

Contents

Title	Page No.
Title of thesis	i
Dedication	ii
Certificate	iii
Declaration by the candidate and certificate by the supervisor	iv
Copyright transfer certificate	v
Acknowledgment	vi
Contents	viii
List of Figures	xii
List of Schemes	xix
List of Tables	xx
List of Symbols/Abbreviations	xxii
Preface	xxiv
Chapter-1: General Introduction	1-34
1. Introduction	2
1.1. Electrochemical water oxidation	3
1.2. Electrocatalytic kinetic parameters for OER	3
1.2.1. Overpotential (η)	4
1.2.2. Tafel slope	4
1.2.3. Faradaic efficiency	5
1.2.4. Turnover frequency (TOF)	6
1.2.5. Stability	7
1.2.6. Electrochemical active surface area	8
1.2.7. Electrochemical impedance spectroscopy (EIS)	9
1.3. Electrocatalysts for OER based on transition metal	10
1.4. Layered double hydroxides (LDHs)	12
1.5. Metal-organic framework-derived LDHs for OER	18

1.6. Zeolitic imidazolate frameworks (ZIFs)	19
1.6.1. ZIFs as OER electrocatalysts	21
1.6.2. ZIF-67 derived LDHs for OER	22
1.7. Motivation and objective of thesis	23
1.8. References	26
Chapter-2: Metal-Organic Framework Derived Hollow Cobalt Vanadium Layered Double Hydroxide Nanocages for Efficient Electrochemical Water Oxidation	35-50
2.1. Introduction	36
2.2. Chemicals	38
2.3. Instruments	38
2.4. Experimental	38
2.4.1. Synthesis of ZIF-67	38
2.4.2. Synthesis of V _x Co-LDH	39
2.4.3. Activation of nickel foam	39
2.4.4. Deposition of catalysts on nickel foam	39
2.5. Result and discussion	40
2.5.1. Characterization of catalysts	40
2.5.2. Electrochemical activity	43
2.6. Conclusion	46
2.7. References	46
Chapter-3: Iron(III) ion-Facilitated Conversion of ZIF-67 to a Self-supported Fe_xCo-Layered Double Hydroxide for Improved Water Oxidation	51-72
3.1. Introduction	52
3.2. Chemicals	53
3.3. Instruments	53
3.4. Experimental	53

3.4.1. Activation of nickel foam	53
3.4.2. Synthesis of cobalt hydroxide carbonate template on nickel foam	54
3.4.3. Synthesis of iron cobalt hydroxide carbonate template on nickel foam (Fe _{0.4} Co-HC@NF	54
3.4.4. Synthesis of ZIF-67@NF	54
3.4.5. Synthesis of Fe _{0.4} Co-ZIF-67@NF	55
3.4.6. Synthesis of Fe _{0.4} Co-LDH@NF	55
3.4.7. Synthesis of Co-LDH@NF	55
3.4.8. Synthesis of ZnCo-LDH@NF	55
3.5. Results and discussion	56
3.5.1. Characterizations of the catalyst	56
3.5.2. Electrochemical activity	60
3.6. Conclusion	69
3.7. Reference	69
Chapter-4: Electrochemical Fe(III) ion Incorporation in the Structure of ZIF-67- Derived Co-Layered Double Hydroxide Boosts Water Oxidation Activity	73-85
4.1. Introduction	74
4.2. Chemicals	75
4.3. Instruments	76
4.4. Experimental	76
4.4.1. Activation of nickel foam	76
4.4.2. Synthesis of ZIF-67@NF	76
4.4.3. Electrochemical reconstruction of ZIF@NF precatalyst into FeCo-LDH-x and Co-LDH	76
4.5. Results and discussion	76
4.5.1. Characterizations of the catalyst	76
4.5.2. Electrochemical activity	80
4.6. Conclusion	83
4.7. Reference	84

Chapter-5: The 4f-2p-3d Orbital Overlap Formed in a CeO₂/CeCo-LDH Heterostructure Derived from a Metal-Organic Framework for Improved Water Oxidation	86-106
5.1. Introduction	87
5.2. Chemicals	89
5.3. Instruments	89
5.4. Experimental	89
5.4.1. Activation of nickel foam	89
5.4.2. Synthesis of cobalt hydroxide carbonate template on nickel foam (Co-HC@NF)	90
5.4.3. Synthesis of ZIF-67@NF	90
5.4.4. Synthesis of CeCo-2	90
5.4.5. Synthesis of CeO ₂ +Co-LDH@NF	90
5.4.6. Synthesis of CeCo-LDH	90
5.4.7. Synthesis of Co-LDH	91
5.5. Results and discussion	91
5.5.1. Characterizations of the catalyst	91
5.5.2. Electrochemical Activity	96
5.6. Conclusion	102
5.7. Reference	103
Chapter-6: Conclusion and future prospective	107-111
6.1. Summary	108
6.2. Future scope and perspective	109
List of publications	111