The Electrochemistry of Novel Materials

EDITORS

Jacek Lipkowski and Philip N. Ross
Contents

1. Electrode Materials and Strategies for Photoelectrochemistry  1
   by N. Alonso-Vante and H. Tributsch

   1.1 Introduction and Scope  1
   1.2 Mechanism of Interfacial Reactions  2
   1.3 Parameters Affecting Electrode Behavior  6
   1.4 Electrocatalytic Processes in Semiconducting Materials  22
   1.5 Photoelectrocatalytic Process (Fuel Generation)  36
   1.6 Photoconversion Process (Current Generation)  42
   1.7 Challenges for Research and Application  49

   1.8 Summary and Outlook  54
   Acknowledgments  55
   References  55

2. Polymeric Materials for Lithium Batteries  65
   by M. Armand, J. Y. Sanchez, M. Gauthier, and Y. Choquette

   2.1 Introduction  65
   2.2 Principles and Requirements for Electrochemical Energy Storage  66
   2.3 Polymers as Solid-State Ionizing Solvents  69
   2.4 Polymers as Electrode Materials for Lithium Batteries  85
CONTENTS

2.5 Cell Geometry and Power Densities 90
2.6 EMFs and Stability Windows 93
2.7 Realizations and Prototypes 96
2.8 Safety 102
2.9 Conclusions 105
References 106

3. Insertion Compounds for Lithium Rocking Chair Batteries 111
by B. Scrosati

3.1 Introduction 111
3.2 Lithium Batteries 112
3.3 Criteria for the Selection of Insertion Electrodes for Rocking Chair Batteries 116
3.4 Carbon Insertion Materials 117
3.5 Layered Lithium Metal Oxides 125
3.6 Manganese Oxides 132
3.7 Other Types of Rocking Chair Configurations 135
3.8 Conclusions 136
References 137

4. Thin Polymer Films on Electrodes: A Physicochemical Approach 141
by K. Doblerhofer

4.1 Introduction 141
4.2 The Permeability of Nonionic Polymers 148
4.3 Ionic Polymers on Electrodes 165
4.4 Electronically Conducting Polymer Films 189
Acknowledgments 200
References 201

5. Transition Metal Oxides: Versatile Materials for Electrocatalysis 207
by S. Trasatti

5.1 Introduction 207
5.2 Properties of Oxides for Electrodes 210
5.3 Interfacial Properties 219
5.4 Electrocatalytic Properties 238
5.5 Factors of Electrocatalysis 259
5.6 Problems of Electrode Stability 262
5.7 Conclusions and Prospects 271
References 275
6. Electrochemistry of UO₂ Nuclear Fuel  297
by D. W. Shoesmith, S. Sunder, and W. H. Hocking

6.1 Introduction  297
6.2 Fuel Composition  299
6.3 Structural Properties  299
6.4 Electrical Properties  301
6.5 Electrochemical Properties  303
6.6 Thermodynamic Properties  305
6.7 Surface Composition Under Electrochemical Conditions  307
6.8 Anodic Dissolution  313
6.9 Redox Reactions on UO₂ Surfaces  321
6.10 Electrochemical Reactivity  331
Acknowledgments  332
References  332

7. Electrochemistry of Clays and Zeolites  339
by M. D. Baker and C. Senaratne

7.1 Introduction  339
7.2 Zeolites and Clays: Structure and Properties Pertaining to Electrode Modification  340
7.3 Fabrication of Electrodes  344
7.4 Historical Perspective  347
7.5 Mechanism of Electrochemistry Occurring at Clay- and Zeolite-Modified Electrodes  348
7.6 Analytical Applications  352
7.7 Electrocatalysis  359
7.8 Ion Exchange in Clays and Zeolites  367
7.9 Molecular Wires  371
7.10 Layered Double Hydroxides (Hydrotalcite Clays)  374
7.11 Studies of Diffusion  376
7.12 Conclusion  376
References  376

Index  381