

SPUTTERING TARGETS AND SPUTTERED FILMS: TECHNOLOGY AND MARKETS



SMC037G
February 2017

Margareth Gagliardi
Project Analyst

ISBN: 1-62296-444-6



BCC Research
49 Walnut Park, Building 2
Wellesley, MA 02481 USA
866-285-7215 (toll-free within the USA),
or (+1) 781-489-7301
www.bccresearch.com
info@bccresearch.com

TABLE OF CONTENTS

TOPIC	PAGE NO.
CHAPTER 1 INTRODUCTION	2
STUDY GOALS AND OBJECTIVES	2
REASONS FOR DOING THIS STUDY	3
INTENDED AUDIENCE	3
SCOPE OF REPORT	4
METHODOLOGY AND INFORMATION SOURCES	5
RELATED BCC RESEARCH REPORTS	6
ANALYST'S CREDENTIALS	7
BCC RESEARCH WEBSITE	8
DISCLAIMER	8
CHAPTER 2 EXECUTIVE SUMMARY	10
<i>SUMMARY TABLE GLOBAL MARKET FOR SPUTTERED FILMS AND SPUTTERING TARGETS, THROUGH 2021 (VARIETY OF UNITS)</i>	12
<i>SUMMARY FIGURE GLOBAL MARKET FOR SPUTTERED FILMS AND SPUTTERING TARGETS, 2016 AND 2021 (\$ MILLIONS)</i>	12
CHAPTER 3 OVERVIEW	14
INTRODUCTION	14
THICK, THIN AND ULTRATHIN FILMS	14
COST FACTOR AND MANUFACTURING PROCESSES	14
THICK-FILM TECHNOLOGIES	15
<i>TABLE 1 THICK-FILM TECHNOLOGIES, 2016</i>	15
THIN-, NANO- AND ULTRATHIN-FILM TECHNOLOGIES	17
Additive Methods	17
<i>TABLE 2 THIN-FILM PRINTING TECHNOLOGIES, 2016</i>	18
Subtractive Methods	18
Coating Methods Used in Subtractive Processes	19
<i>TABLE 3 THIN-FILM COATING TECHNOLOGIES, 2016</i>	19
Physical Processes	22
Chemical Processes	23
Hybrid Processes	23
Technological and Market Trends in the Thin-Film Industry	23
<i>FIGURE 1 GLOBAL MARKET SHARE OF THIN-FILM METHODS (EQUIPMENT, MATERIALS, SERVICES), BY GROUP OF TECHNOLOGIES, 2016 (%)</i>	23
MILESTONES IN THE HISTORY OF THE SPUTTERING PROCESS AND RECENT EVENTS	24
<i>TABLE 4 SPUTTERING - TECHNOLOGICAL MILESTONES</i>	25
<i>FIGURE 2 GLOBAL PATENT APPLICATIONS AND PATENTS ISSUED OF SPUTTERING, 1970-2015 (NUMBER)</i>	25
LATEST DEVELOPMENTS IN THE SPUTTERING PROCESS	27
<i>TABLE 5 SPUTTERING TECHNOLOGIES, 2016</i>	27
ROLL-TO-ROLL SPUTTERING SYSTEM FOR LARGE SUBSTRATES	28
SPUTTERING SYSTEM USING COUNTERWEIGHT	29
HIGH-POWER IMPULSE MAGNETRON SPUTTERING FOR NANOCRYSTALLINE DIAMOND FILMS	29
SPUTTERING WITH A PLASMA LENS	30

TOPIC	PAGE NO.
CURRENT AND EMERGING APPLICATIONS FOR SPUTTERING	30
<i>TABLE 6 SPUTTERING APPLICATIONS, 2016</i>	31
ELECTRONICS	32
<i>TABLE 7 SPUTTERING APPLICATIONS IN ELECTRONICS, 2016</i>	33
OPTOELECTRONICS	35
<i>TABLE 8 SPUTTERING APPLICATIONS IN OPTOELECTRONICS, 2016</i>	35
ENERGY	36
<i>TABLE 9 SPUTTERING APPLICATIONS IN THE ENERGY SECTOR, 2016</i>	37
OPTICAL COATINGS	38
<i>TABLE 10 SPUTTERING APPLICATIONS IN THE OPTICAL COATINGS SECTOR, 2016</i>	38
MECHANICAL/CHEMICAL	39
<i>TABLE 11 SPUTTERING APPLICATIONS IN THE MECHANICAL/CHEMICAL SECTOR, 2016</i>	40
LIFE SCIENCES	40
<i>TABLE 12 SPUTTERING APPLICATIONS IN THE LIFE SCIENCES SECTOR, 2016</i>	41
SENSORS AND INSTRUMENTATION	41
<i>TABLE 13 SPUTTERING APPLICATIONS IN SENSORS AND INSTRUMENTATION, 2016</i>	41
OTHER SECTORS	42
<i>TABLE 14 SPUTTERING APPLICATIONS IN OTHER SECTORS, 2016</i>	42
CHAPTER 4 TECHNOLOGY	44
INTRODUCTION	44
SPUTTERING TARGET TYPES	44
TARGET SHAPES	44
<i>TABLE 15 TARGET CONFIGURATIONS, 2016</i>	44
<i>TABLE 16 TYPICAL TARGET SHAPES, 2016 (%)</i>	45
TARGET SIZES	46
LATEST TECHNOLOGICAL DEVELOPMENTS, 2014 TO PRESENT	46
Multiblock Sputtering Target	46
Sputtering Target With Reverse Bowing Geometry	46
TARGET MATERIALS AND APPLICATIONS	47
<i>TABLE 17 TARGET MATERIALS AND APPLICATIONS, 2016</i>	47
LATEST TECHNOLOGICAL DEVELOPMENTS, 2014 TO PRESENT	48
Al-Ni-La Sputtering Target	49
Cu-In-Ga-Se Quaternary Alloy Sputtering Target	49
Ytterbium Sputtering Target	50
Electride Sputtering Target	50
Complex Oxide Sputtering Targets	51
PRODUCTION METHODS	51
<i>TABLE 18 SPUTTERING TARGETS - TRADITIONAL PROCESS TECHNOLOGIES, 2016</i>	52
LATEST TECHNOLOGICAL DEVELOPMENTS, 2011 TO PRESENT	54
Fabrication Process for Indium-Gallium-Zinc Oxynitride Targets	54
Production Process for High-Purity Lanthanum Sputtering Targets	55
Low-Cost Fabrication of Sputtering Targets based on High-Melting-Point Materials	55
Cold Spraying of Sputtering Targets	56
OTHER RELEVANT R&D ACTIVITIES	57
<i>TABLE 19 OTHER RELEVANT R&D ACTIVITIES, 2016</i>	57

TOPIC	PAGE NO.
CHAPTER 5 GLOBAL MARKETS	60
ANALYSIS OUTLINE	60
GLOBAL MARKET SUMMARY	60
TOTAL WORLD MARKETS	60
TABLE 20 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS, THROUGH 2021 (VARIETY OF UNITS)	62
FIGURE 3 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS, 2016 AND 2021 (METRIC TONS)	62
TABLE 21 AVERAGE SPUTTERING TARGET WEIGHT AND PRICE, THROUGH 2021 (KG/\$)	63
MARKET SEGMENTATION BY APPLICATION	63
TABLE 22 GLOBAL MARKET FOR SPUTTERING TARGETS, BY APPLICATION, THROUGH 2021 (\$ MILLIONS)	64
FIGURE 4 GLOBAL MARKET SHARE OF SPUTTERING TARGETS, BY APPLICATION, 2016 AND 2021 (%)	64
MARKET SEGMENTATION BY MATERIAL TYPE	65
TABLE 23 GLOBAL MARKET FOR SPUTTERING TARGETS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	66
FIGURE 5 GLOBAL MARKET SHARE OF SPUTTERING TARGETS, BY MATERIAL TYPE, 2016 AND 2021 (%)	66
MARKET SEGMENTATION BY REGION	67
TABLE 24 GLOBAL MARKET FOR SPUTTERING TARGETS, BY REGION, THROUGH 2021 (\$ MILLIONS)	68
FIGURE 6 GLOBAL MARKET SHARE OF SPUTTERING TARGETS, BY REGION, 2016 AND 2021 (%)	68
ELECTRONICS	69
CURRENT MARKET SUMMARY	69
TABLE 25 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, THROUGH 2016 (\$ MILLIONS)	70
FIGURE 7 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, 2014-2016 (\$ MILLIONS)	70
Sputtered Films and Target Consumption	70
TABLE 26 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR ELECTRONICS, THROUGH 2016 (VARIETY OF UNITS)	71
Revenues by Material Type	71
TABLE 27 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)	72
FIGURE 8 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, 2016 (%)	72
Revenues by Region	73
TABLE 28 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, THROUGH 2016 (\$ MILLIONS)	73
FIGURE 9 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, 2016 (%)	73
MARKET GROWTH TRENDS	74
Semiconductor Devices	74
TABLE 29 GLOBAL MARKET FOR SEMICONDUCTORS, BY REGION, THROUGH 2021 (\$ BILLIONS)	75
Printed Circuits, Other Circuit Devices and Passive Components	75
MEMS and NEMS	76

TOPIC	PAGE NO.
<i>TABLE 30 GLOBAL MARKET FOR MEMS AND NEMS, BY TYPE, THROUGH 2021 (\$ BILLIONS)</i>	76
Magnetic Storage Media and Recording Heads	76
Hard Disk Drives	76
<i>TABLE 31 GLOBAL PRODUCTION FOR HARD DISK DRIVES, BY TYPE, THROUGH 2021 (MILLION UNITS)</i>	77
<i>TABLE 32 GLOBAL PRODUCTION FOR HARD DISK DRIVES, BY END USE, THROUGH 2021 (MILLION UNITS)</i>	78
Optical Storage Media	78
<i>TABLE 33 GLOBAL PRODUCTION FOR OPTICAL STORAGE MEDIA, BY TYPE, THROUGH 2021 (MILLION UNITS)</i>	78
Technological Trends	79
On-Going Miniaturization in the Semiconductor Industry	79
Advent of Nanoelectronics and 2D Devices	79
<i>FIGURE 10 FROM MICROELECTRONICS TO NANOELECTRONICS</i>	80
Increased Use of Alloys	80
Regional Trends	81
MARKET FORECAST	81
Sputtered Films and Target Consumption	81
<i>TABLE 34 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR ELECTRONICS, THROUGH 2021 (VARIETY OF UNITS)</i>	81
<i>FIGURE 11 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR ELECTRONICS, 2016 AND 2021 (METRIC TONS)</i>	82
Revenues by Material Type	82
<i>TABLE 35 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)</i>	83
<i>FIGURE 12 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, 2021 (%)</i>	83
Revenues by Region	84
<i>TABLE 36 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, THROUGH 2021 (\$ MILLIONS)</i>	84
<i>FIGURE 13 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, 2021 (%)</i>	84
OPTOELECTRONICS	85
CURRENT MARKET SUMMARY	85
<i>TABLE 37 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, THROUGH 2016 (\$ MILLIONS)</i>	86
<i>FIGURE 14 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, 2014-2016 (\$ MILLIONS)</i>	86
Sputtered Films and Target Consumption	87
<i>TABLE 38 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTOELECTRONICS, THROUGH 2016 (VARIETY OF UNITS)</i>	87
Revenues by Material Type	87
<i>TABLE 39 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)</i>	88
<i>FIGURE 15 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, 2016 (%)</i>	88
Revenues by Region	89
<i>TABLE 40 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, THROUGH 2016 (\$ MILLIONS)</i>	89

TOPIC	PAGE NO.
<i>FIGURE 16 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, 2016 (%)</i>	89
MARKET GROWTH TRENDS	90
Advanced Displays	90
<i>TABLE 41 GLOBAL MARKET FOR ADVANCED DISPLAYS, BY TYPE, THROUGH 2021 (\$ BILLIONS)</i>	91
Solid-State Lighting	92
Lasers	92
Optical Waveguides	92
<i>TABLE 42 GLOBAL MARKET FOR OPTICAL FIBERS, THROUGH 2021 (\$ MILLIONS/MILLIONS KM)</i>	92
Technological Trends	93
Regional Trends	93
MARKET FORECAST	93
Sputtered Films and Target Consumption	94
<i>TABLE 43 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTOELECTRONICS, THROUGH 2021 (VARIETY OF UNITS)</i>	94
<i>FIGURE 17 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTOELECTRONICS, 2016 AND 2021 (METRIC TONS)</i>	94
Revenues by Material Type	95
<i>TABLE 44 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)</i>	95
<i>FIGURE 18 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, 2021 (%)</i>	96
Revenues by Region	96
<i>TABLE 45 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, THROUGH 2021 (\$ MILLIONS)</i>	97
<i>FIGURE 19 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, 2021 (%)</i>	97
ENERGY	98
CURRENT MARKET SUMMARY	98
<i>TABLE 46 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, THROUGH 2016 (\$ MILLIONS)</i>	98
<i>FIGURE 20 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, 2014-2016 (\$ MILLIONS)</i>	99
Sputtered Films and Target Consumption	99
<i>TABLE 47 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE ENERGY SECTOR, THROUGH 2016 (VARIETY OF UNITS)</i>	100
Revenues by Material Type	100
<i>TABLE 48 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)</i>	101
<i>FIGURE 21 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, 2016 (%)</i>	101
Revenues by Region	102
<i>TABLE 49 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, THROUGH 2016 (\$ MILLIONS)</i>	102
<i>FIGURE 22 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, 2016 (%)</i>	102
MARKET GROWTH TRENDS	103
Photovoltaic Cells	103

TOPIC	PAGE NO.
<i>TABLE 50 GLOBAL PRODUCTION OF PHOTOVOLTAIC MODULES, BY TYPE, THROUGH 2021 (MW)</i>	104
Flexible Solar Cells	104
Photothermal Devices	106
Fuel Cells	106
<i>TABLE 51 GLOBAL MARKET FOR FUEL CELLS, BY TYPE, THROUGH 2021 (\$ MILLIONS)</i>	106
Batteries	107
Thermoelectric Devices	107
Other Energy Applications	107
Technological Trends	108
Perovskite Solar Cells	108
Planar Supercapacitors	108
New Materials	109
Regional Trends	109
MARKET FORECAST	109
Sputtered Films and Target Consumption	109
<i>TABLE 52 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE ENERGY SECTOR, THROUGH 2021 (VARIETY OF UNITS)</i>	110
<i>FIGURE 23 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE ENERGY SECTOR, 2016 AND 2021 (METRIC TONS)</i>	110
Revenues by Material Type	110
<i>TABLE 53 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)</i>	111
<i>FIGURE 24 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, 2021 (%)</i>	111
Revenues by Region	112
<i>TABLE 54 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, THROUGH 2021 (\$ MILLIONS)</i>	112
<i>FIGURE 25 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, 2021 (%)</i>	113
OPTICAL COATINGS	113
CURRENT MARKET SUMMARY	113
<i>TABLE 55 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, THROUGH 2016 (\$ MILLIONS)</i>	114
<i>FIGURE 26 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, 2014-2016 (\$ MILLIONS)</i>	114
Sputtered Films and Target Consumption	115
<i>TABLE 56 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTICAL COATINGS, THROUGH 2016 (VARIETY OF UNITS)</i>	115
Revenues by Material Type	115
<i>TABLE 57 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)</i>	116
<i>FIGURE 27 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, 2016 (%)</i>	116
Revenues by Region	117
<i>TABLE 58 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, THROUGH 2016 (\$ MILLIONS)</i>	117
<i>FIGURE 28 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, 2016 (%)</i>	118

TOPIC	PAGE NO.
MARKET GROWTH TRENDS	118
Flat Glass	118
<i>TABLE 59 GLOBAL MARKET FOR FLAT GLASS, BY SECTOR, THROUGH 2021 (\$ BILLIONS)</i>	119
Eyewear	120
Technological Trends	120
Regional Trends	120
MARKET FORECAST	120
Sputtered Films and Target Consumption	120
<i>TABLE 60 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTICAL COATINGS, THROUGH 2021 (VARIETY OF UNITS)</i>	121
<i>FIGURE 29 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTICAL COATINGS, 2016 AND 2021 (METRIC TONS)</i>	121
Revenues by Material Type	122
<i>TABLE 61 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)</i>	122
<i>FIGURE 30 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, 2021 (%)</i>	122
Revenues by Region	123
<i>TABLE 62 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, THROUGH 2021 (\$ MILLIONS)</i>	123
<i>FIGURE 31 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, 2021 (%)</i>	124
MECHANICAL/CHEMICAL	124
CURRENT MARKET SUMMARY	124
<i>TABLE 63 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, THROUGH 2016 (\$ MILLIONS)</i>	125
<i>FIGURE 32 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, 2014-2016 (\$ MILLIONS)</i>	125
Sputtered Films and Target Consumption	126
<i>TABLE 64 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, THROUGH 2016 (VARIETY OF UNITS)</i>	126
Revenues by Material Type	126
<i>TABLE 65 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)</i>	127
<i>FIGURE 33 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, 2016 (%)</i>	127
Revenues by Region	128
<i>TABLE 66 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, THROUGH 2016 (\$ MILLIONS)</i>	128
<i>FIGURE 34 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, 2016 (%)</i>	128
MARKET GROWTH TRENDS	129
Protective Coatings	129
<i>TABLE 67 GLOBAL MARKET FOR AEROSPACE, BY REGION, THROUGH 2021 (\$ BILLIONS)</i>	130
<i>TABLE 68 GLOBAL MARKET FOR MECHANICAL COMPONENTS UTILIZING PROTECTIVE COATINGS, BY TYPE, THROUGH 2021 (\$ BILLIONS)</i>	131
Solid Lubricants	131
Membranes and Filters	131

TOPIC	PAGE NO.
<i>TABLE 69 MEMBRANE-BASED SEPARATION PROCESSES, 2016</i>	132
<i>TABLE 70 GLOBAL MARKET FOR THE MEMBRANE, BY REGION, THROUGH 2021 (\$ MILLIONS)</i>	133
Particle and Surface Modification Coatings	133
Catalysts and Photocatalysts	133
<i>TABLE 71 GLOBAL MARKET FOR CATALYSTS AND PHOTOCATALYSTS, THROUGH 2021 (\$ MILLIONS)</i>	134
Composite Materials	134
Technological Trends	134
Regional Trends	135
MARKET FORECAST	135
Sputtered Films and Target Consumption	135
<i>TABLE 72 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, THROUGH 2021 (VARIETY OF UNITS)</i>	136
<i>FIGURE 35 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, 2016 AND 2021 (METRIC TONS)</i>	136
Revenues by Material Type	136
<i>TABLE 73 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)</i>	137
<i>FIGURE 36 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, 2021 (%)</i>	137
Revenues by Region	138
<i>TABLE 74 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, THROUGH 2021 (\$ MILLIONS)</i>	138
<i>FIGURE 37 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, 2021 (%)</i>	139
LIFE SCIENCES AND OTHERS	139
CURRENT MARKET SUMMARY	139
<i>TABLE 75 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, THROUGH 2016 (\$ MILLIONS)</i>	140
<i>FIGURE 38 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, 2014-2016 (\$ MILLIONS)</i>	140
Sputtered Films and Target Consumption	141
<i>TABLE 76 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, THROUGH 2016 (VARIETY OF UNITS)</i>	141
Revenues by Material Type	141
<i>TABLE 77 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)</i>	142
<i>FIGURE 39 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, 2016 (%)</i>	142
Revenues by Region	143
<i>TABLE 78 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, THROUGH 2016 (\$ MILLIONS)</i>	143
<i>FIGURE 40 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, 2016 (%)</i>	143
MARKET GROWTH TRENDS	144
Biomedical Coatings	144
Implantable Devices	144

TOPIC	PAGE NO.
<i>TABLE 79 GLOBAL MARKET FOR IMPLANTABLE DEVICES, BY REGION, THROUGH 2021 (\$ BILLIONS)</i>	145
Medical Instruments	145
Sensors and Instrumentation	145
Sensors	145
<i>TABLE 80 GLOBAL MARKET FOR SENSORS, BY TYPE, THROUGH 2021 (\$ MILLIONS)</i>	146
Biosensors, Gas Sensors and Temperature Sensors	146
<i>TABLE 81 GLOBAL MARKET FOR BIOSENSORS AND OTHER COMMON SENSORS, THROUGH 2021 (\$ BILLIONS)</i>	147
Other Industry Segments	147
<i>TABLE 82 GLOBAL MARKET FOR OTHER INDUSTRY SECTORS, BY TYPE, THROUGH 2021 (\$ MILLIONS)</i>	147
Technological Trends	148
Regional Trends	148
MARKET FORECAST	148
Sputtered Films and Target Consumption	148
<i>TABLE 83 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, THROUGH 2021 (VARIETY OF UNITS)</i>	149
<i>FIGURE 41 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTOR, 2016 AND 2021 (METRIC TONS)</i>	149
Revenues by Material Type	149
<i>TABLE 84 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)</i>	150
<i>FIGURE 42 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, 2021 (%)</i>	150
Revenues by Region	151
<i>TABLE 85 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, THROUGH 2021 (\$ MILLIONS)</i>	151
<i>FIGURE 43 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, 2021 (%)</i>	152
CHAPTER 6 GLOBAL INDUSTRY STRUCTURE	154
LEADING MANUFACTURERS OF SPUTTERING TARGETS	154
<i>TABLE 86 LEADING MANUFACTURERS OF SPUTTERING TARGETS, 2016</i>	154
<i>TABLE 87 LEADING MANUFACTURERS OF SPUTTERING TARGETS, BY TYPE, 2016</i>	160
<i>TABLE 88 LEADING MANUFACTURERS OF SPUTTERING TARGETS, BY TYPE AND REGION, 2016 (NUMBER)</i>	168
OTHER PLAYERS IN THE SPUTTERING INDUSTRY	168
<i>TABLE 89 OTHER RELEVANT INDUSTRY PLAYERS, 2016</i>	168
COMPANY PROFILES	172
ALFA AESAR	172
AMETEK SPECIALTY METAL PRODUCTS	173
CORNING PRECISION MATERIALS KOREA	173
DAIDO STEEL	174
FURUYA METAL	176
H.C. STARCK	177
HITACHI METALS	177
HONEYWELL ELECTRONIC MATERIALS	178
JX NIPPON MINING & METALS	179

TOPIC	PAGE NO.
KOBE STEEL	180
MATERION	181
<i>TABLE 90 MATERION TECHNOLOGIES</i>	181
MATSUDA SANGYO	182
MITSUBISHI MATERIALS CORP.	183
MITSUI KINZOKU	184
PRAXAIR	185
SOLERAS ADVANCED COATINGS	186
SUMITOMO METAL MINING	187
TOSOH	188
ULVAC	189
<i>TABLE 91 ULVAC SPUTTERING TARGETS, 2016</i>	190
UMICORE	190
<i>TABLE 92 UMICORE SPUTTERING TARGETS, 2016</i>	191
CHAPTER 7 PATENT ANALYSIS	193
INTRODUCTION	193
SUMMARY OF RECENTLY AWARDED PATENTS	193
<i>TABLE 93 SPUTTERING TARGETS - U.S. PATENTS, 2016</i>	193
<i>TABLE 94 SPUTTERING TARGETS - U.S. PATENTS, 2015</i>	197
GENERAL TRENDS	202
<i>TABLE 95 SPUTTERING TARGETS: U.S. PATENT TRENDS, 2008-2016</i>	202
<i>FIGURE 44 SPUTTERING TARGETS: U.S. PATENT TRENDS, 2008-2016 (NUMBER OF PATENTS)</i>	203
TRENDS BY COUNTRY AND REGION	203
<i>FIGURE 45 GLOBAL PATENT SHARE OF SPUTTERING TARGETS, BY REGION, 2015-2016 (%)</i>	203
<i>FIGURE 46 GLOBAL PATENT SHARE OF SPUTTERING TARGETS, BY COUNTRY, 2015-2016 (%)</i>	204
TRENDS BY ASSIGNEE	205
<i>TABLE 96 ASSIGNEES OF U.S. PATENTS RELATED TO SPUTTERING TARGETS, 2015-2016</i>	206
TRENDS BY MATERIAL TYPE	207
<i>FIGURE 47 U.S. PATENTS SHARE OF SPUTTERING TARGETS, BY MATERIAL TYPE, 2015-2016 (%)</i>	208

LIST OF TABLES

TABLE HEADING	PAGE NO.
SUMMARY TABLE GLOBAL MARKET FOR SPUTTERED FILMS AND SPUTTERING TARGETS, THROUGH 2021 (VARIETY OF UNITS)	12
TABLE 1 THICK-FILM TECHNOLOGIES, 2016	15
TABLE 2 THIN-FILM PRINTING TECHNOLOGIES, 2016	18
TABLE 3 THIN-FILM COATING TECHNOLOGIES, 2016	19
TABLE 4 SPUTTERING - TECHNOLOGICAL MILESTONES	25
TABLE 5 SPUTTERING TECHNOLOGIES, 2016	27
TABLE 6 SPUTTERING APPLICATIONS, 2016	31
TABLE 7 SPUTTERING APPLICATIONS IN ELECTRONICS, 2016	33
TABLE 8 SPUTTERING APPLICATIONS IN OPTOELECTRONICS, 2016	35
TABLE 9 SPUTTERING APPLICATIONS IN THE ENERGY SECTOR, 2016	37
TABLE 10 SPUTTERING APPLICATIONS IN THE OPTICAL COATINGS SECTOR, 2016	38
TABLE 11 SPUTTERING APPLICATIONS IN THE MECHANICAL/CHEMICAL SECTOR, 2016	40
TABLE 12 SPUTTERING APPLICATIONS IN THE LIFE SCIENCES SECTOR, 2016	41
TABLE 13 SPUTTERING APPLICATIONS IN SENSORS AND INSTRUMENTATION, 2016	41
TABLE 14 SPUTTERING APPLICATIONS IN OTHER SECTORS, 2016	42
TABLE 15 TARGET CONFIGURATIONS, 2016	44
TABLE 16 TYPICAL TARGET SHAPES, 2016 (%)	45
TABLE 17 TARGET MATERIALS AND APPLICATIONS, 2016	47
TABLE 18 SPUTTERING TARGETS - TRADITIONAL PROCESS TECHNOLOGIES, 2016	52
TABLE 19 OTHER RELEVANT R&D ACTIVITIES, 2016	57
TABLE 20 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS, THROUGH 2021 (VARIETY OF UNITS)	62
TABLE 21 AVERAGE SPUTTERING TARGET WEIGHT AND PRICE, THROUGH 2021 (KG/\$)	63
TABLE 22 GLOBAL MARKET FOR SPUTTERING TARGETS, BY APPLICATION, THROUGH 2021 (\$ MILLIONS)	64
TABLE 23 GLOBAL MARKET FOR SPUTTERING TARGETS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	66
TABLE 24 GLOBAL MARKET FOR SPUTTERING TARGETS, BY REGION, THROUGH 2021 (\$ MILLIONS)	68
TABLE 25 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, THROUGH 2016 (\$ MILLIONS)	70
TABLE 26 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR ELECTRONICS, THROUGH 2016 (VARIETY OF UNITS)	71
TABLE 27 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)	72
TABLE 28 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, THROUGH 2016 (\$ MILLIONS)	73
TABLE 29 GLOBAL MARKET FOR SEMICONDUCTORS, BY REGION, THROUGH 2021 (\$ BILLIONS)	75
TABLE 30 GLOBAL MARKET FOR MEMS AND NEMS, BY TYPE, THROUGH 2021 (\$ BILLIONS)	76
TABLE 31 GLOBAL PRODUCTION FOR HARD DISK DRIVES, BY TYPE, THROUGH 2021 (MILLION UNITS)	77
TABLE 32 GLOBAL PRODUCTION FOR HARD DISK DRIVES, BY END USE, THROUGH 2021 (MILLION UNITS)	78
TABLE 33 GLOBAL PRODUCTION FOR OPTICAL STORAGE MEDIA, BY TYPE, THROUGH 2021 (MILLION UNITS)	78

TABLE HEADING	PAGE NO.
TABLE 34 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR ELECTRONICS, THROUGH 2021 (VARIETY OF UNITS)	81
TABLE 35 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	83
TABLE 36 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, THROUGH 2021 (\$ MILLIONS)	84
TABLE 37 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, THROUGH 2016 (\$ MILLIONS)	86
TABLE 38 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTOELECTRONICS, THROUGH 2016 (VARIETY OF UNITS)	87
TABLE 39 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)	88
TABLE 40 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, THROUGH 2016 (\$ MILLIONS)	89
TABLE 41 GLOBAL MARKET FOR ADVANCED DISPLAYS, BY TYPE, THROUGH 2021 (\$ BILLIONS)	91
TABLE 42 GLOBAL MARKET FOR OPTICAL FIBERS, THROUGH 2021 (\$ MILLIONS/MILLIONS KM)	92
TABLE 43 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTOELECTRONICS, THROUGH 2021 (VARIETY OF UNITS)	94
TABLE 44 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	95
TABLE 45 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, THROUGH 2021 (\$ MILLIONS)	97
TABLE 46 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, THROUGH 2016 (\$ MILLIONS)	98
TABLE 47 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE ENERGY SECTOR, THROUGH 2016 (VARIETY OF UNITS)	100
TABLE 48 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)	101
TABLE 49 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, THROUGH 2016 (\$ MILLIONS)	102
TABLE 50 GLOBAL PRODUCTION OF PHOTOVOLTAIC MODULES, BY TYPE, THROUGH 2021 (MW)	104
TABLE 51 GLOBAL MARKET FOR FUEL CELLS, BY TYPE, THROUGH 2021 (\$ MILLIONS)	106
TABLE 52 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE ENERGY SECTOR, THROUGH 2021 (VARIETY OF UNITS)	110
TABLE 53 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	111
TABLE 54 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, THROUGH 2021 (\$ MILLIONS)	112
TABLE 55 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, THROUGH 2016 (\$ MILLIONS)	114
TABLE 56 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTICAL COATINGS, THROUGH 2016 (VARIETY OF UNITS)	115
TABLE 57 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)	116
TABLE 58 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, THROUGH 2016 (\$ MILLIONS)	117
TABLE 59 GLOBAL MARKET FOR FLAT GLASS, BY SECTOR, THROUGH 2021 (\$ BILLIONS)	119

TABLE HEADING	PAGE NO.
TABLE 60 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTICAL COATINGS, THROUGH 2021 (VARIETY OF UNITS)	121
TABLE 61 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	122
TABLE 62 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, THROUGH 2021 (\$ MILLIONS)	123
TABLE 63 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, THROUGH 2016 (\$ MILLIONS)	125
TABLE 64 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, THROUGH 2016 (VARIETY OF UNITS)	126
TABLE 65 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)	127
TABLE 66 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, THROUGH 2016 (\$ MILLIONS)	128
TABLE 67 GLOBAL MARKET FOR AEROSPACE, BY REGION, THROUGH 2021 (\$ BILLIONS)	130
TABLE 68 GLOBAL MARKET FOR MECHANICAL COMPONENTS UTILIZING PROTECTIVE COATINGS, BY TYPE, THROUGH 2021 (\$ BILLIONS)	131
TABLE 69 MEMBRANE-BASED SEPARATION PROCESSES, 2016	132
TABLE 70 GLOBAL MARKET FOR THE MEMBRANE, BY REGION, THROUGH 2021 (\$ MILLIONS)	133
TABLE 71 GLOBAL MARKET FOR CATALYSTS AND PHOTOCATALYSTS, THROUGH 2021 (\$ MILLIONS)	134
TABLE 72 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, THROUGH 2021 (VARIETY OF UNITS)	136
TABLE 73 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	137
TABLE 74 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, THROUGH 2021 (\$ MILLIONS)	138
TABLE 75 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, THROUGH 2016 (\$ MILLIONS)	140
TABLE 76 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, THROUGH 2016 (VARIETY OF UNITS)	141
TABLE 77 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, THROUGH 2016 (\$ MILLIONS)	142
TABLE 78 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, THROUGH 2016 (\$ MILLIONS)	143
TABLE 79 GLOBAL MARKET FOR IMPLANTABLE DEVICES, BY REGION, THROUGH 2021 (\$ BILLIONS)	145
TABLE 80 GLOBAL MARKET FOR SENSORS, BY TYPE, THROUGH 2021 (\$ MILLIONS)	146
TABLE 81 GLOBAL MARKET FOR BIOSENSORS AND OTHER COMMON SENSORS, THROUGH 2021 (\$ BILLIONS)	147
TABLE 82 GLOBAL MARKET FOR OTHER INDUSTRY SECTORS, BY TYPE, THROUGH 2021 (\$ MILLIONS)	147
TABLE 83 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, THROUGH 2021 (VARIETY OF UNITS)	149
TABLE 84 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, THROUGH 2021 (\$ MILLIONS)	150
TABLE 85 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, THROUGH 2021 (\$ MILLIONS)	151
TABLE 86 LEADING MANUFACTURERS OF SPUTTERING TARGETS, 2016	154
TABLE 87 LEADING MANUFACTURERS OF SPUTTERING TARGETS, BY TYPE, 2016	160

TABLE HEADING	PAGE NO.
TABLE 88 LEADING MANUFACTURERS OF SPUTTERING TARGETS, BY TYPE AND REGION, 2016 (NUMBER)	168
TABLE 89 OTHER RELEVANT INDUSTRY PLAYERS, 2016	168
TABLE 90 MATERION TECHNOLOGIES	181
TABLE 91 ULVAC SPUTTERING TARGETS, 2016	190
TABLE 92 UMICORE SPUTTERING TARGETS, 2016	191
TABLE 93 SPUTTERING TARGETS - U.S. PATENTS, 2016	193
TABLE 94 SPUTTERING TARGETS - U.S. PATENTS, 2015	197
TABLE 95 SPUTTERING TARGETS: U.S. PATENT TRENDS, 2008-2016	202
TABLE 96 ASSIGNEES OF U.S. PATENTS RELATED TO SPUTTERING TARGETS, 2015-2016	206

LIST OF FIGURES

FIGURE TITLE	PAGE NO.
SUMMARY FIGURE GLOBAL MARKET FOR SPUTTERED FILMS AND SPUTTERING TARGETS, 2016 AND 2021 (\$ MILLIONS)	12
FIGURE 1 GLOBAL MARKET SHARE OF THIN-FILM METHODS (EQUIPMENT, MATERIALS, SERVICES), BY GROUP OF TECHNOLOGIES, 2016 (%)	23
FIGURE 2 GLOBAL PATENT APPLICATIONS AND PATENTS ISSUED OF SPUTTERING, 1970-2015 (NUMBER)	25
FIGURE 3 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS, 2016 AND 2021 (METRIC TONS)	62
FIGURE 4 GLOBAL MARKET SHARE OF SPUTTERING TARGETS, BY APPLICATION, 2016 AND 2021 (%)	64
FIGURE 5 GLOBAL MARKET SHARE OF SPUTTERING TARGETS, BY MATERIAL TYPE, 2016 AND 2021 (%)	66
FIGURE 6 GLOBAL MARKET SHARE OF SPUTTERING TARGETS, BY REGION, 2016 AND 2021 (%)	68
FIGURE 7 GLOBAL MARKET FOR SPUTTERING TARGETS FOR ELECTRONICS, 2014-2016 (\$ MILLIONS)	70
FIGURE 8 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, 2016 (%)	72
FIGURE 9 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, 2016 (%)	73
FIGURE 10 FROM MICROELECTRONICS TO NANOELECTRONICS	80
FIGURE 11 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR ELECTRONICS, 2016 AND 2021 (METRIC TONS)	82
FIGURE 12 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY MATERIAL TYPE, 2021 (%)	83
FIGURE 13 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR ELECTRONICS, BY REGION, 2021 (%)	84
FIGURE 14 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTOELECTRONICS, 2014-2016 (\$ MILLIONS)	86
FIGURE 15 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, 2016 (%)	88
FIGURE 16 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, 2016 (%)	89
FIGURE 17 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTOELECTRONICS, 2016 AND 2021 (METRIC TONS)	94
FIGURE 18 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY MATERIAL TYPE, 2021 (%)	96
FIGURE 19 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTOELECTRONICS, BY REGION, 2021 (%)	97
FIGURE 20 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE ENERGY SECTOR, 2014-2016 (\$ MILLIONS)	99
FIGURE 21 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, 2016 (%)	101
FIGURE 22 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, 2016 (%)	102
FIGURE 23 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE ENERGY SECTOR, 2016 AND 2021 (METRIC TONS)	110
FIGURE 24 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY MATERIAL TYPE, 2021 (%)	111
FIGURE 25 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE ENERGY SECTOR, BY REGION, 2021 (%)	113

FIGURE TITLE	PAGE NO.
FIGURE 26 GLOBAL MARKET FOR SPUTTERING TARGETS FOR OPTICAL COATINGS, 2014-2016 (\$ MILLIONS)	114
FIGURE 27 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, 2016 (%)	116
FIGURE 28 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, 2016 (%)	118
FIGURE 29 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR OPTICAL COATINGS, 2016 AND 2021 (METRIC TONS)	121
FIGURE 30 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY MATERIAL TYPE, 2021 (%)	122
FIGURE 31 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR OPTICAL COATINGS, BY REGION, 2021 (%)	124
FIGURE 32 GLOBAL MARKET FOR SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, 2014-2016 (\$ MILLIONS)	125
FIGURE 33 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, 2016 (%)	127
FIGURE 34 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, 2016 (%)	128
FIGURE 35 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, 2016 AND 2021 (METRIC TONS)	136
FIGURE 36 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY MATERIAL TYPE, 2021 (%)	137
FIGURE 37 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE MECHANICAL/CHEMICAL SECTOR, BY REGION, 2021 (%)	139
FIGURE 38 GLOBAL MARKET FOR SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, 2014-2016 (\$ MILLIONS)	140
FIGURE 39 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, 2016 (%)	142
FIGURE 40 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, 2016 (%)	143
FIGURE 41 GLOBAL CONSUMPTION OF SPUTTERED FILMS AND SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTOR, 2016 AND 2021 (METRIC TONS)	149
FIGURE 42 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR THE LIFE SCIENCES AND OTHER SECTORS, BY MATERIAL TYPE, 2021 (%)	150
FIGURE 43 GLOBAL MARKET SHARE OF SPUTTERING TARGETS FOR LIFE SCIENCES AND OTHER SECTORS, BY REGION, 2021 (%)	152
FIGURE 44 SPUTTERING TARGETS: U.S. PATENT TRENDS, 2008-2016 (NUMBER OF PATENTS)	203
FIGURE 45 GLOBAL PATENT SHARE OF SPUTTERING TARGETS, BY REGION, 2015-2016 (%)	203
FIGURE 46 GLOBAL PATENT SHARE OF SPUTTERING TARGETS, BY COUNTRY, 2015-2016 (%)	204
FIGURE 47 U.S. PATENTS SHARE OF SPUTTERING TARGETS, BY MATERIAL TYPE, 2015-2016 (%)	208