

SUPERCONDUCTORS: TECHNOLOGIES AND GLOBAL MARKETS



AVM066C
October 2012

Andrew McWilliams
Project Analyst

ISBN: 0-89336-154-2

bcc | Research
Market Forecasting

BCC Research
49 Walnut Park, Building 2
Wellesley, MA 02481
866-285-7215, 781-489-7301
www.bccresearch.com
Custom Reports: carol.laverty@bccresearch.com

TABLE OF CONTENTS

TOPIC	PAGE NO.
CHAPTER 1 INTRODUCTION	1
STUDY BACKGROUND	1
STUDY GOALS AND OBJECTIVES	1
INTENDED AUDIENCE	1
SCOPE AND FORMAT	2
INFORMATION SOURCES AND METHODOLOGY	2
ANALYST CREDENTIALS	2
RELATED BCC RESEARCH REPORTS	3
BCC ON-LINE SERVICES	3
DISCLAIMER	4
CHAPTER 2 EXECUTIVE SUMMARY	6
<i>SUMMARY TABLE GLOBAL MARKET FOR SUPERCONDUCTIVITY TECHNOLOGIES, THROUGH 2017 (\$ MILLIONS)</i>	6
<i>SUMMARY FIGURE GLOBAL MARKET FOR SUPERCONDUCTIVITY TECHNOLOGIES, 2011-2017 (\$ MILLIONS)</i>	6
CHAPTER 3 SUPERCONDUCTIVITY OVERVIEW	9
GENERAL DESCRIPTION OF SUPERCONDUCTIVITY	9
PROPERTIES OF SUPERCONDUCTORS	9
Conductivity	9
Magnetic Properties	9
Tunneling	10
MECHANISMS OF SUPERCONDUCTIVITY	10
BRIEF HISTORY OF SUPERCONDUCTIVITY	11
ADVANTAGES AND LIMITATIONS OF SUPERCONDUCTORS	13
Advantages of Superconductors	13
Advantages of Type II versus Type I Superconductors	13
Limitations of Superconductors	13
SUPERCONDUCTING MATERIALS	14
TYPE I SUPERCONDUCTORS	14
TYPE II SUPERCONDUCTORS	14
ATYPICAL SUPERCONDUCTORS	15
APPLICATIONS AND END USES	16
<i>TABLE 1 MAJOR END USES AND APPLICATIONS OF SUPERCONDUCTIVITY</i>	16
APPLICATIONS	17
Superconducting Magnets	17
Superconducting Transformers	17
Superconducting Electric Generators	18
Superconducting Electric Motors	18
Fault Current Limiters (FCLs)	19
Superconducting Power Storage Systems	19
Superconducting Magnetic Energy Storage (SMES)	19
Superconducting Flywheel Energy Storage (SFES)	20
Current Leads	20
Superconducting Wires	21

TOPIC	PAGE NO.
Superconducting Integrated Circuits	21
<i>TABLE 2 POTENTIAL APPLICATIONS OF SUPERCONDUCTOR INTEGRATED CIRCUITS (ICS)</i>	22
Superconducting Radio Frequency (RF) and Microwave Filters	24
Superconducting Quantum Interference Devices (SQUIDs)	25
Other Applications	25
Ultrafast Routers	25
Induction Heaters	26
END USES	27
Science, Research, and Technology Development	27
Health Care	28
Electric Utilities	28
Generation	28
Storage	29
Transmission	29
Computing	30
Transportation	32
Maglev Trains	32
Other Railway Applications	32
Commercial Ship Propulsion	33
Electric Vehicles	33
Communications	33
Military/Defense	35
Other End Uses	37
MARKET SIZE AND SEGMENTATION	37
MARKET SIZE	37
<i>FIGURE 1 TRENDS IN GLOBAL MARKET FOR SUPERCONDUCTIVITY APPLICATIONS, 2011-2017 (\$ MILLIONS)</i>	37
APPLICATION SEGMENTS	38
<i>TABLE 3 GLOBAL MARKET FOR SUPERCONDUCTIVITY APPLICATIONS BY TYPE OF APPLICATION, 2011-2017 (\$ MILLIONS)</i>	38
<i>FIGURE 2 GLOBAL SUPERCONDUCTIVITY APPLICATION SEGMENTS, 2011-2017 (%)</i>	39
END-USE SEGMENTS	40
<i>TABLE 4 GLOBAL MARKET FOR SUPERCONDUCTIVITY APPLICATIONS BY TYPE OF END USE, THROUGH 2017 (\$ MILLIONS)</i>	40
<i>FIGURE 3 GLOBAL SUPERCONDUCTIVITY END USE SEGMENTS, 2011-2017 (%)</i>	40
TYPES OF SUPERCONDUCTING MATERIALS	41
<i>TABLE 5 GLOBAL MARKET FOR SUPERCONDUCTING MATERIALS, THROUGH 2017 (\$ MILLIONS)</i>	42
CHAPTER 4 SUPERCONDUCTING MATERIALS AND TECHNOLOGIES	44
SUPERCONDUCTING MATERIALS	44
TYPE I SUPERCONDUCTORS	44
<i>TABLE 6 TYPE I SUPERCONDUCTORS</i>	44
TYPE II SUPERCONDUCTORS	45
<i>TABLE 7 TYPE II SUPERCONDUCTORS</i>	45
Low-Temperature Superconductors (LTSs) versus High-Temperature Superconductors (HTSs)	48
CURRENT RESEARCH IN SUPERCONDUCTIVITY	48

TOPIC	PAGE NO.
MAJOR PLAYERS AND AREAS OF CONCENTRATION	48
<i>TABLE 8 MAJOR ORGANIZATIONS CONDUCTING SUPERCONDUCTIVITY RESEARCH</i>	48
RECENT TECHNOLOGICAL ADVANCES	49
PATENT ANALYSIS	51
<i>FIGURE 4 U.S. PATENTS RELATING TO LOW-TEMPERATURE SUPERCONDUCTIVITY (LTS) VERSUS HIGH-TEMPERATURE SUPERCONDUCTIVITY (HTS) (% OF TOTAL SUPERCONDUCTIVITY-RELATED PATENTS)</i>	51
<i>FIGURE 5 NUMBER OF U.S. SUPERCONDUCTIVITY-RELATED PATENTS BY TYPE OF APPLICATION (NO. OF PATENTS)</i>	52
<i>FIGURE 6 U.S. SUPERCONDUCTIVITY-RELATED PATENTS BY TYPE OF ASSIGNEE (% OF 200-PATENT SAMPLE)</i>	53
<i>FIGURE 7 U.S. SUPERCONDUCTIVITY-RELATED PATENTS BY ASSIGNEE'S COUNTRY OF ORIGIN (% OF 200-PATENT SAMPLE)</i>	54
CHAPTER 5 SUPERCONDUCTING MAGNET TECHNOLOGIES AND MARKETS	56
TECHNOLOGY	56
CHARACTERISTICS OF SUPERCONDUCTING MAGNETS	56
CONSTRUCTION, MATERIALS AND PERFORMANCE	56
Construction	56
Materials	57
TYPES OF SYSTEMS	57
Cryogen-Free Magnets	57
Low-Helium Consumption Magnets	58
Projected Magnetic Field Superconducting Magnets	58
High-Magnetic-Field Systems	58
Hybrid Magnets	59
Shielded Magnet Systems	59
END USES	59
<i>TABLE 9 SUPERCONDUCTING MAGNET END USES</i>	60
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT	60
Particle Accelerators	60
Beam Transport Magnets	60
Accelerator Magnets	61
Bubble Chamber Magnets	61
Nuclear Magnetic Resonance (NMR) Spectroscopy	61
HEALTH CARE	62
Magnetic Resonance Imaging (MRI)	62
TRANSPORTATION	62
Maglev Trains	62
Other Maglev Applications	63
OTHER END USES	64
Magnetic Separations	64
Disposable Mixing Systems	64
SUPPLIERS	64
<i>TABLE 10 SUPPLIERS OF SUPERCONDUCTING MAGNETS AND COMPONENTS</i>	65
MARKET FOR SUPERCONDUCTING MAGNETS	65
SUMMARY	65
<i>TABLE 11 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS, THROUGH 2017 (\$ MILLIONS)</i>	65

TOPIC	PAGE NO.
<i>FIGURE 8 GLOBAL SUPERCONDUCTING MAGNET MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	66
<i>TABLE 12 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN MAGNETIC APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	67
<i>FIGURE 9 GLOBAL SUPERCONDUCTING MAGNET MARKET SHARES BY TYPE OF SUPERCONDUCTING MATERIAL, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	67
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT	68
<i>TABLE 13 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	68
Nuclear Magnetic Resonance (NMR) Spectrometers	68
<i>FIGURE 10 GLOBAL MARKET FOR NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROMETERS, 2011-2017 (\$ MILLIONS)</i>	69
<i>TABLE 14 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROMETERS, THROUGH 2017 (\$ MILLIONS)</i>	69
<i>TABLE 15 GLOBAL CONSUMPTION OF SUPERCONDUCTING WIRE USED IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROMETER MAGNETS, THROUGH 2017 (\$ MILLIONS)</i>	70
Particle Accelerators	70
<i>TABLE 16 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	71
Research Accelerators	71
Medical Accelerators	71
<i>TABLE 17 U.S. PROTON THERAPY CENTERS</i>	72
<i>FIGURE 11 GLOBAL MARKET FOR PROTON THERAPY MACHINES, 2011-2017 (\$ MILLIONS)</i>	73
<i>TABLE 18 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS AND WIRE USED IN PROTON THERAPY MACHINES, THROUGH 2017 (\$ MILLIONS)</i>	73
HEALTH CARE	74
Magnetic Resonance Imaging (MRI) Scanners	74
<i>FIGURE 12 GLOBAL MARKET FOR MAGNETIC RESONANCE IMAGING (MRI) SCANNERS, 2011-2017 (\$ BILLIONS)</i>	74
<i>TABLE 19 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN MAGNETIC RESONANCE IMAGING (MRI) SCANNERS, THROUGH 2017 (\$ MILLIONS)</i>	75
<i>TABLE 20 GLOBAL CONSUMPTION OF SUPERCONDUCTING WIRE USED IN MAGNETIC RESONANCE IMAGING (MRI) SCANNER MAGNETS, THROUGH 2017 (\$ MILLIONS)</i>	75
TRANSPORTATION	75
Superconducting Maglev Trains	75
<i>TABLE 21 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN MAGLEV RAILCARS, THROUGH 2017 (\$ MILLIONS)</i>	76
OTHER END USES	76
<i>TABLE 22 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN OTHER INDUSTRIAL APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	76
Magnetic Separations	76
<i>FIGURE 13 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETIC SEPARATORS, 2011-2017 (\$ MILLIONS)</i>	77
<i>TABLE 23 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN HIGH-GRADIENT SEPARATION SYSTEMS, THROUGH 2017 (\$ MILLIONS)</i>	78
Disposable Mixing Systems	78
<i>FIGURE 14 GLOBAL MARKET FOR SUPERCONDUCTING MAGNET-DRIVEN DISPOSABLE MIXING SYSTEMS, 2011-2017 (\$ MILLIONS)</i>	79

TOPIC	PAGE NO.
<i>TABLE 24 GLOBAL MARKET FOR SUPERCONDUCTING MATERIALS USED IN DISPOSABLE MIXING SYSTEMS, THROUGH 2017 (\$ MILLIONS)</i>	79
CHAPTER 6 SUPERCONDUCTING TRANSFORMER TECHNOLOGIES AND MARKETS	81
TECHNOLOGY	81
CHARACTERISTICS OF SUPERCONDUCTING TRANSFORMERS	81
Reduced Load Losses	81
Lower Cost of Ownership	82
Safety and Environmental Advantages	82
Smaller Footprint and Lower Weight	82
CONSTRUCTION, MATERIALS AND PERFORMANCE	82
Construction	82
Materials	83
TYPES OF SYSTEMS	83
Iron Core versus Air Core	83
Hybrid Transformers	84
END USES	84
<i>TABLE 25 SUPERCONDUCTING TRANSFORMER END USES</i>	84
ELECTRIC POWER GENERATION AND TRANSMISSION	84
Electricity Distribution	84
TRANSPORTATION	84
SUPPLIERS	85
<i>TABLE 26 SUPPLIERS OF SUPERCONDUCTING TRANSFORMERS AND COMPONENTS</i>	85
MARKET FOR SUPERCONDUCTING TRANSFORMERS	85
SUMMARY	85
<i>TABLE 27 GLOBAL MARKET FOR SUPERCONDUCTING TRANSFORMERS, THROUGH 2017 (\$ MILLIONS)</i>	85
<i>FIGURE 15 GLOBAL SUPERCONDUCTING TRANSFORMER MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	86
<i>TABLE 28 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN TRANSFORMER APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	87
ELECTRIC POWER GENERATION AND TRANSMISSION	87
<i>FIGURE 16 GLOBAL MARKET FOR POWER TRANSFORMERS RATED 10 MEGAVOLT AMPERE (MVA) AND ABOVE, 2011-2017 (\$ BILLIONS)</i>	87
<i>TABLE 29 GLOBAL MARKET FOR SUPERCONDUCTING UTILITY POWER TRANSFORMERS AND RELATED CONSUMPTION OF SUPERCONDUCTING MATERIALS, THROUGH 2017 (\$ MILLIONS)</i>	88
TRANSPORTATION	88
<i>TABLE 30 ESTIMATED SHINKANSEN-TYPE TRAIN SET DELIVERIES, THROUGH 2017 (NUMBER OF TRAIN SETS)</i>	89
<i>TABLE 31 GLOBAL MARKET FOR SUPERCONDUCTING TRACTION TRANSFORMERS AND RELATED CONSUMPTION OF SUPERCONDUCTING MATERIALS, THROUGH 2017 (\$ MILLIONS)</i>	89
CHAPTER 7 SUPERCONDUCTING ELECTRIC GENERATOR TECHNOLOGIES AND MARKETS	91
TECHNOLOGY	91
CHARACTERISTICS OF SUPERCONDUCTING GENERATORS	91
Greater Efficiency	91
Longer Life	91

TOPIC	PAGE NO.
Smaller Size and Lighter Weight	91
Lower Acquisition and Installation Costs	91
CONSTRUCTION, MATERIALS AND PERFORMANCE	92
Construction and Operation	92
Materials	92
END USES	92
<i>TABLE 32 SUPERCONDUCTING GENERATOR END USES</i>	93
ELECTRIC POWER GENERATION AND TRANSMISSION	93
TRANSPORTATION	93
MILITARY/DEFENSE	93
SUPPLIERS	94
<i>TABLE 33 SUPPLIERS OF SUPERCONDUCTING GENERATORS AND COMPONENTS</i>	94
MARKET FOR SUPERCONDUCTING GENERATORS	95
SUMMARY	95
<i>TABLE 34 GLOBAL MARKET FOR SUPERCONDUCTING GENERATORS, THROUGH 2017 (\$ MILLIONS)</i>	95
<i>FIGURE 17 GLOBAL SUPERCONDUCTING GENERATOR MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	95
<i>TABLE 35 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN GENERATOR APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	96
ELECTRIC POWER GENERATION AND TRANSMISSION	96
TRANSPORTATION	97
<i>FIGURE 18 GLOBAL MARKET FOR MARINE PROPULSION GENERATORS, 2011-2017 (\$ MILLIONS)</i>	98
<i>TABLE 36 GLOBAL MARKET FOR SUPERCONDUCTING MARINE PROPULSION GENERATORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)</i>	98
MILITARY/DEFENSE	99
Warship Propulsion Systems	99
Directed Energy Weapons (DEWs)	99
<i>TABLE 37 GLOBAL MARKET FOR SUPERCONDUCTING AIRBORNE GENERATORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)</i>	99
CHAPTER 8 SUPERCONDUCTING ELECTRIC MOTOR TECHNOLOGIES AND APPLICATIONS	101
TECHNOLOGY	101
CHARACTERISTICS OF SUPERCONDUCTING MOTORS	101
Compact Size	101
Flexibility	101
Reduced Noise	101
Increased Stability	101
Lower Acquisition and Operating Cost	101
CONSTRUCTION, MATERIALS AND PERFORMANCE	102
Construction and Operation	102
Materials	102
TYPES OF SYSTEMS	102
Linear Motors	103
Homopolar Motors	103
END USES	103
<i>TABLE 38 SUPERCONDUCTING MOTOR END USES</i>	104
TRANSPORTATION	104

TOPIC	PAGE NO.
Marine Propulsion Systems	104
Electric Vehicles	104
Electric Airplanes	105
MILITARY/DEFENSE	105
PROCESS INDUSTRIES	105
SUPPLIERS	105
<i>TABLE 39 SUPPLIERS OF SUPERCONDUCTING ELECTRIC MOTORS AND COMPONENTS</i>	106
MARKET FOR SUPERCONDUCTING ELECTRIC MOTORS	106
SUMMARY	106
<i>TABLE 40 GLOBAL MARKET FOR SUPERCONDUCTING ELECTRIC MOTORS, THROUGH 2017 (\$ MILLIONS)</i>	106
<i>FIGURE 19 SUPERCONDUCTING MOTOR MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	106
<i>TABLE 41 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN ELECTRIC MOTOR APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	107
TRANSPORTATION	108
<i>FIGURE 20 GLOBAL MARKET FOR MARINE ELECTRIC MOTORS, 2011-2017 (\$ MILLIONS)</i>	108
<i>TABLE 42 GLOBAL MARKET FOR SUPERCONDUCTING MARINE ELECTRIC MOTORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)</i>	109
MILITARY/DEFENSE	109
PROCESS INDUSTRIES	109
<i>TABLE 43 GLOBAL MARKET FOR SUPERCONDUCTING MARINE ELECTRIC MOTORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)</i>	110
CHAPTER 9 FAULT CURRENT LIMITER (FCL) TECHNOLOGIES AND MARKETS	112
TECHNOLOGY	112
CHARACTERISTICS	112
CONSTRUCTION, MATERIALS AND PERFORMANCE	112
Construction	112
Materials	113
TYPES OF SYSTEMS	113
Resistive Fault Current Limiters (FCLs)	113
Inductive Fault Current Limiters (FCLs)	113
END USES	113
<i>TABLE 44 FAULT CURRENT LIMITER (FCL) APPLICATIONS</i>	113
ELECTRIC POWER GENERATION AND TRANSMISSION	114
TRANSPORTATION	114
SUPPLIERS	114
<i>TABLE 45 SUPPLIERS OF FAULT CURRENT LIMITERS (FCLS)</i>	114
MARKET FOR FAULT CURRENT LIMITERS (FCLS)	115
SUMMARY	115
<i>TABLE 46 GLOBAL MARKET FOR FAULT CURRENT LIMITERS (FCLS), 2011-2017 (\$ MILLIONS)</i>	115
<i>FIGURE 21 FAULT CURRENT LIMITER (FCL) MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	115
<i>TABLE 47 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN FAULT CURRENT LIMITERS (FCLS), THROUGH 2017 (\$ MILLIONS)</i>	116
ELECTRIC POWER GENERATION AND TRANSMISSION	117

TOPIC	PAGE NO.
<i>TABLE 48 GLOBAL ELECTRIC UTILITY MARKET FOR FAULT CURRENT LIMITERS (FCLS), THROUGH 2017 (\$ MILLIONS)</i>	117
TRANSPORTATION	118
<i>TABLE 49 GLOBAL MARINE MARKET FOR FAULT CURRENT LIMITERS (FCLS), THROUGH 2017 (\$ MILLIONS)</i>	118
CHAPTER 10 SUPERCONDUCTING POWER STORAGE TECHNOLOGIES AND MARKETS	120
TECHNOLOGY	120
CHARACTERISTICS	120
TYPES OF SYSTEMS	120
Superconducting Magnetic Energy Storage (SMES)	120
Superconducting Flywheel Energy Storage (SFES)	120
CONSTRUCTION, MATERIALS AND PERFORMANCE	121
Construction	121
Materials	121
END USES	121
<i>TABLE 50 SUPERCONDUCTING ENERGY STORAGE APPLICATIONS</i>	122
ELECTRIC POWER GENERATION AND TRANSMISSION	122
MANUFACTURING	122
SUPPLIERS	122
<i>TABLE 51 DEVELOPERS OF SUPERCONDUCTING POWER STORAGE SYSTEMS</i>	122
MARKET FOR SUPERCONDUCTING POWER STORAGE SYSTEMS	123
SUMMARY	123
<i>TABLE 52 GLOBAL MARKET FOR SUPERCONDUCTING POWER STORAGE SYSTEMS, THROUGH 2017 (\$ MILLIONS)</i>	123
<i>FIGURE 22 GLOBAL SUPERCONDUCTING POWER STORAGE SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	123
<i>TABLE 53 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN POWER STORAGE APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	124
ELECTRICITY GENERATION AND TRANSMISSION	124
<i>TABLE 54 GLOBAL ELECTRIC UTILITY MARKET FOR SUPERCONDUCTING ENERGY STORAGE, THROUGH 2017 (\$ MILLIONS)</i>	125
OTHER INDUSTRIAL APPLICATIONS	125
<i>TABLE 55 GLOBAL INDUSTRIAL MARKET FOR SUPERCONDUCTING ENERGY STORAGE, THROUGH 2017 (\$ MILLIONS)</i>	125
CHAPTER 11 SUPERCONDUCTING CURRENT LEAD TECHNOLOGIES AND MARKETS	127
TECHNOLOGY	127
CHARACTERISTICS OF SUPERCONDUCTING CURRENT LEADS	127
CONSTRUCTION, MATERIALS AND PERFORMANCE	127
Construction	127
Materials	127
END USES	127
<i>TABLE 56 SUPERCONDUCTING CURRENT LEAD END USES</i>	128
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT	128
HEALTH CARE AND OTHER APPLICATIONS	128
SUPPLIERS	128
<i>TABLE 57 SUPPLIERS OF SUPERCONDUCTING CURRENT LEADS</i>	128
MARKET FOR SUPERCONDUCTING CURRENT LEADS	129

TOPIC	PAGE NO.
<i>TABLE 58 GLOBAL MARKET FOR SUPERCONDUCTING CURRENT LEADS, THROUGH 2017 (\$ MILLIONS)</i>	129
<i>FIGURE 23 SUPERCONDUCTING MAGNET MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	129
<i>TABLE 59 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN SUPERCONDUCTING CURRENT LEAD APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	130
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT	131
<i>TABLE 60 GLOBAL MARKET FOR SUPERCONDUCTING CURRENT LEADS USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	131
HEALTH CARE	131
<i>TABLE 61 GLOBAL MARKET FOR SUPERCONDUCTING CURRENT LEADS USED IN HEALTH CARE APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	131
CHAPTER 12 SUPERCONDUCTING CABLE TECHNOLOGIES AND MARKETS	133
TECHNOLOGY	133
CHARACTERISTICS OF SUPERCONDUCTING WIRES	133
CONSTRUCTION, MATERIALS AND PERFORMANCE	133
END USES	134
SUPPLIERS	134
<i>TABLE 62 DEVELOPERS AND SUPPLIERS OF SUPERCONDUCTING ELECTRIC TRANSMISSION WIRE AND CABLE</i>	134
MARKET FOR SUPERCONDUCTING CABLE	135
<i>TABLE 63 GLOBAL MARKET FOR SUPERCONDUCTING ELECTRIC TRANSMISSION CABLE, THROUGH 2017 (NO. OF MILES/\$ MILLIONS)</i>	135
CHAPTER 13 SUPERCONDUCTING INTEGRATED CIRCUIT (IC) TECHNOLOGIES AND MARKETS	138
TECHNOLOGY	138
CHARACTERISTICS	138
CONSTRUCTION, MATERIALS AND PERFORMANCE	138
END USES	138
<i>TABLE 64 SUPERCONDUCTING INTEGRATED CIRCUIT (IC) END USES</i>	139
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS	139
COMMUNICATIONS	139
COMPUTING	139
SUPPLIERS	139
<i>TABLE 65 SUPPLIERS OF SUPERCONDUCTING INTEGRATED CIRCUITS (ICS)</i>	140
MARKETS FOR SUPERCONDUCTING	140
SUMMARY	140
<i>TABLE 66 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS), THROUGH 2017 (\$ MILLIONS)</i>	140
<i>FIGURE 24 GLOBAL SUPERCONDUCTING INTEGRATED CIRCUIT (IC) MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	140
<i>TABLE 67 GLOBAL CONSUMPTION OF SUPERCONDUCTING THIN-FILM MATERIALS IN THE FABRICATION OF SUPERCONDUCTING INTEGRATED CIRCUITS (ICS), THROUGH 2017 (\$ MILLIONS)</i>	141
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS	142
Voltage Standard Integrated Circuits (ICs)	142
<i>TABLE 68 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS) USED IN VOLTAGE METROLOGY APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	142

TOPIC	PAGE NO.
COMMUNICATIONS	142
Digital Signal Processors (DSPs)	142
<i>TABLE 69 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS) USED IN DIGITAL SIGNAL PROCESSING APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	143
COMPUTING	143
High-Performance Computing (HPC)	143
<i>TABLE 70 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS) USED IN QUANTUM AND OTHER HIGH-PERFORMANCE PROCESSORS, THROUGH 2017 (\$ MILLIONS)</i>	144
CHAPTER 14 SUPERCONDUCTING RADIO FREQUENCY (RF) AND MICROWAVE FILTER TECHNOLOGIES AND APPLICATIONS	146
TECHNOLOGY	146
CHARACTERISTICS	146
CONSTRUCTION, MATERIALS AND PERFORMANCE	146
END USES	146
SUPPLIERS	146
<i>TABLE 71 COMPANIES THAT ARE MANUFACTURING OR DEVELOPING SUPERCONDUCTING RADIO FREQUENCY (RF) FILTERS</i>	147
MARKETS	147
<i>TABLE 72 GLOBAL MARKET FOR SUPERCONDUCTING RADIO FREQUENCY (RF) FILTERS, THROUGH 2017 (\$ MILLIONS)</i>	148
CHAPTER 15 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE (SQUID) TECHNOLOGIES AND MARKETS	150
TECHNOLOGY	150
CHARACTERISTICS	150
CONSTRUCTION, MATERIALS AND PERFORMANCE	150
END USES	150
<i>TABLE 73 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE (SQUID) END USES</i>	150
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT	150
HEALTH CARE	151
OTHER	151
SUPPLIERS	151
<i>TABLE 74 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE (SQUID) SUPPLIERS</i>	152
MARKETS	152
<i>TABLE 75 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS), THROUGH 2017 (\$ MILLIONS)</i>	152
<i>FIGURE 25 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE (SQUID) SENSOR MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)</i>	152
<i>TABLE 76 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS IN THE FABRICATION OF SUPERCONDUCTING QUANTUM INTERFERENCE (SQUID) SENSORS, THROUGH 2017 (\$ MILLIONS)</i>	154
SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT	154
<i>TABLE 77 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS) USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT, THROUGH 2017 (\$ MILLIONS)</i>	154
HEALTH CARE	154
<i>TABLE 78 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS) USED IN HEALTH CARE APPLICATIONS, THROUGH 2017 (\$ MILLIONS)</i>	155

TOPIC	PAGE NO.
OTHER APPLICATIONS	155
<i>TABLE 79 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS) USED IN OTHER APPLICATIONS, 2011-2017 (\$ MILLIONS)</i>	155
CHAPTER 16 APPENDIX: COMPANY PROFILES	157
ABB LTD.	157
ACCEL INSTRUMENTS GMBH	157
ADVANCED MAGNET LAB INC.	157
ALSTOM	158
AMERICAN MAGNETICS INC.	158
AMERICAN SUPERCONDUCTOR CORP.	158
ASG SUPERCONDUCTORS SPA	159
BABCOCK NOELL GMBH	159
COLORADO SUPERCONDUCTOR CORP.	159
CRYOELECTRA GMBH	159
CRYOMAGNETICS INC.	160
CRYOTON LTD.	160
DIBORIDE CONDUCTORS LTD.	160
D-WAVE SYSTEMS INC.	161
ERIEZ MANUFACTURING CO.	161
EUROPEAN HIGH-TEMPERATURE SUPERCONDUCTORS GMBH & CO. KG	161
EVICO GMBH	161
FUJI ELECTRIC CO.	162
FUJIKURA LTD.	162
FURUKAWA ELECTRIC CO. LTD.	162
GENERAL ELECTRIC CO.	163
HITACHI LTD.	163
HTS-110 LTD.	164
HYPER TECH RESEARCH INC.	164
HYPRES INC.	164
INNOVA SUPERCONDUCTOR TECHNOLOGIES	165
ISCO INTERNATIONAL LLC	165
ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO. LTD.	166
JANIS RESEARCH CO. INC.	166
KARLSRUHER INSTITUT FUR TECHNOLOGIE	166
KAWASAKI HEAVY INDUSTRIES LTD.	166
LEVTECH INC.	167
LUVATA PORI OY	167
MAGLEV 2000	167
METAL OXIDE TECHNOLOGIES INC.	168
NEOCERA INC.	168
NEXANS	169
NORTHROP GRUMMAN CORP.	169
OXFORD INSTRUMENTS PLC	169
OXFORD SUPERCONDUCTING TECHNOLOGY LP	169
QUANTUM DESIGN INC.	170
ROYAL PHILIPS ELECTRONICS NV	170
SCIENTIFIC MAGNETICS	170

TOPIC	PAGE NO.
SIEMENS AG	171
SUMITOMO ELECTRIC INDUSTRIES LTD.	171
SUPERPOWER INC.	171
SUPERCONDUCTOR TECHNOLOGIES INC.	171
TOSHIBA CORP.	172
WAUKESHA ELECTRIC SYSTEMS INC.	172
ZENERGY POWER PLC	172

LIST OF TABLES

TABLE HEADING	PAGE NO.
SUMMARY TABLE GLOBAL MARKET FOR SUPERCONDUCTIVITY TECHNOLOGIES, THROUGH 2017 (\$ MILLIONS)	6
TABLE 1 MAJOR END USES AND APPLICATIONS OF SUPERCONDUCTIVITY	16
TABLE 2 POTENTIAL APPLICATIONS OF SUPERCONDUCTOR INTEGRATED CIRCUITS (ICS)	22
TABLE 3 GLOBAL MARKET FOR SUPERCONDUCTIVITY APPLICATIONS BY TYPE OF APPLICATION, 2011-2017 (\$ MILLIONS)	38
TABLE 4 GLOBAL MARKET FOR SUPERCONDUCTIVITY APPLICATIONS BY TYPE OF END USE, THROUGH 2017 (\$ MILLIONS)	40
TABLE 5 GLOBAL MARKET FOR SUPERCONDUCTING MATERIALS, THROUGH 2017 (\$ MILLIONS)	42
TABLE 6 TYPE I SUPERCONDUCTORS	44
TABLE 7 TYPE II SUPERCONDUCTORS	45
TABLE 8 MAJOR ORGANIZATIONS CONDUCTING SUPERCONDUCTIVITY RESEARCH	48
TABLE 9 SUPERCONDUCTING MAGNET END USES	60
TABLE 10 SUPPLIERS OF SUPERCONDUCTING MAGNETS AND COMPONENTS	65
TABLE 11 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS, THROUGH 2017 (\$ MILLIONS)	65
TABLE 12 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN MAGNETIC APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	67
TABLE 13 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	68
TABLE 14 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROMETERS, THROUGH 2017 (\$ MILLIONS)	69
TABLE 15 GLOBAL CONSUMPTION OF SUPERCONDUCTING WIRE USED IN NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROMETER MAGNETS, THROUGH 2017 (\$ MILLIONS)	70
TABLE 16 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	71
TABLE 17 U.S. PROTON THERAPY CENTERS	72
TABLE 18 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS AND WIRE USED IN PROTON THERAPY MACHINES, THROUGH 2017 (\$ MILLIONS)	73
TABLE 19 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN MAGNETIC RESONANCE IMAGING (MRI) SCANNERS, THROUGH 2017 (\$ MILLIONS)	75
TABLE 20 GLOBAL CONSUMPTION OF SUPERCONDUCTING WIRE USED IN MAGNETIC RESONANCE IMAGING (MRI) SCANNER MAGNETS, THROUGH 2017 (\$ MILLIONS)	75
TABLE 21 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN MAGLEV RAILCARS, THROUGH 2017 (\$ MILLIONS)	76
TABLE 22 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN OTHER INDUSTRIAL APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	76
TABLE 23 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETS USED IN HIGH-GRADIENT SEPARATION SYSTEMS, THROUGH 2017 (\$ MILLIONS)	78
TABLE 24 GLOBAL MARKET FOR SUPERCONDUCTING MATERIALS USED IN DISPOSABLE MIXING SYSTEMS, THROUGH 2017 (\$ MILLIONS)	79
TABLE 25 SUPERCONDUCTING TRANSFORMER END USES	84
TABLE 26 SUPPLIERS OF SUPERCONDUCTING TRANSFORMERS AND COMPONENTS	85
TABLE 27 GLOBAL MARKET FOR SUPERCONDUCTING TRANSFORMERS, THROUGH 2017 (\$ MILLIONS)	85
TABLE 28 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN TRANSFORMER APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	87
TABLE 29 GLOBAL MARKET FOR SUPERCONDUCTING UTILITY POWER TRANSFORMERS AND RELATED CONSUMPTION OF SUPERCONDUCTING MATERIALS, THROUGH 2017 (\$ MILLIONS)	88

TABLE HEADING	PAGE NO.
TABLE 30 ESTIMATED SHINKANSEN-TYPE TRAIN SET DELIVERIES, THROUGH 2017 (NUMBER OF TRAIN SETS)	89
TABLE 31 GLOBAL MARKET FOR SUPERCONDUCTING TRACTION TRANSFORMERS AND RELATED CONSUMPTION OF SUPERCONDUCTING MATERIALS, THROUGH 2017 (\$ MILLIONS)	89
TABLE 32 SUPERCONDUCTING GENERATOR END USES	93
TABLE 33 SUPPLIERS OF SUPERCONDUCTING GENERATORS AND COMPONENTS	94
TABLE 34 GLOBAL MARKET FOR SUPERCONDUCTING GENERATORS, THROUGH 2017 (\$ MILLIONS)	95
TABLE 35 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN GENERATOR APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	96
TABLE 36 GLOBAL MARKET FOR SUPERCONDUCTING MARINE PROPULSION GENERATORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)	98
TABLE 37 GLOBAL MARKET FOR SUPERCONDUCTING AIRBORNE GENERATORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)	99
TABLE 38 SUPERCONDUCTING MOTOR END USES	104
TABLE 39 SUPPLIERS OF SUPERCONDUCTING ELECTRIC MOTORS AND COMPONENTS	106
TABLE 40 GLOBAL MARKET FOR SUPERCONDUCTING ELECTRIC MOTORS, THROUGH 2017 (\$ MILLIONS)	106
TABLE 41 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN ELECTRIC MOTOR APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	107
TABLE 42 GLOBAL MARKET FOR SUPERCONDUCTING MARINE ELECTRIC MOTORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)	109
TABLE 43 GLOBAL MARKET FOR SUPERCONDUCTING MARINE ELECTRIC MOTORS AND RELATED CONSUMPTION OF SUPERCONDUCTING WIRE, THROUGH 2017 (\$ MILLIONS)	110
TABLE 44 FAULT CURRENT LIMITER (FCL) APPLICATIONS	113
TABLE 45 SUPPLIERS OF FAULT CURRENT LIMITERS (FCLS)	114
TABLE 46 GLOBAL MARKET FOR FAULT CURRENT LIMITERS (FCLS), 2011-2017 (\$ MILLIONS)	115
TABLE 47 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN FAULT CURRENT LIMITERS (FCLS), THROUGH 2017 (\$ MILLIONS)	116
TABLE 48 GLOBAL ELECTRIC UTILITY MARKET FOR FAULT CURRENT LIMITERS (FCLS), THROUGH 2017 (\$ MILLIONS)	117
TABLE 49 GLOBAL MARINE MARKET FOR FAULT CURRENT LIMITERS (FCLS), THROUGH 2017 (\$ MILLIONS)	118
TABLE 50 SUPERCONDUCTING ENERGY STORAGE APPLICATIONS	122
TABLE 51 DEVELOPERS OF SUPERCONDUCTING POWER STORAGE SYSTEMS	122
TABLE 52 GLOBAL MARKET FOR SUPERCONDUCTING POWER STORAGE SYSTEMS, THROUGH 2017 (\$ MILLIONS)	123
TABLE 53 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN POWER STORAGE APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	124
TABLE 54 GLOBAL ELECTRIC UTILITY MARKET FOR SUPERCONDUCTING ENERGY STORAGE, THROUGH 2017 (\$ MILLIONS)	125
TABLE 55 GLOBAL INDUSTRIAL MARKET FOR SUPERCONDUCTING ENERGY STORAGE, THROUGH 2017 (\$ MILLIONS)	125
TABLE 56 SUPERCONDUCTING CURRENT LEAD END USES	128
TABLE 57 SUPPLIERS OF SUPERCONDUCTING CURRENT LEADS	128
TABLE 58 GLOBAL MARKET FOR SUPERCONDUCTING CURRENT LEADS, THROUGH 2017 (\$ MILLIONS)	129
TABLE 59 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS USED IN SUPERCONDUCTING CURRENT LEAD APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	130
TABLE 60 GLOBAL MARKET FOR SUPERCONDUCTING CURRENT LEADS USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	131

TABLE HEADING	PAGE NO.
TABLE 61 GLOBAL MARKET FOR SUPERCONDUCTING CURRENT LEADS USED IN HEALTH CARE APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	131
TABLE 62 DEVELOPERS AND SUPPLIERS OF SUPERCONDUCTING ELECTRIC TRANSMISSION WIRE AND CABLE	134
TABLE 63 GLOBAL MARKET FOR SUPERCONDUCTING ELECTRIC TRANSMISSION CABLE, THROUGH 2017 (NO. OF MILES/\$ MILLIONS)	135
TABLE 64 SUPERCONDUCTING INTEGRATED CIRCUIT (IC) END USES	139
TABLE 65 SUPPLIERS OF SUPERCONDUCTING INTEGRATED CIRCUITS (ICS)	140
TABLE 66 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS), THROUGH 2017 (\$ MILLIONS)	140
TABLE 67 GLOBAL CONSUMPTION OF SUPERCONDUCTING THIN-FILM MATERIALS IN THE FABRICATION OF SUPERCONDUCTING INTEGRATED CIRCUITS (ICS), THROUGH 2017 (\$ MILLIONS)	141
TABLE 68 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS) USED IN VOLTAGE METROLOGY APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	142
TABLE 69 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS) USED IN DIGITAL SIGNAL PROCESSING APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	143
TABLE 70 GLOBAL MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS (ICS) USED IN QUANTUM AND OTHER HIGH-PERFORMANCE PROCESSORS, THROUGH 2017 (\$ MILLIONS)	144
TABLE 71 COMPANIES THAT ARE MANUFACTURING OR DEVELOPING SUPERCONDUCTING RADIO FREQUENCY (RF) FILTERS	147
TABLE 72 GLOBAL MARKET FOR SUPERCONDUCTING RADIO FREQUENCY (RF) FILTERS, THROUGH 2017 (\$ MILLIONS)	148
TABLE 73 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE (SQUID) END USES	150
TABLE 74 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE (SQUID) SUPPLIERS	152
TABLE 75 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS), THROUGH 2017 (\$ MILLIONS)	152
TABLE 76 GLOBAL CONSUMPTION OF SUPERCONDUCTING MATERIALS IN THE FABRICATION OF SUPERCONDUCTING QUANTUM INTERFERENCE (SQUID) SENSORS, THROUGH 2017 (\$ MILLIONS)	154
TABLE 77 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS) USED IN SCIENCE, RESEARCH, AND TECHNOLOGY DEVELOPMENT, THROUGH 2017 (\$ MILLIONS)	154
TABLE 78 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS) USED IN HEALTH CARE APPLICATIONS, THROUGH 2017 (\$ MILLIONS)	155
TABLE 79 GLOBAL MARKET FOR SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES (SQUIDS) USED IN OTHER APPLICATIONS, 2011-2017 (\$ MILLIONS)	155

LIST OF FIGURES

FIGURE TITLE	PAGE NO.
SUMMARY FIGURE GLOBAL MARKET FOR SUPERCONDUCTIVITY TECHNOLOGIES, 2011-2017 (\$ MILLIONS)	6
FIGURE 1 TRENDS IN GLOBAL MARKET FOR SUPERCONDUCTIVITY APPLICATIONS, 2011-2017 (\$ MILLIONS)	37
FIGURE 2 GLOBAL SUPERCONDUCTIVITY APPLICATION SEGMENTS, 2011-2017 (%)	39
FIGURE 3 GLOBAL SUPERCONDUCTIVITY END USE SEGMENTS, 2011-2017 (%)	40
FIGURE 4 U.S. PATENTS RELATING TO LOW-TEMPERATURE SUPERCONDUCTIVITY (LTS) VERSUS HIGH-TEMPERATURE SUPERCONDUCTIVITY (HTS) (% OF TOTAL SUPERCONDUCTIVITY-RELATED PATENTS)	51
FIGURE 5 NUMBER OF U.S. SUPERCONDUCTIVITY-RELATED PATENTS BY TYPE OF APPLICATION (NO. OF PATENTS)	52
FIGURE 6 U.S. SUPERCONDUCTIVITY-RELATED PATENTS BY TYPE OF ASSIGNEE (% OF 200-PATENT SAMPLE)	53
FIGURE 7 U.S. SUPERCONDUCTIVITY-RELATED PATENTS BY ASSIGNEE'S COUNTRY OF ORIGIN (% OF 200-PATENT SAMPLE)	54
FIGURE 8 GLOBAL SUPERCONDUCTING MAGNET MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	66
FIGURE 9 GLOBAL SUPERCONDUCTING MAGNET MARKET SHARES BY TYPE OF SUPERCONDUCTING MATERIAL, 2011-2017 (% OF TOTAL SHIPMENTS)	67
FIGURE 10 GLOBAL MARKET FOR NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROMETERS, 2011-2017 (\$ MILLIONS)	69
FIGURE 11 GLOBAL MARKET FOR PROTON THERAPY MACHINES, 2011-2017 (\$ MILLIONS)	73
FIGURE 12 GLOBAL MARKET FOR MAGNETIC RESONANCE IMAGING (MRI) SCANNERS, 2011-2017 (\$ BILLIONS)	74
FIGURE 13 GLOBAL MARKET FOR SUPERCONDUCTING MAGNETIC SEPARATORS, 2011-2017 (\$ MILLIONS)	77
FIGURE 14 GLOBAL MARKET FOR SUPERCONDUCTING MAGNET-DRIVEN DISPOSABLE MIXING SYSTEMS, 2011-2017 (\$ MILLIONS)	79
FIGURE 15 GLOBAL SUPERCONDUCTING TRANSFORMER MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	86
FIGURE 16 GLOBAL MARKET FOR POWER TRANSFORMERS RATED 10 MEGAVOLT AMPERE (MVA) AND ABOVE, 2011-2017 (\$ BILLIONS)	87
FIGURE 17 GLOBAL SUPERCONDUCTING GENERATOR MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	95
FIGURE 18 GLOBAL MARKET FOR MARINE PROPULSION GENERATORS, 2011-2017 (\$ MILLIONS)	98
FIGURE 19 SUPERCONDUCTING MOTOR MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	106
FIGURE 20 GLOBAL MARKET FOR MARINE ELECTRIC MOTORS, 2011-2017 (\$ MILLIONS)	108
FIGURE 21 FAULT CURRENT LIMITER (FCL) MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	115
FIGURE 22 GLOBAL SUPERCONDUCTING POWER STORAGE SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	123
FIGURE 23 SUPERCONDUCTING MAGNET MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	129
FIGURE 24 GLOBAL SUPERCONDUCTING INTEGRATED CIRCUIT (IC) MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	140
FIGURE 25 SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE (SQUID) SENSOR MARKET SHARES BY APPLICATION SEGMENT, 2011-2017 (% OF TOTAL SHIPMENTS)	152