

CHAPTER ONE: INTRODUCTION.....	1
STUDY BACKGROUND .....	1
STUDY GOALS AND OBJECTIVES.....	1
INTENDED AUDIENCE.....	2
SCOPE AND FORMAT .....	2
INFORMATION SOURCES AND METHODOLOGY.....	3
ANALYST CREDENTIALS.....	4
RELATED BCC RESEARCH REPORTS.....	4
BCC ONLINE SERVICES.....	5
DISCLAIMER .....	5
 CHAPTER TWO: EXECUTIVE SUMMARY.....	 6
<i>SUMMARY TABLE GLOBAL MARKET FOR METAMATERIALS</i> <i>APPLICATIONS, BY TYPE OF MATERIAL, THROUGH 2018</i> <i>(\$ MILLIONS).....</i>	   6
<i>SUMMARY FIGURE GLOBAL MARKET FOR METAMATERIALS</i> <i>APPLICATIONS, BY TYPE OF MATERIAL, 2007-2018 (\$ MILLIONS).....</i>	  7
 CHAPTER THREE: OVERVIEW .....	 8
GENERAL DESCRIPTION OF METAMATERIALS.....	8
DEFINITION.....	8
HISTORY.....	9
TYPES/APPLICATIONS OF METAMATERIALS.....	10
<i>TABLE 1 MAJOR TYPES OF METAMATERIALS .....</i>	<i>10</i>
<i>TABLE 1 (CONTINUED).....</i>	<i>11</i>
ELECTROMAGNETIC METAMATERIALS .....	11
Artificial Dielectrics.....	11
Negative Refraction Media.....	12
Active Terahertz Metamaterials.....	12
Chiral Materials .....	13
Photonic Crystals.....	13
Superconducting Metamaterials.....	14
Magnetic Nanocomposites.....	15
ACOUSTIC METAMATERIALS .....	15
EXTREME-PARAMETER METAMATERIALS .....	15
OVERALL MARKET SIZE AND SEGMENTATION.....	16
MARKET SIZE.....	16
<i>FIGURE 1 TRENDS IN GLOBAL MARKET FOR METAMATERIALS,</i> <i>2007–2018 (\$ MILLIONS) .....</i>	  <i>16</i>
TYPES OF METAMATERIALS .....	17
<i>TABLE 2 GLOBAL MARKET FOR METAMATERIALS BY TYPE OF</i> <i>MATERIAL, THROUGH 2018 (\$ MILLIONS).....</i>	  <i>17</i>
<i>FIGURE 2 TRENDS IN METAMATERIALS MARKET BY TYPE OF</i> <i>METAMATERIAL, 2007–2018 (% OF TOTAL MARKET).....</i>	  <i>18</i>

END USES .....	18
<i>TABLE 3 GLOBAL MARKET FOR METAMATERIALS BY END-USE</i>	
<i>SECTOR, THROUGH 2018 (\$ MILLIONS)</i> .....	19
<i>FIGURE 3 TRENDS IN METAMATERIALS MARKET BY END USE,</i>	
<i>2007–2018 (% OF TOTAL MARKET)</i> .....	20
CHAPTER FOUR: ARTIFICIAL DIELECTRICS: MATERIALS, END USES	
AND MARKETS, 2007 TO 2018 .....	21
MATERIALS .....	21
PROPERTIES.....	21
APPLICATIONS .....	22
WIRELESS COMMUNICATIONS.....	22
AUTOMOTIVE RADAR.....	23
AIRBORNE ANTENNAS.....	24
MARKETS.....	24
SUMMARY .....	24
<i>TABLE 4 PROJECTED MARKET FOR ARTIFICIAL DIELECTRICS,</i>	
<i>THROUGH 2018 (\$ MILLIONS)</i> .....	25
<i>FIGURE 4 TRENDS IN MARKET FOR ARTIFICIAL DIELECTRICS,</i>	
<i>2007–2018 (\$ MILLIONS)</i> .....	25
<i>FIGURE 5 TRENDS IN ARTIFICIAL DIELECTRICS MARKET BY</i>	
<i>TYPE OF APPLICATION, 2007–2018 (% OF TOTAL MARKET)</i> .....	26
AUTOMOTIVE RADAR.....	26
<i>TABLE 5 MARKET FOR AUTOMOTIVE RADAR APPLICATIONS,</i>	
<i>THROUGH 2018 (\$ MILLIONS)</i> .....	27
<i>TABLE 6 MATERIALS CONSUMPTION ASSOCIATED WITH</i>	
<i>AUTOMOTIVE RADAR APPLICATIONS, THROUGH 2018</i>	
<i>(\$ MILLIONS)</i> .....	28
AIRBORNE ANTENNAS.....	28
<i>TABLE 7 AIRBORNE ANTENNAS AND RELATED MARKET FOR</i>	
<i>METAMATERIALS, THROUGH 2018 (\$ MILLIONS)</i> .....	28
WIRELESS COMMUNICATIONS.....	29
<i>TABLE 8 GLOBAL MARKET FOR WIMAX DATA COMMUNICATION</i>	
<i>EQUIPMENT AND POTENTIAL SUCCESSOR TECHNOLOGIES,</i>	
<i>THROUGH 2018 (\$ MILLIONS)</i> .....	30
<i>TABLE 9 SMART ANTENNAS AND RELATED MARKET FOR</i>	
<i>ARTIFICIAL DIELECTRICS, THROUGH 2018 (\$ MILLIONS)</i> .....	30
CHAPTER FIVE: NEGATIVE REFRACTION MEDIA: MATERIALS, END	
USES AND MARKETS, 2007 TO 2018 .....	31
MATERIALS .....	31
PROPERTIES.....	31
<i>FIGURE 6 NEGATIVE REFRACTION</i> .....	31
EXAMPLES .....	32
Copper-Fiberglass Media .....	32

Gold Nanorods .....	32
Layered Ferromagnets and Superconductors .....	33
Nanoscale Silver .....	33
Silver Thin Films .....	33
Nanoscale Silver Mesh Structure.....	33
Silicon Nitride/Silver/Gold Prism Sandwich .....	34
Yttrium Vanadate Crystals.....	34
Teflon-Ceramic-Copper Capacitor Material .....	34
Naturally Occurring Negatively Refractive Materials .....	34
APPLICATIONS .....	35
OPTICAL MICROSCOPY.....	35
PHOTOLITHOGRAPHY.....	36
DATA STORAGE .....	37
OTHER POTENTIAL APPLICATIONS .....	37
MARKETS.....	38
SUMMARY .....	38
<i>TABLE 10 PROJECTED MARKET FOR NEGATIVELY REFRACTIVE METAMATERIALS, THROUGH 2018 (MILLION \$)</i> .....	38
<i>FIGURE 7 TRENDS IN NEGATIVELY REFRACTIVE METAMATERIALS MARKET BY TYPE OF APPLICATION, 2007– 2018 (% OF TOTAL MARKET)</i> .....	39
OPTICAL MICROSCOPES.....	39
<i>TABLE 11 METAMATERIALS MARKET IN OPTICAL MICROSCOPY APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	40
NEAR-FIELD PHOTOLITHOGRAPHY .....	40
Near-field Photolithography (Continued).....	41
<i>TABLE 12 METAMATERIALS MARKET IN PHOTOLITHOGRAPHY APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	42
DATA STORAGE .....	42
<i>TABLE 13 METAMATERIALS MARKET IN DATA STORAGE APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	43
MAGNETIC RESONANCE IMAGING .....	43
<i>TABLE 14 METAMATERIALS MARKET IN MRI APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	43
Magnetic Resonance Imaging (Continued).....	44
CHAPTER SIX: ACTIVE TERAHERTZ METAMATERIALS: MATERIALS, END USES AND MARKETS, 2007 TO 2018.....	45
MATERIALS .....	45
PROPERTIES.....	45
<i>FIGURE 8 SPLIT RING RESONATOR</i> .....	46
APPLICATIONS .....	47
NON DESTRUCTIVE TESTING .....	47
MEDICAL IMAGING.....	48
Intraoperative Imaging .....	49

Skin Cancer Detection.....	50
Clinical Dentistry .....	50
AIRPORT SECURITY.....	50
Airport Security (Continued) .....	51
MARKETS.....	52
SUMMARY .....	52
TABLE 15 PROJECTED MARKET FOR THZ ACTIVE METAMATERIALS, THROUGH 2018 (\$ MILLIONS).....	52
FIGURE 9 TRENDS IN TERAHERZ ACTIVE METAMATERIALS MARKET BY TYPE OF APPLICATION, 2007–2018 (% OF TOTAL MARKET).....	53
AIRPORT SECURITY.....	53
TABLE 16 GLOBAL MARKET FOR TERAHERTZ AND OTHER AIRPORT SECURITY SCREENING EQUIPMENT, THROUGH 2018 (\$ MILLIONS).....	54
NON-DESTRUCTIVE TESTING .....	55
TABLE 17 GLOBAL MARKET FOR TERAHERTZ AND OTHER RADIOGRAPHIC NDT EQUIPMENT, THROUGH 2018 (\$ MILLIONS).....	56
MEDICAL IMAGING.....	56
TABLE 18 GLOBAL MARKET FOR TERAHERTZ MEDICAL IMAGING APPLICATIONS, THROUGH 2018 (\$ MILLIONS).....	57
TABLE 19 GLOBAL MARKET FOR TERAHERTZ ACTIVE METAMATERIALS IN MEDICAL IMAGING APPLICATIONS, THROUGH 2018 (\$ MILLIONS).....	57
Intraoperative Imaging .....	57
TABLE 20 GLOBAL MARKET FOR INTRAOPERATIVE IMAGING EQUIPMENT, THROUGH 2018 (\$ MILLIONS).....	58
FIGURE 10 INTRAOPERATIVE IMAGING TECHNOLOGIES MARKET SHARES, 2007 (PERCENT OF TOTAL INTRAOPERATIVE IMAGING EQUIPMENT SALES).....	58
TABLE 21 GLOBAL MARKET FOR INTRAOPERATIVE TERAHERTZ IMAGING EQUIPMENT, 2007–2018 (\$ MILLIONS).....	59
Skin Cancer Detection.....	59
TABLE 22 GLOBAL MARKET FOR TERAHERTZ SKIN CANCER IMAGING EQUIPMENT, THROUGH 2018 (\$ MILLIONS).....	60
Clinical Dentistry .....	60
TABLE 23 GLOBAL MARKET FOR TERAHERTZ DENTAL CARIES IMAGING EQUIPMENT, THROUGH 2018 (\$ MILLIONS).....	61
CHAPTER SEVEN: CHIRAL MATERIALS: MATERIALS, END USES AND MARKETS, 2007 TO 2018 .....	62
MATERIALS .....	62
FIGURE 11 CHIRALITY.....	62
PROPERTIES.....	62

Electromagnetic Chiral Metamaterials .....	63
Optical Activity .....	63
Circular Dichroism .....	63
Negative Refraction .....	63
Artificial Magnetism .....	64
Enantioselectivity .....	64
EXAMPLES .....	64
Optically Active Chiral Metamaterials.....	64
<i>FIGURE 12 OPTICALLY ACTIVE CHIRAL METAMATERIAL</i> .....	65
Asymmetric Catalysts .....	65
APPLICATIONS .....	66
POLARIZATION CODING OF QUANTUM INFORMATION .....	66
CIRCULAR DICHROISM SPECTROSCOPY .....	67
CHEMICAL AND PHARMACEUTICAL PRODUCTION .....	67
Chemical and Pharmaceutical ... (Continued) .....	68
MARKETS .....	69
SUMMARY .....	69
<i>TABLE 24 PROJECTED MARKET FOR CHIRAL METAMATERIALS,</i> <i>THROUGH 2018 (\$ MILLIONS)</i> .....	69
<i>FIGURE 13 TRENDS IN MARKET FOR CHIRAL METAMATERIALS,</i> <i>2007–2018 (\$ MILLIONS)</i> .....	70
<i>FIGURE 14 TRENDS IN CHIRAL MATERIALS MARKET BY TYPE OF</i> <i>APPLICATION, 2007–2018 (% OF TOTAL MARKET)</i> .....	71
QUANTUM INFORMATION PROCESSING.....	71
<i>TABLE 25 METAMATERIALS MARKET IN QUANTUM ENCRYPTION</i> <i>APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	72
CIRCULAR DICHROISM SPECTROSCOPY .....	72
<i>TABLE 26 METAMATERIALS MARKET IN CIRCULAR DICHROISM</i> <i>SPECTROSCOPY APPLICATIONS, THROUGH 2018 (\$ MILLIONS)</i> .....	73
CATALYSIS.....	73
<i>TABLE 27 METAMATERIALS MARKET IN CIRCULAR DICHROISM</i> <i>SPECTROSCOPY APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	74
Pharmaceuticals .....	74
<i>TABLE 28 CONSUMPTION OF ASSYMETRIC CATALYSTS IN</i> <i>PHARMACEUTICALS PRODUCTION, THROUGH 2008</i> <i>(\$ MILLIONS)</i> .....	74
<i>TABLE 28 (CONTINUED)</i> .....	75
<i>FIGURE 15 TRENDS IN PHARMACEUTICAL MARKET FOR</i> <i>ASYMMETRIC CATALYSTS, 2007–2018 (\$ MILLIONS)</i> .....	75
Other Chemicals .....	75
<i>TABLE 29 CONSUMPTION OF ASSYMETRIC CATALYSTS IN OTHER</i> <i>CHEMICALS PRODUCTION, THROUGH 2008 (\$ MILLION)</i> .....	76
CHAPTER EIGHT: PHOTONIC CRYSTALS: MATERIALS, END USES AND MARKETS, 2007 TO 2018 .....	77

MATERIALS .....	77
PROPERTIES.....	77
<i>FIGURE 16 PHOTONIC CRYSTAL STRUCTURE.....</i>	<i>77</i>
Two Dimensional vs. Three Dimensional Crystals .....	78
<i>FIGURE 17 2D VS. 3D PHOTONIC CRYSTALS.....</i>	<i>79</i>
Defects.....	79
<i>FIGURE 18 PHOTONIC CRYSTAL POINT DEFECT.....</i>	<i>80</i>
Static vs. Tunable Crystals .....	80
COMPOSITION.....	81
FABRICATION .....	81
Micromachining .....	82
Microlithographic Techniques.....	82
Layer-by-Layer Fabrication .....	83
<i>FIGURE 19 “WOODPILE” STRUCTURE.....</i>	<i>83</i>
Autocloneing .....	84
<i>FIGURE 20 AUTOCLONED CRYSTAL STRUCTURE.....</i>	<i>85</i>
Holographic Lithography .....	85
Glancing Angle Deposition.....	86
Stack Methods .....	86
Low Temperature Deposition.....	87
Self-Assembly.....	87
Opal Method.....	87
Other Self-Assembly Techniques .....	88
Drawing and Extruding .....	89
APPLICATIONS .....	89
FIBER LASERS .....	89
FLAT PANEL DISPLAYS.....	90
HIGH-BRIGHTNESS LEDS.....	91
SENSORS.....	92
OPTICAL COMPUTING.....	93
DATA STORAGE .....	94
OPTICAL COMMUNICATIONS ADD/DROP FILTERS .....	94
SOLAR CELLS.....	95
OTHER APPLICATIONS .....	96
MARKETS.....	96
SUMMARY .....	96
<i>TABLE 30 PROJECTED MARKET FOR PHOTONIC CRYSTALS,</i>	
<i>    THROUGH 2018 (\$ MILLIONS).....</i>	<i>97</i>
<i>FIGURE 21 GLOBAL MARKET TRENDS FOR PHOTONIC CRYSTAL</i>	
<i>    METAMATERIALS, 2007–2018 (\$ MILLIONS).....</i>	<i>97</i>
<i>FIGURE 22 TRENDS IN PHOTONIC CRYSTALS MARKET BY TYPE</i>	
<i>    OF APPLICATION, 2007–2018 (% OF TOTAL MARKET).....</i>	<i>98</i>
FIBER LASERS .....	99

<i>TABLE 31 GLOBAL MARKET FOR PHOTONIC CRYSTAL FIBER USED IN FIBER LASER APPLICATIONS, THROUGH 2018 (\$ MILLIONS)</i> .....	99
<i>TABLE 32 GLOBAL MARKET FOR FIBER LASERS, THROUGH 2018 (\$ MILLIONS)</i> .....	99
HIGH BRIGHTNESS LEDS.....	100
<i>TABLE 33 GLOBAL MARKET FOR HIGH-BRIGHTNESS LEDS, THROUGH 2018 (\$ MILLIONS)</i> .....	100
<i>TABLE 34 GLOBAL CONSUMPTION OF PHOTONIC CRYSTALS IN THE FABRICATION OF HB- LEDS, THROUGH 2018 (\$ MILLIONS)</i> .....	101
SOLAR CELLS.....	101
<i>TABLE 35 PROJECTED MARKET FOR PHOTONIC CRYSTAL-BASED PHOTOVOLTAICS AND RELATED CONSUMPTION OF PHOTONIC CRYSTALS, THROUGH 2018 (\$ MILLIONS)</i> .....	101
DATA STORAGE .....	102
<i>TABLE 36 MARKET FOR PHOTONIC CRYSTAL-BASED DATE STORAGE PRODUCTS AND RELATED CONSUMPTION OF PHOTONIC CRYSTALS, THROUGH 2018 (\$ MILLIONS)</i> .....	102
SENSORS .....	102
<i>TABLE 37 WORLD MARKETS FOR QUANTUM DOTS IN BIODETECTION APPLICATIONS, THROUGH 2018 (\$ MILLIONS)</i> .....	103
<i>TABLE 38 WORLD MARKETS FOR PHOTONIC CRYSTAL FLUORESCENCE ENHANCERS, THROUGH 2018 (\$ MILLIONS)</i> .....	104
OPTICAL COMPUTING.....	104
<i>TABLE 39 WORLD MARKETS FOR HIGH PERFORMANCE PROCESSORS, THROUGH 2018 (\$ MILLIONS)</i> .....	104
<i>TABLE 40 WORLD MARKETS FOR HIGH PERFORMANCE ALL- OPTICAL PROCESSORS, THROUGH 2018 (\$ MILLION)</i> .....	105
FLAT PANEL DISPLAYS.....	105
<i>TABLE 41 WORLD MARKETS FOR PHOTONIC CRYSTAL-BASED DISPLAYS AND RELATED CONSUMPTION OF PHOTONIC CRYSTAL MATERIALS, THROUGH 2018 (\$ MILLION)</i> .....	106
OPTICAL COMMUNICATIONS ADD/DROP FILTERS .....	106
<i>TABLE 42 GLOBAL MARKET FOR PHOTONIC CRYSTAL ADD/DROP FILTERS, THROUGH 2018 (\$ MILLIONS)</i> .....	107
 CHAPTER NINE: SUPERCONDUCTING METAMATERIALS:	
MATERIALS, END USES AND MARKETS, 2007 TO 2018.....	108
MATERIALS .....	108
PROPERTIES.....	108
EXAMPLES .....	109
END USES .....	110
HIGH PERFORMANCE COMPUTERS .....	110
ELECTRICAL TRANSMISSION WIRES.....	111
MARKETS.....	112

SUMMARY .....	112
<i>TABLE 43 PROJECTED MARKET FOR SUPERCONDUCTING POLYMER METAMATERIALS, THROUGH 2018 (\$ MILLIONS)</i> .....	113
<i>FIGURE 23 TRENDS IN SUPERCONDUCTING POLYMER METAMATERIALS MARKET BY TYPE OF APPLICATION, 2007– 2018 (% OF TOTAL MARKET)</i> .....	113
<i>FIGURE 23 (CONTINUED)</i> .....	114
HIGH PERFORMANCE COMPUTERS .....	114
<i>TABLE 44 WORLD MARKETS FOR SPECIALIZED HPC PROCESSORS, THROUGH 2018 (\$ MILLIONS)</i> .....	114
<i>TABLE 45 MARKET FOR SUPERCONDUCTING INTEGRATED CIRCUITS USED IN QUANTUM AND OTHER HIGH PERFORMANCE AND RELATED CONSUMPTION OF METAMATERIALS, THROUGH 2018 (\$ MILLIONS)</i> .....	115
ELECTRICAL TRANSMISSION WIRES .....	115
<i>TABLE 46 MARKET FOR SUPERCONDUCTING ELECTRIC TRANSMISSION WIRES AND RELATED CONSUMPTION OF METAMATERIALS, THROUGH 2018 (\$ MILLION)</i> .....	116
Electrical Transmission Wires (Continued) .....	117
 CHAPTER TEN: EXTREME-PARAMETER METAMATERIALS:	
MATERIALS, END USES AND MARKETS, 2007 TO 2018.....	118
MATERIALS .....	118
PROPERTIES.....	118
FABRICATION .....	119
Consolidation of Nanoparticles into Monolithics .....	119
Severe Plastic Deformation.....	119
EXAMPLES .....	119
Nanostructured Steel .....	120
High-Strength Titanium .....	120
END USES .....	120
MEDICAL DEVICES .....	120
Surgical Needles .....	121
High Strength Medical and Dental Implants.....	121
STEEL COATINGS AND STRUCTURAL STEEL.....	121
MARKETS .....	122
SUMMARY .....	122
<i>TABLE 47 PROJECTED MARKET FOR EXTREME PARAMETER METAMATERIALS, THROUGH 2018 (\$ MILLION)</i> .....	122
<i>FIGURE 24 TRENDS IN EXTREME PARAMETER METAMATERIALS MARKET BY TYPE OF APPLICATION, 2007–2018 (% OF TOTAL MARKET)</i> .....	123
MEDICAL DEVICES .....	123
<i>TABLE 48 PROJECTED MEDICAL DEVICE MARKET FOR EXTREME PARAMETER METAMATERIALS, THROUGH 2018 (\$ MILLION)</i> .....	124



Surgical Needles .....	124
<i>TABLE 49 GLOBAL MARKET FOR NANOSTRUCTURED STEEL SUTURE NEEDLES, 2007–2018 (\$ MILLION)</i> .....	124
High-Strength Medical and Dental Implants .....	124
<i>TABLE 50 GLOBAL CONSUMPTION OF CONVENTIONAL AND NANOSTURCTURED TITANIUM IN MEDICAL IMPLANTS, THROUGH 2018 (\$ MILLION)</i> .....	125
STEEL COATINGS AND STRUCTURAL STEEL.....	125
<i>TABLE 51 GLOBAL CONSUMPTION OF NANOSTRUCTURED STEEL, THROUGH 2018 (\$ MILLIONS)</i> .....	126
Steel Coatings .....	126
<i>TABLE 52 GLOBAL CONSUMPTION OF NANOSTRUCTURED STEEL COATINGS, THROUGH 2018 (\$ MILLION)</i> .....	126
Structural Steel .....	127
<i>TABLE 53 GLOBAL CONSUMPTION OF NANOSTRUCTURED STRUCTURAL STEEL, THROUGH 2018 (\$ MILLION)</i> .....	127
 CHAPTER ELEVEN: MAGNETIC NANOCOMPOSITES: MATERIALS, END USES AND MARKETS, 2007 TO 2018.....	
MATERIALS .....	128
PROPERTIES.....	128
FABRICATION .....	128
END USES .....	128
MAGNETIC REFRIGERATORS .....	129
SPINTRONICS.....	129
MARKETS.....	129
<i>TABLE 54 GLOBAL CONSUMPTION OF MAGNETIC NANOCOMPOSITES FOR ELECTRICAL AND ELECTRONIC APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	129
 CHAPTER TWELVE: ACOUSTIC METAMATERIALS: MATERIALS, END USES AND MARKETS, 2007 TO 2018.....	
MATERIALS .....	130
PROPERTIES.....	130
FABRICATION .....	130
END USES .....	131
ULTRASOUND IMAGING.....	131
ACOUSTIC CLOAKS.....	131
SEISMIC PROTECTION .....	132
MARKETS.....	132
SUMMARY .....	132
<i>TABLE 55 PROJECTED MARKET FOR ACOUSTIC METAMATERIALS, THROUGH 2018 (\$ MILLIONS)</i> .....	132

<i>FIGURE 25 TRENDS IN TERAHERZ ACTIVE METAMATERIALS MARKET BY TYPE OF APPLICATION, 2007 TO 2018 (% OF TOTAL MARKET)</i> .....	133
ULTRASOUND IMAGING.....	133
<i>TABLE 56 METAMATERIALS MARKET IN MEDICAL ULTRASOUND APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	134
NOISE BARRIERS.....	134
<i>TABLE 57 METAMATERIALS MARKET IN OUTDOOR NOISE BARRIERS, THROUGH 2018 (\$ MILLIONS)</i> .....	134
SEISMIC PROTECTION.....	134
<i>TABLE 58 METAMATERIALS MARKET IN SEISMIC PROTECTION APPLICATIONS, THROUGH 2018 (\$ MILLION)</i> .....	135
APPENDIX I: : COMPANY PROFILES .....	136
ALIGHT TECHNOLOGIES APS .....	136
ALPS ELECTRIC CO., LTD.....	136
COLOSSAL STORAGE CORP. ....	136
CRYSTAL FIBRE A/S.....	137
ERA TECHNOLOGY, LTD. ....	137
FIANIUM LTD.....	138
ICX TECHNOLOGIES .....	138
INFRAMAT CORP.....	138
JEM ENGINEERING LLC.....	139
KOHERAS A/S .....	139
LUMINUS DEVICES, INC. ....	139
LUXTERA, INC.....	140
NEOMAX CO., LTD.....	140
OMNIGUIDE, INC. ....	140
MESOPHOTONICS LIMITED.....	141
NANOSTEEL CO., INC.....	141
NEWPORT CORP.....	142
OMNIGUIDE, INC. ....	142
OPALUX INC.....	142
PHOTEON TECHNOLOGIES GMBH .....	143
PHOTONIC LATTICE, INC.....	143
RAYSPAN INC.....	144
ROOM TEMPERATURE SUPERCONDUCTORS, INC.....	144
SANDVIK MATERIALS TECHNOLOGY AB .....	145
TERAVIEW LTD.....	145
VACUUMSCHMELZE GMBH.....	145
APPENDIX II: PATENT ANALYSIS .....	146
<i>FIGURE 26 RECENT U.S. METAMATERIALS-RELATED PATENTS AND PATENT APPLICATIONS BY TYPE OF MATERIAL, AS OF</i>	

<i>9/1/2008 (PERCENT OF US PATENTS AND PATENT APPLICATIONS PENDING) .....</i>	<i>146</i>
<i>FIGURE 26 (CONTINUED) .....</i>	<i>147</i>
<i>FIGURE 27 RECENT U.S. METAMATERIALS-RELATED PATENTS AND PATENT APPLICATIONS (PERCENT OF U.S. PATENTS AND PATENT APPLICATIONS PENDING).....</i>	<i>148</i>
<i>FIGURE 28 NUMBER OF U.S. SUPERCONDUCTIVITY-RELATED PATENTS AND APPLICATIONS, BY COUNTRY (NUMBER OF PATENTS).....</i>	<i>149</i>
<i>TABLE 59 MAJOR U.S. METAMATERIALS PATENT PORTFOLIOS (NUMBER OF PATENTS ISSUED THROUGH SEPTEMBER 1, 2008).....</i>	<i>150</i>