	Anode coating optimization of Ag-CB/CNT blend.....	59
5.3	Anode coating optimization of Ag-graphite anode	61

5.4	Cycling performance of full pouch cells with different anodes	62
5.5	Post-mortem analysis and characterization	64
Chapter 6 Results of lithiophilic alloys-CB anode approach		69
6.1	Particle size distribution and particle morphology	69
6.2	Cycling performance of full pouch cell with different anodes	71
6.3	Post-mortem analysis and characterization	72
Chapter 7 Results of dual-layered anode structure approach.....		81
7.1	Morphology of zinc layer	81
7.2	Cycling performance of full pouch cell with different anodes	82
7.3	Post-mortem analysis and characterization	88
Chapter 8 Full pouch cell failure studying.....		95
8.1	Challenges from components manufacturing.....	95
8.1.1	Challenges in separator manufacturing	95
8.1.2	Challenges in cathode manufacturing	96
8.1.3	Challenges in anode manufacturing	97
8.2	Different cell failure cases and possible reasons	99
Chapter 9 Solid-state batteries characterization challenges		103
9.1	Limitation in choice of characterization methods	103
9.2	Challenges in post-mortem analysis	103
9.3	Challenges in in-situ measurement.....	105
9.4	Challenges in lithium migration	108

Chapter 10 Conclusion	111
Chapter 11 Outlook	115
Acknowledgement.....	i
Curriculum Vitae.....	ii
List of References	iii