

CHAPTER ONE: INTRODUCTION	1
STUDY GOALS AND OBJECTIVES.....	1
REASONS FOR DOING THE STUDY	2
REASONS FOR DOING THE STUDY (CONTINUED).....	3
SCOPE OF THE REPORT	4
METHODOLOGY	5
INTENDED AUDIENCE.....	6
INFORMATION SOURCES.....	6
ANALYST CREDENTIALS.....	6
RELATED BCC REPORTS	6
BCC ONLINE SERVICES.....	7
DISCLAIMER	7
CHAPTER TWO: SUMMARY.....	8
<i>SUMMARY TABLE GLOBAL MARKET FORECAST FOR LITHIUM</i> <i>BATTERY SALES, THROUGH 2014 (\$ MILLIONS)</i>	8
<i>SUMMARY FIGURE GLOBAL MARKET FORECAST FOR LITHIUM</i> <i>BATTERY SALES, 2004-2014 (\$ MILLIONS)</i>	9
CHAPTER THREE: LITHIUM BATTERY TECHNOLOGIES	10
LITHIUM BATTERY TECHNOLOGY BACKGROUND	10
PRIMARY LITHIUM BATTERIES.....	10
PRIMARY LITHIUM BATTERY SUMMARY	10
<i>TABLE 1 PRIMARY LITHIUM BATTERY TYPES</i>	11
<i>TABLE 1 (CONTINUED)</i>	12
PRIMARY LITHIUM BATTERY COMPOSITIONS	12
<i>TABLE 2 PRIMARY LITHIUM BATTERY COMPOSITIONS</i>	12
<i>TABLE 2 (CONTINUED)</i>	13
PRIMARY LITHIUM BATTERY APPLICATIONS.....	13
<i>TABLE 3 CONSUMER PRIMARY LITHIUM BATTERY APPLICATIONS</i>	13
<i>TABLE 3 (CONTINUED)</i>	14
<i>TABLE 4 INDUSTRIAL PRIMARY LITHIUM BATTERY</i> <i>APPLICATIONS</i>	14
<i>TABLE 4 (CONTINUED)</i>	15
<i>TABLE 5 MILITARY/AEROSPACE PRIMARY LITHIUM BATTERY</i> <i>APPLICATIONS</i>	15
PRIMARY LITHIUM BATTERY TYPES.....	16
Lithium–Carbon Monofluoride Batteries	16
Lithium–Copper Oxyphosphate Batteries.....	16
Lithium–Copper Oxide Batteries.....	16
Lithium–Iodine Batteries.....	17
Lithium–Iron Sulfide Batteries	17
Lithium–Manganese Dioxide Batteries.....	17
Lithium–Manganese Dioxide Batteries (Continued)	18
Lithium–Silver Vanadium Pentoxide Batteries.....	19

Lithium–Sulfur Dioxide Batteries	19
Lithium–Sulfuryl Chloride Batteries	20
Lithium–Thionyl Chloride Batteries	20
PRIMARY LITHIUM BATTERY COMPANIES	21
<i>TABLE 6 PRIMARY LITHIUM BATTERY COMPANIES</i>	<i>21</i>
ACR Electronics	22
Applied Power, Inc.	22
Duracell International	22
EaglePicher Corp.	23
Ener1, Inc. (EnerDel)	24
Energizer Holdings	24
GP Batteries (Gold Peak International)	25
Greatbatch, Inc.	26
Medtronic, Inc.	26
MiniMax Energy Technology	26
Moltech Corp.	27
Panasonic (Matsushita Electric Industrial Co.)	27
Panasonic (America)	27
Panasonic Batteries	28
Rayovac Corp. (Spectrum Brands)	28
SAFT (Johnson Controls– Saft-Advanced Power Solutions)	29
Saft America, Inc.	29
Solicore	30
Sanyo Electric Co., Ltd.	31
Sanyo Electric Co. USA	31
Sony Corp.	32
Sony (USA)	32
Tadiran Batteries (SAFT)	32
Ultralife Batteries, Inc.	33
Ultralife Batteries, Inc. (Continued)	34
Varta AG (Varta Batteries, Inc)	35
Varta Microbattery (USA)	35
Yardney (Lithion, Ener–Tek)	36
PRIMARY LITHIUM BATTERY MARKET SUMMARY	37
Primary Lithium Battery Market Fundamentals	37
<i>TABLE 7 PRIMARY LITHIUM MARKET SUMMARY</i>	<i>37</i>
<i>TABLE 7 (CONTINUED)</i>	<i>38</i>
Portable Product Primary Lithium Batteries	38
Medical Product Primary Lithium Batteries	39
Stationary Product Primary Lithium Batteries	39
Military/Aerospace Primary Lithium Batteries	39
Automotive/Motive Primary Lithium Batteries	40

BASIS FOR PRIMARY LITHIUM BATTERY MARKET PROJECTION	40
<i>TABLE 8 GLOBAL PRIMARY LITHIUM BATTERY VOLUME AND VALUE, 2008</i>	40
PRIMARY LITHIUM BATTERY MARKET PROJECTION	41
<i>TABLE 9 PROJECTED GLOBAL PRIMARY LITHIUM BATTERY VALUE BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	41
<i>FIGURE 1 PROJECTED GLOBAL PRIMARY LITHIUM BATTERY VALUE BY TYPE, 2004-2014 (\$ MILLIONS)</i>	42
<i>TABLE 10 PROJECTED GLOBAL PRIMARY LITHIUM BATTERY VALUE BY TECHNOLOGY, THROUGH 2014 (\$ MILLIONS)</i>	42
SECONDARY LITHIUM BATTERIES.....	43
SECONDARY LITHIUM BATTERY SUMMARY	43
<i>TABLE 11 SECONDARY LITHIUM BATTERY TYPES</i>	43
<i>TABLE 11 (CONTINUED)</i>	44
SECONDARY LITHIUM BATTERY COMPOSITIONS	45
<i>TABLE 12 SECONDARY LITHIUM BATTERY COMPOSITIONS</i>	45
<i>TABLE 12 (CONTINUED)</i>	46
SECONDARY LITHIUM BATTERY TYPES.....	46
Lithium/Aluminum–Polymer Batteries.....	46
Lithium/Aluminum–Manganese Dioxide Batteries	46
Lithium/Aluminum–Vanadium Pentoxide Batteries	47
Lithium–Cobalt Oxide Batteries.....	47
Lithium–Copper Chloride Batteries	47
Lithium–Ion and Lithium–Ion Polymer Batteries.....	47
Lithium–Ion Compared to Lithium–Ion Polymer	48
Lithium–Ion ... (Continued).....	49
Lithium–Ion as Smart Batteries.....	50
Lithium–Ion ... (Continued)	51
Lithium–Ion ... (Continued)	51
Lithium–Ion ... (Continued).....	52
<i>TABLE 13 SMART BATTERY SYSTEM (SBS) STAKEHOLDERS</i>	53
High–Temperature Lithium–Iron Sulfide Batteries.....	53
<i>TABLE 14 HIGH-TEMPERATURE LITHIUM-IRON SULFIDE BATTERY R&D</i>	54
High–Temperature ... (Continued)	54
Rechargeable Lithium–Manganese Dioxide Batteries	55
Lithium–Molybdenum Disulfide Batteries.....	56
Lithium–Niobium Selenide Batteries.....	56
Rechargeable Lithium–Sulfur Dioxide Batteries.....	57
Lithium–Titanium Disulfide Batteries.....	57
Lithium–Titanium Disulfide Polymer Electrolyte Batteries	57
Lithium–Vanadium Oxide Polymer Electrolyte Batteries	57

Thin-Film Batteries	58
Thin-Film Batteries (Continued).....	59
<i>TABLE 15 THIN-FILM MICRO-BATTERY COMPANIES</i>	60
Rechargeable Lithium-Air Batteries.....	60
Rechargeable ... (Continued).....	61
Rechargeable Lithium-... (Continued)	62
SECONDARY LITHIUM BATTERY COMPANIES.....	62
<i>TABLE 16 SECONDARY LITHIUM BATTERY COMPANIES</i>	63
<i>TABLE 16 (CONTINUED)</i>	64
<i>TABLE 16 (CONTINUED)</i>	65
A123Systems.....	65
<i>TABLE 17 A123 BATTERY COMPARED TO OTHER HIGH-CAPACITY</i> <i>BATTERY SYSTEMS</i>	66
<i>TABLE 18 A123 BATTERY PULSE DURATION AND POWER DENSITY</i>	67
A123Systems (Continued)	68
A123Systems (Continued)	69
Advanced Battery Systems	70
Advanced Battery Technologies, Inc. (ABAT)	70
Advanced ... (Continued).....	71
Apple Computer, Inc.....	72
Applied Power, Inc.....	73
Arotech Corp. (Epsilon & Electric Fuel).....	73
Arthur D. Little, Inc.	74
Avestor (Hydro-Québec and Kerr McGee)	74
Avestor ... (Continued)	75
BAE Systems	76
Battery-Biz.....	77
Battery Clinic, Inc.	77
Battery Technology, Inc. (BTI).....	77
Robert Bosch GmbH (SB LiMotive Co. Ltd).....	78
Robert Bosch ... (Continued)	79
Bolloré Group.....	80
Bolloré Group (continued)	81
Boston-Power	82
Boundless Corp.....	83
Bren-Tronics.....	83
BYD Batteries.....	84
Cadex.....	85
Cell-Con.....	85
China BAK Battery, Inc.	85
China BAK Battery, Inc. (Continued).....	86
China BAK Battery, Inc. (Continued).....	87
Cobasys (SB LiMotive Co. Ltd.)	88
Cobasys (SB LiMotive Co. Ltd.) (Continued).....	89

Continental Corporation	90
China Sun (Dalian Xinyang High-Tech Development Co.).....	90
Covalent Associates, Inc.....	91
Cymbet Corp.....	91
EaglePicher Corp.....	92
EaglePicher (Continued).....	93
EIC Laboratories	94
Electro Energy	94
Electrovaya (Electrofuel).....	95
Electrovaya ... (Continued)	96
Ener1, Inc. (EnerDel)	97
Ener1, Inc. ... (Continued).....	98
Ener1, Inc. ... (Continued).....	99
Ener1, Inc. ... (Continued).....	100
Enerize Corp. (FiFe Batteries).....	101
FIFE Batteries Ltd.....	101
Energizer Holdings.....	102
E-One Moli Energy	103
NEC	103
NEC (Continued).....	104
Evonik Industries AG.....	105
Excellatron Solid State.....	106
Farasis Energy.....	106
Fuji Photo Film Co., Ltd.....	107
Furukawa Battery Co.....	107
General Motors	107
General Motors Continued).....	108
General Motors Continued).....	109
GP Batteries (Gold Peak International)	110
Greatbatch, Inc.....	110
Harding Energy, Inc.....	111
Hitachi Maxell Corp.....	111
Honeywell Batteries	112
Hong Kong Highpower Technology.....	112
HYB Battery Co., Ltd. (Hua-Yue-Bao Battery)	113
Huanyu Battery	113
Hymotion (A123Systems).....	113
IBM Corp.....	114
Industrial Battery Engineering	115
Industries International, Inc. (INDI).....	115
Infinite Power Solutions.....	116
Innergy Power Corp. (Portable Energy Products, Inc.)	116
International Battery	117

Johnson Controls (Johnson Controls–Saft Advanced Power Solutions).....	118
Johnson Controls ... (Continued)	119
Johnson Controls ... (Continued)	120
Johnson Controls ... (Continued)	121
K2	122
Keystone Battery Corp.....	123
Kokam America, Inc.	123
Lithium Power Technologies.....	123
Lithium Technology Corp. (LTC)	124
GAIA Akkumulatorenwerke GmbH.....	124
GAIA ... Continued).....	125
GAIA ... Continued).....	126
GAIA ... Continued).....	127
MaxPower, Inc.	128
Medtronic, Inc.....	128
Microchip Technology, Inc.....	129
MiniMax Energy Technology	129
Mitsubishi International	129
Mitsubishi ... (Continued)	130
Moltech Corp.....	131
Multiplier Industries	132
Nanoexa	132
NEC Corp. (E–One Moli Energy).....	133
NEC ... (Continued)	134
Nexergy (Promark Electronics, DC Battery Products, Tauber)	135
Nissan Motor Co.	135
Nissan ... (Continued)	136
Oak Ridge Micro–Energy, Inc.....	137
Panasonic (Matsushita Electric Industrial Co.).....	138
Panasonic (America)	138
Panasonic Batteries	139
PolyPlus Battery Company	139
Quallion LLC	140
Rayovac Corp. (Spectrum Brands).....	141
Renata Batteries.....	142
Ricardo, Inc.	142
Saft (Johnson Controls–Saft Advanced Power Solutions)	143
Saft America, Inc.	143
Saft America, Inc. (Continued).....	144
Saft America, Inc. (Continued).....	145
Sanyo Electric Co., Ltd.	146
Sanyo Electric Co. USA	146

SETO Holdings, Inc.....	147
Sion Power	147
Solicore, Inc.....	148
Sony Corp.....	149
Sony (USA).....	149
Sony ... (Continued).....	150
Sony (USA) (Continued)	151
<i>TABLE 19 COMPARISON BETWEEN CONVENTIONAL BATTERY</i>	
<i>AND NEXELION.....</i>	<i>152</i>
SRI International.....	153
Toshiba.....	153
<i>TABLE 20 SCIB SPECIFICATIONS.....</i>	<i>154</i>
TIAX.....	155
Tracer Technologies.....	156
Ultralife Batteries, Inc.	156
Ultralife ... (Continued)	157
Valence Technology, Inc.	158
Ultralife Batteries, Inc. (Continued).....	159
Ultralife Batteries, Inc. (Continued).....	160
Ultralife Batteries, Inc. (Continued).....	161
Ultralife Batteries, Inc. (Continued).....	162
Varta AG (Varta Batteries, Inc).....	163
Varta Microbattery (USA).....	163
Yardney (Lithion, Ener-Tek).....	164
Yuasa, Inc. (GS Yuasa Corp., Yuasa Battery America,	
Inc., Yuasa-Exide)	165
Yuasa ... (Continued).....	166
SECONDARY LITHIUM BATTERY MARKET SUMMARY.....	167
Secondary Lithium Battery Market Fundamentals And	
Basis For Forecast.....	167
<i>TABLE 21 SECONDARY LITHIUM MARKET SUMMARY.....</i>	<i>167</i>
Portable Product Secondary Lithium Batteries	168
Medical Product Secondary Lithium Batteries	168
Stationary Product Secondary Lithium Batteries.....	168
Military/Aerospace Secondary Lithium Batteries.....	169
Automotive/Motive Secondary Lithium Batteries.....	170
BASIS FOR SECONDARY LITHIUM BATTERY MARKET	
PROJECTION.....	171
<i>TABLE 22 2008 SECONDARY GLOBAL LITHIUM BATTERY VOLUME</i>	
<i>AND VALUE (MILLIONS).....</i>	<i>171</i>
SECONDARY LITHIUM BATTERY MARKET PROJECTION	171
<i>TABLE 23 GLOBAL PROJECTED SECONDARY LITHIUM BATTERY</i>	
<i>VALUE BY TYPE, THROUGH 2014 (\$ MILLIONS).....</i>	<i>172</i>

<i>FIGURE 2 GLOBAL PROJECTED SECONDARY LITHIUM BATTERY VALUE BY TYPE, 2004-2014 (\$ MILLIONS)</i>	172
<i>TABLE 24 GLOBAL PROJECTED SECONDARY LITHIUM BATTERY VALUE BY TECHNOLOGY, 2004-2014 (\$ MILLIONS)</i>	173
CHAPTER FOUR: LITHIUM BATTERY MARKETS	174
LITHIUM BATTERY MARKET SUMMARY	174
<i>TABLE 25 LITHIUM BATTERY MARKET SECTORS</i>	174
LITHIUM BATTERY PORTABLE PRODUCT MARKETS	175
Portable Computing Product Market	175
Portable Computing Product Market Fundamentals and Basis for Market Projection	175
<i>TABLE 26 PORTABLE COMPUTER DRIVING FORCES AND MARKET DEVELOPMENTS</i>	176
<i>TABLE 26 (CONTINUED)</i>	177
Portable Computing Product Market Projection	177
<i>TABLE 27 GLOBAL MARKET FORECAST FOR PORTABLE COMPUTING LITHIUM BATTERIES BY TYPE, THROUGH 2018 (\$ MILLIONS)</i>	177
Portable Communications Product Market.....	177
Portable Communications Product Market Fundamentals and Basis for Market Projection	177
Portable Communications ... (Continued)	178
Portable Communications ... (Continued)	179
<i>TABLE 28 PORTABLE COMMUNICATIONS PRODUCT DRIVING FORCES AND MARKET DEVELOPMENTS</i>	180
Portable Communications Product Market Projection	181
<i>TABLE 29 GLOBAL MARKET FORECAST FOR PORTABLE COMMUNICATIONS LITHIUM BATTERIES BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	181
Portable Tool Markets.....	181
Portable Tool Market Fundamentals and Basis for Market Projection	181
Portable Tool ... (Continued).....	182
<i>TABLE 30 PORTABLE TOOL PRODUCT DRIVING FORCES AND MARKET DEVELOPMENTS</i>	183
Basis for Portable Tool Battery Market Projection	184
<i>TABLE 31 GLOBAL MARKET FORECAST FOR PORTABLE TOOL LITHIUM BATTERIES BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	184
Other Portable Product Markets	184
Other Portable Product Market Fundamentals and Basis for Market Projection	185

Portable Toy and Novelty Product Market	
Fundamentals and Basis for Market	
Projection	185
Portable Toy...(Continued).....	186
Portable Toy...(Continued).....	187
<i>TABLE 32 PORTABLE TOY AND NOVELTY DRIVING FORCES AND</i>	
<i>MARKET DEVELOPMENTS</i>	188
Portable Entertainment Product Market	
Fundamentals and Basis for Market	
Projection	188
Portable Entertainment...(Continued).....	189
<i>TABLE 33 PORTABLE ENTERTAINMENT DRIVING FORCES AND</i>	
<i>MARKET DEVELOPMENTS</i>	190
Portable Scientific Product Market	
Fundamentals and Basis for Market	
Projection	191
<i>TABLE 34 PORTABLE SCIENTIFIC PRODUCT DRIVING FORCES</i>	
<i>AND MARKET DEVELOPMENTS</i>	192
Digital Video and Still Camera Market	
Fundamentals and Basis for Market Projection	193
Portable Camera Product Market Drivers and	
Technology Factors.....	193
<i>TABLE 35 DIGITAL VIDEO AND STILL CAMERA DRIVING FORCES</i>	
<i>AND MARKET DEVELOPMENTS</i>	194
<i>TABLE 35 (CONTINUED)</i>	195
Other Portable Product Market Projections	195
<i>TABLE 36 GLOBAL MARKET FORECAST FOR OTHER PORTABLE</i>	
<i>PRODUCT LITHIUM BATTERIES BY TYPE THROUGH 2014 (\$</i>	
<i>MILLIONS)</i>	195
LITHIUM BATTERY MEDICAL PRODUCTS MARKET	
SUMMARY.....	195
Medical Products Market Fundamentals and Basis for	
Market Projection.....	195
Medical Products ... (Continued)	196
Medical Products ... (Continued)	197
Medical Products ... (Continued)	198
<i>TABLE 37 PORTABLE MEDICAL PRODUCT DRIVING FORCES AND</i>	
<i>MARKET DEVELOPMENTS</i>	199
Medical Product Market Projection	199
<i>TABLE 38 GLOBAL MARKET FORECAST FOR MEDICAL LITHIUM</i>	
<i>BATTERIES BY TYPE THROUGH 2014 (\$ MILLIONS)</i>	199
LITHIUM BATTERY STATIONARY APPLICATION MARKET	
SUMMARY.....	200

Computer Memory Preservation Market Fundamentals and Basis for Market Projection	200
Computer Memory Preservation Market Projection	200
<i>TABLE 39 PROJECTED GLOBAL COMPUTER MEMORY PRESERVATION LITHIUM BATTERY VALUE BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	200
Uninterruptible Power Supply Market	200
Uninterruptible Power Supply Market Fundamentals and Basis for Market Projection	200
Uninterruptible Power Supply Market Projections	201
<i>TABLE 40 PROJECTED GLOBAL UPS LITHIUM BATTERY VALUE BY TYPE THROUGH 2014 (\$ MILLIONS)</i>	202
LITHIUM BATTERY MILITARY/AEROSPACE MARKET	202
Military/Aerospace Market Fundamentals and Basis for Market Projection.....	202
<i>TABLE 41 SELECTED PORTABLE BATTERY-POWERED MILITARY PRODUCT ROLES</i>	203
Portable Military Product Market Drivers and Technology Factors	203
Portable Military...(Continued)	204
<i>TABLE 42 PORTABLE MILITARY PRODUCT DRIVING FORCES AND MARKET DEVELOPMENTS</i>	205
<i>TABLE 42 (CONTINUED)</i>	206
Military Electric Vehicles Scenario.....	207
Battery-Powered Fighting Vehicle Scenario.....	207
Strategic Defense Initiative (SDI) Revival Scenario	208
Military/Aerospace Market Projections	208
<i>TABLE 43 GLOBAL MARKET FORECAST FOR MILITARY & AEROSPACE LITHIUM BATTERIES BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	209
LITHIUM BATTERY AUTOMOTIVE AND MOTIVE POWER MARKET SUMMARY	209
Industrial Electric Vehicles (Traction) Market	209
Industrial Electric Vehicles (Traction) Market Fundamentals and Basis for Market Projection	209
Industrial Electric Vehicles (Traction) Market Projections.....	210
<i>TABLE 44 GLOBAL MARKET FORECAST FOR INDUSTRIAL EV LITHIUM BATTERIES BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	211
Electric Vehicle, Plug-in and HEV Market.....	211
EV, PHEV and HEV Market Fundamentals and Basis for Market Projection	211
EV, PHEV...(Continued)	212
EV, PHEV...(Continued)	213
EV, PHEV...(Continued)	214

EV, PHEV...(Continued)	215
EV and HEV Market Projections	216
<i>TABLE 45 MARKET FORECAST FOR GLOBAL EV AND HEV</i>	
<i>LITHIUM BATTERIES BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	216
Automotive Market.....	216
Automotive Market Fundamentals and Basis for	
Market Projection	216
Automotive Market Projections.....	217
<i>TABLE 46 MARKET FORECAST FOR GLOBAL AUTOMOTIVE</i>	
<i>LITHIUM BATTERIES BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	217
CHAPTER FIVE: LITHIUM BATTERY MATERIALS	218
LITHIUM BATTERY MATERIAL BACKGROUND.....	218
TYPES OF LITHIUM BATTERY MATERIALS	218
TYPES OF LITHIUM BATTERY ... (CONTINUED).....	219
<i>TABLE 47 LITHIUM BATTERY CATHODE MATERIALS</i>	220
<i>TABLE 47 (CONTINUED)</i>	221
<i>TABLE 48 LITHIUM BATTERY ELECTROLYTE MATERIALS</i>	221
<i>TABLE 48 (CONTINUED)</i>	222
<i>TABLE 49 LITHIUM BATTERY SEPARATOR MATERIALS</i>	222
<i>TABLE 49 (CONTINUED)</i>	223
ELECTRODE MATERIALS AND ACTIVE ELEMENTS.....	223
Electrode Material and Active Element Background	223
Electrode Material and Active Element Companies	224
<i>TABLE 50 LITHIUM BATTERY ELECTRODE MATERIAL COMPANIES ...</i>	224
<i>TABLE 50 (CONTINUED)</i>	225
<i>TABLE 50 (CONTINUED)</i>	226
3M.....	227
Acheson Colloids, Inc. (Henkel).....	227
Admiralty Resources.....	228
Advance NanoPower, Inc.....	228
Air Products	229
Ajay SQM Group.....	229
Akzo Nobel	230
Alfa Aesar–Johnson Matthey Co.....	230
Allan Chemical Corp.....	230
Allchem Industries, Inc.	231
Altair Nanotechnologies, Inc.	231
Altair ... (Continued).....	232
Altair Nanotechnologies, Inc. (Continued)	232
Altair ... (Continued).....	233
American Lithium Minerals.....	234
Amber Synthetics (AmSyn)	235
Applied Nanomaterials, Inc (ApNano).....	236
Advanced Research Chemicals (ARC).....	236

Arkema	237
Ashland Chemicals	237
Avalon Rare Metals	238
BASF Corp.	238
Baytubes (Bayer MaterialScience).....	239
Belmont Metals, Inc.....	239
Bikita Minerals	239
Borchers France S.A.	240
Cabot Corp.....	240
Caledonia Mining Corp.....	241
Cannon–Muskegon Corp.	241
CarboLex, Inc.	241
Chambishi Metals, plc	242
Chemetall Foote Corp. (Sociedad Chilena de Litio, Ltda., SCL).....	242
Chempro	243
Climax Molybdenum.....	243
Columbus Chemical Industries	244
Conoco.....	244
Corn. Van Loocke N.V.	244
Coyne Chemical	244
CTT	245
CVRD/Inco, Ltd.	245
Darton Commodities, Ltd.	245
Delta EMD	246
Dexmet Corp.	246
Dow Chemical Co.....	246
Elementis Pigments–Durham	247
Eurotungstene Poudres S.A.	247
Ferro Corp.	247
FMC Corp.	247
Frontier Carbon Corp. (FCC)	248
Fusite (Division of Emerson Electric Co.).....	249
GFS Chemicals, Inc.	250
Glencore International AG	250
GrafTech International.....	250
Hermetic Seal Technology, Inc.....	251
Honjo Chemical Corp.	251
Hunan Xiangtan Electrochemical Group.....	251
Inco Special Products.....	252
International Cobalt Co., Inc.....	252
ISE Corp.	252
Kennametal, Inc.....	253
Lamart Corp.....	253

LG Chemical.....	253
mPhase Technologies.....	254
MPhase ... (Continued).....	255
Mays Chemical Co.	256
Materials and Electrochemical Research Corp (MER)	256
Mitsui & Co., Ltd.	257
Mitsui Benelux.....	257
Nano-C, Inc.....	257
Nanergy, Inc.....	258
Nanocyl S.A.....	258
Noah Technologies	259
Norilsk Nickel	260
Novolyte Technologies, Inc.	260
OM Group.....	260
Phostech Lithium.....	261
Pred Materials	262
Premenco, Ltd.....	262
Prince Minerals (American Minerals, Inc.)	262
QNI Pty, Ltd.....	263
QuantumSphere.....	263
Raymor Industries, Inc.	264
Reade Advanced Materials.....	265
Sheperd Chemical Co.....	266
Shu Powders, Ltd.....	266
Sons of Gwalia.....	266
Spectrum Chemicals	267
SQM Minsal	267
SQM Minsal (Continued).....	268
Sheldahl Technical Materials.....	269
Showa Denko K.K. (SDK).....	269
Showa ... (Continued)	270
H.C. Starck.....	271
Sumitomo Metal Mining Co., Ltd.....	271
Superlattice Power.....	271
Superlattice Power (Continued)	272
<i>TABLE 51 OPERATING VOLTAGE RANGE AND MAXIMUM CAPACITY COMPARISON.....</i>	<i>273</i>
Superior Graphite Co.....	274
Teck (Teck Cominco, Ltd.)	274
Thomas Swan & Co., Ltd.....	275
T/J Technologies (A123 Systems).....	276
Timcall Graphite & Carbon.....	276
Todini and Co. SPA.....	276

Toray.....	277
Toxco, Inc. (Lithchem International)	277
Tronox.....	277
Umicore (Union Miniere).....	278
U.S. Nanocorp	279
U.S. Vanadium Corp. (Stratcor).....	279
Ube Industries	279
Unidym (Arrowhead Research Corp.)	280
Wego Chemical & Mineral.....	281
Wogen Resources, Ltd.....	281
Xiamen Tungsten Co., Ltd.....	281
Xstrata Nickel (Falconbridge)	282
LITHIUM METAL AND COMPOUNDS	282
LITHIUM MINERS AND PROCESSORS	282
Lithium Brine Sources	282
<i>TABLE 52 LITHIUM MINERALS AND BRINE: ESTIMATED WORLD PRODUCTION BY COUNTRY, 2002–2007 (METRIC TONS)^{1, 2}</i>	283
Lithium ... (Continued)	284
<i>TABLE 53 LITHIUM BRINE PROCESSORS</i>	285
Lithium Brine Sources (Continued)	286
Lithium Brine Sources (Continued)	287
Lithium Hardrock Sources	288
Lithium Compound Companies	288
<i>TABLE 54 LITHIUM COMPOUND COMPANIES</i>	289
LITHIUM APPLICATIONS, PRODUCTION, AND CONSUMPTION.....	290
<i>TABLE 55 U.S. LITHIUM CONSUMPTION, 1994–2006 (METRIC TONS OF CONTAINED LITHIUM)</i>	290
<i>TABLE 56 GLOBAL LITHIUM MARKETS (%)</i>	290
<i>TABLE 56 (CONTINUED)</i>	291
LITHIUM PRICES.....	291
COPPER COMPOUNDS.....	292
NICKEL AND IRON METAL AND COMPOUNDS.....	292
Nickel Metal and Compounds	292
Iron Compounds (Lithium Iron Phosphate)	293
ELECTROLYTIC MANGANESE DIOXIDE COMPOUNDS.....	294
Manganese Dioxide Companies	295
<i>TABLE 57 MANGANESE DIOXIDE COMPANIES</i>	295
Manganese Dioxide Developments and Constraints	296
COBALT COMPOUNDS.....	296
Cobalt Companies.....	297
<i>TABLE 58 COBALT COMPOUND COMPANIES</i>	298
Cobalt Consumption Patterns.....	298
<i>TABLE 59 GLOBAL COBALT MARKETS</i>	299

<i>TABLE 60 U.S. COBALT CONSUMPTION, 1994–2008 (MT OF COBALT CONTENT)</i>	299
Cobalt Prices	300
<i>TABLE 61 HISTORIC GLOBAL COBALT PRICES, 1991–2009 (\$/LB)</i>	300
ALUMINUM METAL COMPOUNDS	301
SULFUR COMPOUNDS.....	302
VANADIUM COMPOUNDS.....	302
<i>TABLE 62 VANADIUM COMPOUND COMPANIES</i>	303
RARE EARTH COMPOUNDS.....	303
INORGANIC CARBON.....	303
<i>TABLE 63 CARBON COMPOUND COMPANIES</i>	304
<i>TABLE 63 (CONTINUED)</i>	305
FULLERENES	305
Fullerenes (Continued).....	306
<i>TABLE 64 FULLERENE COMPANIES</i>	307
<i>TABLE 64 (CONTINUED)</i>	308
CONDUCTIVE POLYMERS	308
<i>TABLE 65 CONDUCTIVE POLYMER BATTERY ENERGY DENSITIES</i>	309
HALOGENS	309
<i>TABLE 66 HALOGEN BATTERY APPLICATIONS</i>	310
Iodine Compounds	311
Bromine Compounds	311
Chlorine Compounds	311
<i>TABLE 67 HALOGEN COMPOUND COMPANIES</i>	311
LITHIUM BATTERY ELECTROLYTES.....	312
<i>TABLE 68 LITHIUM CONTAINING BATTERY ELECTROLYTE MATERIALS</i>	312
<i>TABLE 68 (CONTINUED)</i>	313
LITHIUM BATTERY ELECTROLYTE COMPANIES.....	313
<i>TABLE 69 LITHIUM BATTERY ELECTROLYTE MATERIAL COMPANIES</i>	313
<i>TABLE 69 (CONTINUED)</i>	314
LITHIUM BATTERY SEPARATORS.....	315
LITHIUM BATTERY SEPARATOR COMPANIES.....	316
<i>TABLE 70 BATTERY SEPARATOR COMPANIES</i>	316
<i>TABLE 70 (CONTINUED)</i>	317
Amerace Microporous Products	317
Asahi Kasei	317
Bekaert (Advanced Refractory Technologies).....	317
Celgard, LLC.....	318
Celgard, LLC/Continued)	319
Dexmet Corp.	320
Entek Membranes	320
ExxonMobil (Tonen Chemical Affiliate)	320

ExxonMobil ... (Continued)	321
W. L. Gore & Associates, Inc.....	322
Hollingsworth and Vose Co.	322
Lynntech, Inc.	323
Nippon Kodoshi Corp. (NKK).....	323
Pall Corp.	323
SK Energy Corp.	324
TFP, Inc.....	324
Ube Industries	325
LITHIUM BATTERY MATERIALS MARKET SUMMARY	325
<i>TABLE 71 PROJECTED GLOBAL PRIMARY LITHIUM BATTERY ACTIVE ELEMENT VALUE, THROUGH 2014 (\$ MILLIONS)</i>	326
<i>TABLE 72 PROJECTED GLOBAL PRIMARY LITHIUM BATTERY ELECTROLYTE VALUE, THROUGH 2014 (\$ MILLIONS)</i>	326
<i>TABLE 73 PROJECTED GLOBAL PRIMARY LITHIUM BATTERY SEPARATOR VALUE, THROUGH 2014 (\$ MILLIONS)</i>	327
<i>TABLE 74 PROJECTED SECONDARY LITHIUM BATTERY ACTIVE ELEMENT VALUE, THROUGH 2014 (\$ MILLIONS)</i>	327
<i>TABLE 75 PROJECTED GLOBAL SECONDARY LITHIUM BATTERY ELECTROLYTE VALUE, THROUGH 2014 (\$ MILLIONS)</i>	328
<i>TABLE 76 PROJECTED GLOBAL SECONDARY LITHIUM BATTERY SEPARATOR VALUE, THROUGH 2014 (\$ MILLIONS)</i>	328
<i>TABLE 77 PROJECTED GLOBAL LITHIUM BATTERY MATERIALS VALUE BY TYPE, THROUGH 2014 (\$ MILLIONS)</i>	328
<i>FIGURE 3 PROJECTED GLOBAL LITHIUM BATTERY MATERIALS VALUE BY TYPE, 2004-2014 (\$ MILLIONS)</i>	329
CHAPTER SIX: INDUSTRY STRUCTURE AND COMPETITIVE ASPECTS	330
THE DRIVING FORCES OF THE INDUSTRY	330
TREND ANALYSIS.....	330
Trend Analysis (Continued)	331
<i>TABLE 78 BATTERY MARKET (END USE) TREND</i>	332
Trend Analysis (Continued)	333
DRIVING FORCE 1: LITHIUM BATTERY AND BATTERY MATERIAL PATENT SITUATION	334
Patent Disputes	334
University of Texas, Hydro Quebec, and NTT, and Others.....	334
3M, Sony, and Lenovo.....	335
3M and Panasonic.....	336
DRIVING FORCE 2: IMPROVING BATTERY TECHNICAL MATURITY	336
DRIVING FORCE 3: DEVELOPING NEW APPLICATIONS FOR LITHIUM BATTERIES	337

DRIVING FORCE 4: EVOLVING TRANSPORTATION	
APPLICATIONS – EVS TO HEVS TO PLUG–INS	338
Pollution Abatement.....	339
<i>TABLE 79 ANNUAL GREENHOUSE GAS EMISSIONS REDUCTIONS</i>	
<i>FROM PHEVS, 2005</i>	340
<i>TABLE 80 PEAK NEW VEHICLE MARKET SHARE FOR THE THREE</i>	
<i>PHEV ADOPTION SCENARIOS, 2050 (%)</i>	341
Electric Utility Efficiency	341
Electric Utility Efficiency (Continued).....	342
Promotion of Domestic Energy Sources.....	343
Maintaining Technological Competitiveness	344
Obama Administration Incentives	344
Obama Administration ... (Continued).....	345
Obama Administration ... (Continued).....	346
<i>TABLE 81 ELECTRIC VEHICLE BATTERY MANUFACTURING</i>	
<i>INITIATIVE WINNERS</i>	347
<i>TABLE 81 (CONTINUED)</i>	348
Obama Administration ... (Continued).....	349
Obama Administration ... (Continued).....	350
DRIVING FORCE 5: PUBLIC SECTOR R&D.....	351
Ames National Laboratory	352
Argonne National Laboratory	352
Argonne National ... (Continued).....	353
Argonne National ... (Continued).....	354
Argonne National ... (Continued).....	355
Arizona State University.....	356
Battelle Memorial Institute	357
Brookhaven National Laboratory	357
California Institute of Technology	357
California Institute ... (Continued).....	358
California Nanosystems Institute.....	359
Center for Nanoscale Science (CNS).....	360
Clark University	360
Ecole Polytechnique Fédérale De Lausanne	360
Florida State University.....	361
Georgia Institute Of Technology, Polymer Research	
Center	361
Hunter College.....	361
Idaho National Engineering Laboratory	362
Iowa State University, Ames Laboratory	362
John Hopkins University, Applied Physics Laboratory.....	362
Kyoto University.....	362
Kyushu University	362

Laboratoire d'Electrochimie Organique Et De Photochimie Redox	363
Lawrence Berkeley National Laboratory	363
Lawrence Livermore National Laboratory	363
Los Alamos National Laboratory	364
Massachusetts Institute of Technology	364
Massachusetts ... (Continued).....	365
Max Planck Institut Für Festkorperforschung	366
Michigan State University	366
National Nanotechnology Initiative	366
National ... (Continued).....	367

TABLE 82 NATIONAL NANOFABRICATION INFRASTRUCTURE

<i>NETWORK</i>	368
National Aeronautics and Space Administration (NASA).....	368
National ... (Continued).....	369
NASA Jet Propulsion Lab	370
National Renewable Energy Laboratory (NREL)	371
North Carolina Center For Nanoscale Materials (NCCNM).....	372
North Carolina State University	373
Northwestern University	373
Northwestern ... (Continued)	374
Northwestern ... (Continued)	375
Oak Ridge National Laboratory.....	376
Ohio State University.....	376
Oregon State University.....	376
Penn State University	376
Pennsylvania State University, Center For Advanced Materials.....	377
Purdue University Birck Nanotechnology Center	377
Polytechnic University	378
Princeton University	378
Rensselaer Polytechnic Institute (RPI)	378
Rice University	379
Rochester Institute of Technology	380
Rutgers, The State University of New Jersey	380
Sandia National Laboratory	380
Sandia ... (Continued)	381
Simon Fraser University	382
Sophia University	382
Stanford University	383
State University of New York (SUNY)	383
University of Kentucky	383
Università La Sapienza.....	384

University of Oklahoma Carbon Nanotubes Technology Center (CaNTeC).....	384
Universität Tübingen Institut Für Organische Chemie.....	385
University of California, Institute for Polymers and Organic Solids	385
University of Chicago	386
University of Colorado.....	386
University of Dayton Research Institute.....	386
University of Durham.....	386
University of Illinois.....	387
University of Kentucky	387
University of Massachusetts	387
University of Minnesota	387
University of Missouri	388
University of Nevada at Las Vegas	389
University of New Mexico	389
University of New South Wales	390
University of North Carolina	390
University of Pennsylvania	390
University of Rhode Island.....	391
University of Southern California	391
University of St. Andrews	391
University of Texas.....	391
University of Tokyo	392
USCAR	392
Waseda University, Department of Chemistry, School of Science and Engineering.....	392
DRIVING FORCE 6: BATTERY QUALITY CONTROL & PRODUCT SAFETY	392
The Manufacturing and Assembly Process	392
<i>TABLE 83 GENERIC BATTERY MANUFACTURING TREE.....</i>	<i>393</i>
Product Safety Issues	394
Alternative Designs	395
Alternative ... (Continued)	396
Alternative ... (Continued)	397
Lithium Battery Patents that Address Battery Safety	398
Battery Pack.....	398
Secondary Battery with Protective Circuit.....	398
Battery Capacity Calculating Method	399
System and Method for Efficiently Implementing a Battery Controller for an Electronic Device	399
Material Safety Issues.....	399

Material Safety ... (Continued)	400
Material Safety ... (Continued)	401
<i>TABLE 84 TYPICAL C₆₀ MSDS DATA</i>	402
<i>TABLE 84 (CONTINUED)</i>	403
<i>TABLE 84 (CONTINUED)</i>	404
MARKET SEGMENTATION AND INDUSTRY CONCENTRATION	
FACTORS	404
MARKET CONCENTRATION FACTORS	404
<i>TABLE 85 LITHIUM BATTERY CONCENTRATION FACTORS</i>	405
<i>TABLE 86 LITHIUM BATTERY MARKET SEGMENTATION AND</i>	
<i>MARKET FORCES</i>	406
MARKET SEGMENTATION FACTORS	406
Mining	406
Processing/Refining	407
Chemical Synthesis	407
Compounding	408
Recycling	408
INDUSTRY ENVIRONMENT AND TRADE PRACTICES	409
LITHIUM BATTERIES AS PART OF THE OVERALL GLOBAL	
BATTERY MARKET	409
<i>TABLE 87 TOTAL BATTERY MARKET, THROUGH 2014 (\$ MILLIONS)</i>	409
DISTRIBUTION CHANNELS	409
<i>TABLE 88 LITHIUM BATTERY DISTRIBUTION CHANNELS</i>	410
INDUSTRY PURCHASING INFLUENCES	411
LITHIUM BATTERY PURCHASING INFLUENCE	
SIGNIFICANCE	411
LITHIUM BATTERY PURCHASING INFLUENCES	412
<i>TABLE 89 TYPICAL RETAIL LITHIUM BATTERY PRICES, 1996–2009</i>	
<i>(\$)</i>	412
LITHIUM BATTERY MATERIAL PURCHASING	
INFLUENCES	412
How Significant Are Material Prices?	412
How Significant ... (Continued)	413