

CHAPTER ONE: INTRODUCTION.....	1
STUDY BACKGROUND	1
STUDY GOALS AND OBJECTIVES.....	1
INTENDED AUDIENCE.....	2
SCOPE AND FORMAT	2
METHODOLOGY AND INFORMATION SOURCES.....	2
ANALYST CREDENTIALS.....	3
RELATED BCC RESEARCH	4
BCC ON-LINE SERVICES.....	4
DISCLAIMER	5
DISCLAIMER (CONTINUED).....	5
CHAPTER TWO: EXECUTIVE SUMMARY.....	6
<i>SUMMARY TABLE GLOBAL CONSUMPTION OF</i>	
<i>NANOCOMPOSITES, THROUGH 2016 (\$ MILLIONS)</i>	6
<i>SUMMARY FIGURE GLOBAL CONSUMPTION OF</i>	
<i>NANOCOMPOSITES, 2010-2016 (\$ MILLIONS)</i>	6
EXECUTIVE SUMMARY (CONTINUED).....	7
CHAPTER THREE: NANOCOMPOSITES OVERVIEW	8
GENERAL DESCRIPTION.....	8
DEFINITIONS	8
Composites	8
Nanocomposites	8
Fillers versus Matrix Materials	8
BRIEF HISTORY OF NANOCOMPOSITES	8
GENERAL PROPERTIES OF NANOCOMPOSITES VERSUS	
CONVENTIONAL COMPOSITES	9
INCREASED TENSILE STRENGTH, MODULUS, AND HEAT	
DISTORTION TEMPERATURE.....	10
COLOR/TRANSPARENCY.....	10
CONDUCTIVITY	10
FLAME RETARDANCY	11
BARRIER PROPERTIES.....	11
ANTICORROSIVE PROPERTIES	11
TYPES OF NANOCOMPOSITES, THEIR PROPERTIES AND	
APPLICATIONS.....	11
CLAY NANOCOMPOSITES.....	12
Materials.....	12
Clay Fillers.....	12
Natural Clays	12
Montmorillonite	12
Vermiculite	13
Octosilicate	13

Bentonite13	
Hectorite	14
Halloysite.....	14
Synthetic Clays	14
Fluorohectorite.....	15
Hydrotalcite.....	15
Laponite	15
Matrix Materials.....	16
Nylon.....	16
Butyl	17
Thermoplastic Olefins.....	17
Polyethylene	17
Polypropylene	18
Polyvinyl Chloride.....	18
Ethylene Vinyl Acetate	19
Other Matrix Materials	19
Polyethylene Terephthalate	20
Acetal	20
Polychloroprene.....	20
Nitrile Rubber	20
Ethylene Vinyl Alcohol	20
Fabrication.....	21
Production and Pre-Treatment of Clay Filler	
Materials.....	21
Compounding	21
Types of Clay Nanocomposites.....	22
Commercial Clay Nanocomposites	22
<i>TABLE 1 PROPERTIES AND MAIN APPLICATIONS OF PRINCIPAL</i>	
<i>TYPES OF COMMERCIAL CLAY NANOCOMPOSITES.....</i>	<i>22</i>
<i>TABLE 1 (CONTINUED).....</i>	<i>23</i>
Nylon/Montmorillonite	23
Automotive Applications	23
Packaging Applications	24
Life Sciences Applications	24
TPO/Montmorillonite.....	24
Automotive Applications	24
EVA/Montmorillonite.....	24
Flame-retardant Applications.....	25
Polypropylene/Montmorillonite.....	25
Automotive Applications	25
Fire-retardant Applications.....	25
Other Applications	26
Polyethylene/Montmorillonite.....	26
Packaging Applications	26

Automotive Applications	26
Acetal/Montmorillonite	26
Nylon/Mica Fluoride	26
Automotive Applications	27
Butyl/Vermiculite.....	27
Consumer Products Applications.....	27
Other Applications.....	27
Other Polymer/Clay Nanocomposites under Development	27
<i>TABLE 2 OTHER CLAY NANOCOMPOSITES</i>	28
PET/Montmorillonite.....	28
EVOH/Montmorillonite	29
Other Matrix Materials/Vermiculite.....	29
Applications	29
<i>TABLE 3 PRINCIPAL APPLICATIONS OF CLAY CONTAINING COMPOSITES</i>	29
<i>TABLE 3 (CONTINUED)</i>	30
Automotive.....	30
Packaging.....	30
Healthcare.....	30
Consumer Products.....	31
Flame-retardants.....	31
Suppliers	31
<i>TABLE 4 CLAY NANOCOMPOSITE SUPPLIERS</i>	31
<i>TABLE 4 (CONTINUED)</i>	32
Suppliers (Continued).....	33
Suppliers (Continued).....	34
CERAMIC NANOCOMPOSITES	35
Materials.....	35
Ceramic Fillers.....	35
Silica	35
Alumina	36
Zirconia	36
Tungsten Carbide.....	36
Organosilicates.....	36
Matrix Materials.....	37
Polymer Matrix Materials	37
Polyurethane	37
Epoxy	37
Metals and Metal Oxides.....	38
Titanium Dioxide	38
Cobalt.....	38
Other Materials.....	38
Calcium Phosphate	38

	Fabrication	38
	Inorganic Moiety-Containing Monomers	39
	<i>In Situ</i> Fabrication of Ceramic Nanocomposite	
	Films	39
	Fabrication of WC/Co Nanocomposite Aggregates	39
	Types and Properties	40
TABLE 5	PROPERTIES AND MAIN APPLICATIONS FOR PRINCIPAL	
	TYPES OF CERAMIC-CONTAINING NANOCOMPOSITES	40
	Polyurethane/Alumina.....	40
	Titanium Dioxide/Alumina.....	41
	Alumina/Zirconia	41
	Epoxy/Carbon Fiber/Silica	41
	Polyurethane/Organosilica	41
	Cobalt/Tungsten Carbide.....	42
	Calcium Phosphate/Silica	42
	PET-Oxynitride.....	42
	Applications	43
TABLE 6	PRINCIPAL APPLICATIONS OF CERAMIC CONTAINING	
	COMPOSITES	43
	Coating Applications.....	43
	Floor Finishes.....	43
	Thermal Spray Coatings.....	44
	Window Coatings	44
	Life Sciences.....	45
	Hip Implants	45
	Artificial Spinal Disks.....	45
	Bone Replacements and Cements.....	46
	Consumer Products.....	46
	Tennis Racquets	46
	Other Applications	46
	Cutting Tools, Wear Parts	46
	Suppliers	46
TABLE 7	CERAMIC NANOCOMPOSITE SUPPLIERS	47
	CARBON NANOTUBE COMPOSITES	47
	Materials	48
	Fillers	48
	Carbon Nanotubes	48
	Fullerenes	48
	Carbon Nanofibers	48
	Matrix Materials.....	48
	Polymers.....	49
	Polycarbonate.....	49
	Polybutylene Terephthalate	49
	Polyphenyl Ether	49

Fabrication Technologies.....	50
Oriented Nanocomposite Extrusion Process.....	50
Layered Fabrication.....	50
CNT Fibers.....	51
Types of Carbon Nanotube Composites.....	51
<i>TABLE 8 PROPERTIES OF CARBON NANOTUBE COMPOSITE.....</i>	<i>51</i>
Nylon/MWNT Composites	52
Polycarbonate/MWNT Composites.....	52
Polyvinyl Alcohol/MWNT Composites	52
Polybutylene Terephthalate/MWNT Composites.....	52
Polyphenylene Ether/Polyamide/MWNT Composites	52
Epoxy/MWNT/Carbon Fiber Composites.....	53
Polyurethane/Fullerene Composites	53
MDMO-PPV/Fullerene	53
Applications	54
<i>TABLE 9 PRINCIPAL APPLICATIONS OF NANOTUBE COMPOSITES.....</i>	<i>54</i>
Automotive Components.....	54
Fuel System Components.....	54
Exterior Parts.....	55
ESD Applications	55
Consumer Products.....	55
Tennis Racquets.....	56
Golf Clubs	56
Bicycles	56
Bowling Balls.....	56
Boats	57
Other Sporting Goods	57
Textiles	57
Solar Cells	58
Suppliers	58
<i>TABLE 10 CARBON NANOTUBE COMPOSITE SUPPLIERS</i>	<i>58</i>
METAL-CONTAINING NANOCOMPOSITES	59
Hybrid Organic-Metal Photovoltaics	59
METAL OXIDE CONTAINING NANOCOMPOSITES.....	60
Magnetic Nanocomposites.....	60
NANOBIOCOMPOSITES.....	61
Materials.....	61
Fillers	61
Cellulose	61
Chitin.....	62
Matrix Materials.....	62
Polyvinyl Alcohol.....	62
Cellulose Esters.....	63

Polylactic Acid	63
Fabrication	64
Extracting Cellulose Nanofibers	64
Nanocomposite Materials Production	64
Types of Nanobiocomposites	64
Polyvinyl Alcohol/Cellulose Nanocomposites.....	64
Cotton/Clay Nanocomposite Fibers.....	65
PHAS/Clay/Cellulose Nanocomposites	65
Nano-Reinforced Poly(lactic acid)	65
Applications	66
Automotive Applications	66
Textile Applications	66
Other Applications	66
Manufacturers	67
OTHER TYPES OF NANOCOMPOSITES	67
Nanocomposite Fuel Cell Membranes	67
Materials	67
Types of Nanocomposite Fuel Cell Membranes.....	68
Applications.....	68
Energy Applications.....	68
Manufacturers.....	68
Photonic Band Gap Nanocomposites	68
Materials	69
Fabrication	69
Applications.....	70
Channel Add/Drop Filters	70
Optical Switches.....	71
Optical Amplifiers	71
Optical Modulators	72
Suppliers.....	72
Polyhedral Oligomeric Silsesquioxanes (POSS)-	
Containing Nanocomposites	72
Materials, Fabrication, and Nanocomposite	
Properties.....	72
Applications and Manufacturers.....	73
Biomedical Applications	73
Electronics Applications	73
Aerospace Applications.....	74
Hydrophobic/Oleophobic Nanocomposites	74
Materials, Fabrication, and Nanocomposite	
Properties.....	74
Applications and Manufacturers.....	75
Other Applications	75
CHAPTER FOUR: PATENT ANALYSIS	76

PATENTS AND PATENT APPLICATIONS BY TYPE OF NANOCOMPOSITE	76
<i>FIGURE 1 U.S. NANOCOMPOSITES PATENTS BY TYPE, THROUGH OCTOBER 12, 2011 (NO/%)</i>	76
PATENT TRENDS OVER TIME	77
<i>FIGURE 2 ANNUAL TRENDS IN U.S. NANOTECHNOLOGY PATENTS BY TECHNOLOGY TYPE, 1998–2010 (NO.)</i>	77
PATENT HOLDERS.....	78
INDIVIDUAL ENTITIES	78
<i>FIGURE 3 MAJOR NANOCOMPOSITE PATENT HOLDERS, AS OF OCT. 15, 2011 (NO./%)</i>	78
<i>FIGURE 3 (CONTINUED)</i>	79
COMMERCIAL VERSUS OTHER TYPES OF ASSIGNEES	79
<i>FIGURE 4 U.S. NANOCOMPOSITE PATENTS ISSUED SINCE 1976 BY ASSIGNEE TYPE (NO/%)</i>	79
<i>FIGURE 4 (CONTINUED)</i>	80
NATIONALITY OF ASSIGNEES.....	80
<i>FIGURE 5 ASSIGNEES BY COUNTRY, AS OF OCT. 15, 2011 (NO/%)</i>	80
<i>FIGURE 5 (CONTINUED)</i>	81
 CHAPTER FIVE: GLOBAL MARKET FOR NANOCOMPOSITES, 2010– 2016.....	82
SUMMARY.....	82
NANOCOMPOSITE CONSUMPTION BY COUNTRY/REGION	82
<i>TABLE 11 CONSUMPTION OF NANOCOMPOSITES BY COUNTRY/REGION, THROUGH 2016 (\$ MILLIONS)</i>	82
<i>FIGURE 6 TRENDS IN GLOBAL NANOCOMPOSITE CONSUMPTION, 2010–2016 (\$ MILLIONS)</i>	83
<i>FIGURE 7 GLOBAL NANOCOMPOSITE CONSUMPTION BY GEOGRAPHICAL MARKET, 2010 VERSUS 2016 (% OF TOTAL VALUE)</i>	84
NANOCOMPOSITE CONSUMPTION BY TYPE OF MATERIAL	85
<i>TABLE 12 GLOBAL CONSUMPTION OF NANOCOMPOSITES, THROUGH 2016 (TONS/\$ MILLIONS)</i>	85
<i>FIGURE 8 GLOBAL NANOCOMPOSITE CONSUMPTION BY TYPE, 2010 VERSUS 2016 (% OF TOTAL VALUE)</i>	86
<i>TABLE 13 NANOCOMPOSITES WITH THE LARGEST MARKETS, 2010 VS. 2016 (\$ MILLIONS/RANK)</i>	87
NANOCOMPOSITE CONSUMPTION BY TYPE OF APPLICATION	87
<i>FIGURE 9 GLOBAL NANOCOMPOSITE CONSUMPTION BY APPLICATION, 2010 VERSUS 2016 (\$ MILLIONS/%)</i>	88
<i>FIGURE 9 (CONTINUED)</i>	89

CHAPTER SIX: U.S. MARKET FOR NANOCOMPOSITES, 2010–2016.....	90
SUMMARY.....	90
TABLE 14 U.S. CONSUMPTION OF NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	90
FIGURE 10 TRENDS IN U.S. NANOCOMPOSITE CONSUMPTION, 2010–2016 (\$ MILLIONS).....	91
NANOCOMPOSITE CONSUMPTION BY TYPE OF MATERIAL.....	91
FIGURE 11 U.S. NANOCOMPOSITE CONSUMPTION BY TYPE, 2010 VS. 2016 (%).....	92
NANOCOMPOSITE CONSUMPTION BY TYPE OF APPLICATION.....	93
FIGURE 12 U.S. NANOCOMPOSITE CONSUMPTION BY APPLICATION, 2010 VS. 2016 (\$ MILLIONS/%).....	93
FIGURE 12 (CONTINUED).....	94
DETAILED MARKET PROJECTIONS.....	95
CLAY NANOCOMPOSITES.....	95
Summary.....	95
TABLE 15 U.S. SALES OF CLAY NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	95
FIGURE 13 U.S. CONSUMPTION OF CLAY-BASED NANOCOMPOSITES BY END USE, 2010 VERSUS 2016 (%/\$ MILLIONS).....	96
Nylon/Montmorillonite.....	97
FIGURE 14 U.S. NYLON/MONTMORILLONITE NANOCOMPOSITE CONSUMPTION, 2010 (MT/%).....	97
TABLE 16 U.S. MARKET FOR NYLON/MONTMORILLONITE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	98
Butyl/Vermiculite.....	98
EVA/Montmorillonite.....	99
TABLE 17 U.S. MARKET FOR EVA/MONTMORILLONITE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	100
Other Clay Nanocomposites.....	100
TABLE 18 U.S. MARKET FOR OTHER CLAY NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	100
CERAMIC NANOCOMPOSITES.....	101
Summary.....	101
TABLE 19 U.S. MARKET FOR CERAMIC NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	101
FIGURE 15 U.S. CONSUMPTION OF CERAMIC NANOCOMPOSITES BY END USE, 2010 VS. 2016 (%/\$ MILLIONS).....	102
Polyurethane/Alumina.....	103
TABLE 20 U.S. MARKET FOR POLYURETHANE/ALUMINA NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	103

Alumina/Titania	103
<i>TABLE 21 U.S. MARKET FOR ALUMINA/TITANIA NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	104
Calcium Phosphate/Silica.....	104
<i>TABLE 22 U.S. MARKET FOR CALCIUM PHOSPHATE/SILICA NANOCOMPOSITE BONE SUBSTITUTES, THROUGH 2016 (MT/\$ MILLIONS)</i>	105
Tungsten Carbide/Cobalt Nanocomposites.....	105
<i>TABLE 23 U.S. MARKET FOR TUNGSTEN CARBIDE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	106
CARBON NANOTUBE COMPOSITES	106
Summary.....	106
<i>TABLE 24 U.S. MARKET FOR CARBON NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	107
<i>FIGURE 16 U.S. MARKET FOR CARBON NANOTUBE-BASED COMPOSITES, 2010 VS. 2016 (\$ MILLIONS/%)</i>	108
Nylon/MWNT Nanocomposites	109
<i>FIGURE 17 U.S. AUTOMOTIVE MARKETS FOR NYLON/NANOTUBE COMPOSITES, 2010 (\$ MILLIONS/%)</i>	109
<i>TABLE 25 U.S. AUTOMOTIVE MARKET FOR NYLON/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	110
Polycarbonate/MWNT Nanocomposite	110
<i>TABLE 26 U.S. MARKET FOR POLYCARBONATE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	111
PBT/MWNT Nanocomposites.....	111
<i>TABLE 27 U.S. MARKET FOR POLYBUTYLENE TEREPHTHALATE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	111
PPE/MWNT Nanocomposites.....	111
<i>TABLE 28 U.S. MARKET FOR POLYPHENYLENE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	112
Epoxy/Carbon/MWNT Nanocomposites.....	112
<i>TABLE 29 U.S. MARKET FOR EPOXY/CARBON NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	113
PVOH/SWNT Composite Fiber	113
<i>TABLE 30 U.S. MARKET FOR PVOH/SWNT COMPOSITE FIBER, THROUGH 2016 (MT/\$ MILLIONS)</i>	114
METAL/METAL OXIDE CONTAINING NANOCOMPOSITES	114
Nanomagnetic Composites	114
<i>TABLE 31 U.S. MARKET FOR MAGNETIC NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	114
NANOBIOCOMPOSITES.....	115
Summary.....	115

<i>TABLE 32 U.S. CONSUMPTION OF NANOBIOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	115
<i>FIGURE 18 U.S. MARKET FOR NANOBIOCOMPOSITES BY APPLICATION, 2016 (\$ MILLIONS/%)</i>	116
PVOH-Cellulose Nanocomposites	116
<i>TABLE 33 U.S. MARKET FOR PVOH/CELLULOSE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	117
Cotton/Montmorillonite Nanocomposite Fiber	117
<i>TABLE 34 U.S. MARKET FOR COTTON/CLAY NANOCOMPOSITE FABRICS, THROUGH 2016 (MT/\$ MILLIONS)</i>	117
OTHER TYPES OF NANOCOMPOSITES	118
Summary.....	118
<i>TABLE 35 U.S. MARKET FOR OTHER NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	118
<i>FIGURE 19 U.S. MARKET FOR OTHER COMPOSITES, 2010 VS. 2016 (\$ MILLIONS/%)</i>	119
POSS-Containing Nanocomposites.....	120
<i>FIGURE 20 U.S. CONSUMPTION OF POSS-CONTAINING NANOCOMPOSITES, 2010 (\$ MILLIONS/%)</i>	120
<i>TABLE 36 U.S. MARKET FOR POSS-CONTAINING NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	121
Nanocomposite Fuel Cell Membranes	121
<i>TABLE 37 U.S. MARKET FOR NANOCOMPOSITE FUEL-CELL MEMBRANE, THROUGH 2016 (MT/\$ MILLIONS)</i>	122
Photonic Band Gap Nanocomposites	123
<i>TABLE 38 U.S. MARKET FOR PHOTONIC BAND GAP NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	124
 CHAPTER SEVEN: EUROPEAN MARKETS FOR NANOCOMPOSITES, 2010–2016.....	
SUMMARY.....	125
NANOCOMPOSITE CONSUMPTION BY TYPE OF MATERIAL	125
<i>TABLE 39 EUROPEAN CONSUMPTION OF NANOCOMPOSITES, THROUGH 2016 (\$ MILLIONS)</i>	125
<i>FIGURE 21 TRENDS IN EUROPEAN NANOCOMPOSITE CONSUMPTION, 2010–2016 (\$ MILLIONS)</i>	126
<i>FIGURE 22 EUROPEAN NANOCOMPOSITE CONSUMPTION BY TYPE, 2010 VS. 2016 (%)</i>	127
NANOCOMPOSITE CONSUMPTION BY TYPE OF APPLICATION	128
<i>FIGURE 23 EUROPEAN NANOCOMPOSITE CONSUMPTION BY APPLICATION, 2010 VS. 2016 (%)</i>	129
<i>FIGURE 23 (CONTINUED)</i>	130
DETAILED MARKET PROJECTIONS.....	130

CLAY NANOCOMPOSITES.....	130
TABLE 40 EUROPEAN MARKET FOR CLAY NANOCOMPOSITES, 2010–2016 (\$ MILLIONS).....	130
TABLE 40 (CONTINUED).....	131
FIGURE 24 EUROPEAN CONSUMPTION OF CLAY-BASED NANOCOMPOSITES BY END USE, 2010 VS. 2016 (\$ MILLIONS/%).....	131
FIGURE 24 (CONTINUED).....	132
Nylon/Montmorillonite	132
FIGURE 25 EUROPEAN NYLON/MONTMORILLONITE NANOCOMPOSITE CONSUMPTION, 2010 (MT/%)	133
TABLE 41 EUROPEAN MARKET FOR NYLON/MONTMORILLONITE NANOCOMPOSITES, THROUGH 2016 (\$ MILLIONS).....	134
EVA/Montmorillonite	134
TABLE 42 EUROPEAN MARKET FOR EVA/MONTMORILLONITE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	134
Other Clay Nanocomposites.....	135
TABLE 43 EUROPEAN MARKET FOR OTHER CLAY NANOCOMPOSITES, THROUGH 2016 (\$ MILLIONS).....	135
CERAMIC NANOCOMPOSITES.....	135
TABLE 44 EUROPEAN MARKET FOR CERAMIC NANOCOMPOSITES, THROUGH 2016 (\$ MILLIONS).....	136
FIGURE 26 EUROPEAN CONSUMPTION OF CERAMIC NANOCOMPOSITES BY END USE, 2010 VS. 2016 (\$ MILLIONS/%).....	137
Polyurethane/Alumina	138
TABLE 45 EUROPEAN MARKET FOR POLYURETHANE/ALUMINA NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	138
Alumina/Titania	138
TABLE 46 EUROPEAN MARKET FOR ALUMINA/TITANIA NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	139
Tungsten Carbide/Cobalt Nanocomposites.....	139
TABLE 47 EUROPEAN MARKET FOR TUNGSTEN CARBIDE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	139
CARBON NANOTUBE COMPOSITES	140
TABLE 48 EUROPEAN MARKET FOR CARBON NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS).....	140
FIGURE 27 EUROPEAN MARKET FOR CARBON NANOTUBE-BASED COMPOSITES, 2010 VS. 2016 (\$ MILLIONS/%).....	141
Nylon/MWNT Nanocomposites	142
FIGURE 28 EUROPEAN AUTOMOTIVE MARKETS FOR NYLON/NANOTUBE COMPOSITES, 2010 (\$ MILLIONS/%).....	142
TABLE 49 EUROPEAN AUTOMOTIVE MARKET FOR NYLON/NANOTUBE COMPOSITES, THROUGH 2016 (MT\$ MILLIONS).....	143
Polycarbonate/MWNT Nanocomposite	143

<i>TABLE 50 EUROPEAN MARKET FOR POLYCARBONATE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	144
PBT/MWNT Nanocomposites.....	144
<i>TABLE 51 EUROPEAN MARKET FOR POLYBUTYLENE TEREPHTHALATE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	144
PPE/MWNT Nanocomposites.....	144
<i>TABLE 52 EUROPEAN MARKET FOR POLYPHENYLENE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	145
PVOH/SWNT Composite Fiber	145
<i>TABLE 53 EUROPEAN MARKET FOR PVOH/SWNT COMPOSITE FIBER, THROUGH 2016 (MT/\$ MILLIONS)</i>	146
METAL/METAL OXIDE CONTAINING NANOCOMPOSITES	146
Nanomagnetic Composites	146
<i>TABLE 54 EUROPEAN MARKET FOR MAGNETIC NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	146
NANOBIOCOMPOSITES	146
<i>TABLE 55 EUROPEAN CONSUMPTION OF NANOBIOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	147
<i>FIGURE 29 EUROPEAN MARKET FOR NANOBIOCOMPOSITES BY APPLICATION, 2016 (\$ MILLIONS/%)</i>	147
<i>FIGURE 29 (CONTINUED)</i>	148
PVOH-Cellulose Nanocomposites	148
<i>TABLE 56 EUROPEAN MARKET FOR PVOH/CELLULOSE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	148
Cotton/Montmorillonite Nanocomposite Fiber.....	149
<i>TABLE 57 EUROPEAN MARKET FOR COTTON/CLAY NANOCOMPOSITE FABRICS, THROUGH 2016 (MT/\$ MILLIONS)</i>	149
OTHER TYPES OF NANOCOMPOSITES	149
<i>TABLE 58 EUROPEAN MARKET FOR OTHER NANOCOMPOSITES, 2010–2016 (MT/\$ MILLIONS)</i>	150
<i>FIGURE 30 EUROPEAN MARKET FOR OTHER COMPOSITES, 2010 VS. 2016 (\$ MILLIONS/%)</i>	151
Nanocomposite Fuel Cell Membranes	152
<i>TABLE 59 EUROPEAN MARKET FOR NANOCOMPOSITE FUEL-CELL MEMBRANE, THROUGH 2016 (MT/\$ MILLIONS)</i>	152
Photonic Band Gap Nanocomposites	152
<i>TABLE 60 EUROPEAN MARKET FOR PHOTONIC BAND GAP NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	153
Hydrophobic/Oleophobic Nanocomposites	153
<i>TABLE 61 EUROPEAN MARKET FOR HYDROPHOBIC/OLEOPHOBIC NANOCOMPOSITES, 2010–2016 (MT/\$ MILLIONS)</i>	154

CHAPTER EIGHT: ASIA-PACIFIC MARKETS FOR NANOCOMPOSITES, 2010–2016.....	155
SUMMARY.....	155
NANOCOMPOSITE CONSUMPTION BY TYPE OF MATERIAL	155
<i>TABLE 62 ASIA-PACIFIC CONSUMPTION OF NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	155
<i>FIGURE 31 TRENDS IN ASIA-PACIFIC NANOCOMPOSITE CONSUMPTION, 2010-2016 (\$ MILLIONS)</i>	156
<i>FIGURE 32 ASIA-PACIFIC NANOCOMPOSITE CONSUMPTION BY TYPE, 2010 VS. 2016 (% OF TOTAL VALUE)</i>	157
NANOCOMPOSITE CONSUMPTION BY TYPE OF APPLICATION	158
<i>FIGURE 33 ASIA-PACIFIC NANOCOMPOSITE CONSUMPTION BY APPLICATION, 2010 VS. 2016 (\$ MILLIONS/% OF TOTAL VALUE)</i>	159
<i>FIGURE 33 (CONTINUED)</i>	160
DETAILED MARKET PROJECTIONS.....	160
CLAY NANOCOMPOSITES.....	160
<i>TABLE 63 ASIA-PACIFIC MARKET FOR CLAY NANOCOMPOSITES, THROUGH 2016 (\$ MILLIONS)</i>	160
<i>TABLE 63 (CONTINUED)</i>	161
<i>FIGURE 34 ASIA-PACIFIC CONSUMPTION OF CLAY-BASED NANOCOMPOSITES BY END USE, 2010 VS. 2016 (%)</i>	161
<i>FIGURE 34 (CONTINUED)</i>	162
Nylon/Montmorillonite	162
<i>FIGURE 35 ASIA-PACIFIC NYLON/MONTMORILLONITE NANOCOMPOSITE CONSUMPTION, 2010 (% OF TOTAL TONNAGE)</i>	163
<i>TABLE 64 ASIA PACIFIC MARKET FOR NYLON/MONTMORILLONITE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	164
EVA/Montmorillonite	164
<i>TABLE 65 ASIA-PACIFIC MARKET FOR EVA/MONTMORILLONITE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	164
Other Clay Nanocomposites.....	164
<i>TABLE 66 ASIA-PACIFIC MARKET FOR OTHER CLAY NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	165
CERAMIC NANOCOMPOSITES.....	165
<i>TABLE 67 ASIA-PACIFIC MARKET FOR CERAMIC NANOCOMPOSITES, 2010–2016 (MT/\$ MILLIONS)</i>	166
<i>FIGURE 36 ASIA-PACIFIC CONSUMPTION OF CERAMIC NANOCOMPOSITES BY END USE, 2010 VS. 2016 (\$ MILLIONS/%)</i>	167
Polyurethane/Alumina	168

<i>TABLE 68 ASIA-PACIFIC MARKET FOR POLYURETHANE/ALUMINA NANOCOMPOSITES, THROUGH 2016 (MT/MILLIONS)</i>	168
Alumina/Titania	168
<i>TABLE 69 ASIA-PACIFIC CONSUMPTION OF ALUMINA/TITANIA NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	169
Tungsten Carbide/Cobalt Nanocomposites.....	169
<i>TABLE 70 ASIA-PACIFIC MARKET FOR TUNGSTEN CARBIDE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	169
CARBON NANOTUBE COMPOSITES	169
<i>TABLE 71 ASIA-PACIFIC MARKET FOR CARBON NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	170
<i>FIGURE 37 ASIA-PACIFIC MARKET FOR CARBON NANOTUBE- BASED COMPOSITES, 2010 VS. 2016 (\$ MILLIONS/%)</i>	171
Nylon/MWNT Nanocomposites	172
<i>FIGURE 38 ASIA-PACIFIC AUTOMOTIVE MARKETS FOR NYLON/NANOTUBE COMPOSITES, 2010 (\$ MILLIONS/%)</i>	172
<i>TABLE 72 ASIA-PACIFIC AUTOMOTIVE MARKET FOR NYLON/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	173
Polycarbonate/MWNT Nanocomposite	173
<i>TABLE 73 ASIA-PACIFIC MARKET FOR POLYCARBONATE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	174
PBT/MWNT Nanocomposites.....	174
<i>TABLE 74 ASIA-PACIFIC MARKET FOR POLYBUTYLENE TEREPHTHALATE/NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	174
PPE/MWNT Nanocomposites.....	174
<i>TABLE 75 ASIA-PACIFIC MARKET FOR POLYPHENYLENE/NANOTUBE COMPOSITES, THROUGH 2016 MT/\$ MILLIONS)</i>	175
Epoxy/Carbon/MWNT Nanocomposites.....	175
<i>TABLE 76 ASIA-PACIFIC MARKET FOR EPOXY/CARBON NANOTUBE COMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	176
Polyurethane/Fullerene Nanocomposites	176
<i>TABLE 77 ASIA-PACIFIC MARKET FOR POLYURETHANE/FULLERENE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	176
PVOH/SWNT Composite Fiber	177
<i>TABLE 78 ASIA-PACIFIC MARKET FOR PVOH/SWNT COMPOSITE FIBER, THROUGH 2016 (MT/\$ MILLIONS)</i>	177
METAL/METAL OXIDE CONTAINING NANOCOMPOSITES	177
Nanomagnetic Composites	177

<i>TABLE 79 ASIA-PACIFIC MARKET FOR MAGNETIC NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	178
<i>NANOBIOCOMPOSITES</i>	178
<i>TABLE 80 ASIA-PACIFIC CONSUMPTION OF NANOBIOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	178
<i>FIGURE 39 ASIA-PACIFIC MARKET FOR NANOBIOCOMPOSITES BY APPLICATION, 2016 (\$ MILLIONS/%)</i>	179
PVOH-Cellulose Nanocomposites	179
<i>TABLE 81 ASIA-PACIFIC MARKET FOR PVOH/CELLULOSE NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	180
Cotton/Montmorillonite Nanocomposite Fiber	180
<i>TABLE 82 ASIA-PACIFIC MARKET FOR COTTON/CLAY NANOCOMPOSITE FABRICS, THROUGH 2016 (\$ MILLIONS)</i>	180
OTHER TYPES OF NANOCOMPOSITES	180
<i>TABLE 83 ASIA-PACIFIC MARKET FOR OTHER NANOCOMPOSITES, 2010–2016 (\$ MILLIONS)</i>	181
<i>FIGURE 40 ASIA-PACIFIC MARKET FOR OTHER COMPOSITES, 2016 (\$ MILLIONS/%)</i>	182
Nanocomposite Fuel Cell Membranes	182
<i>TABLE 84 ASIA-PACIFIC MARKET FOR NANOCOMPOSITE FUEL-CELL MEMBRANE, THROUGH 2016 (MT/\$ MILLIONS)</i>	183
Photonic Band Gap Nanocomposites	183
<i>TABLE 85 ASIA-PACIFIC MARKET FOR PHOTONIC BAND GAP NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	184
 CHAPTER NINE: OTHER MARKETS FOR NANOCOMPOSITES, 2010–2016.....	185
SUMMARY	185
NANOCOMPOSITE CONSUMPTION BY TYPE OF MATERIAL	185
<i>TABLE 86 OTHER MARKETS CONSUMPTION OF NANOCOMPOSITES, THROUGH 2016 (MT/\$ MILLIONS)</i>	186
<i>FIGURE 41 TRENDS IN OTHER MARKETS NANOCOMPOSITE CONSUMPTION, 2010–2016 (\$ MILLIONS)</i>	186
<i>FIGURE 42 OTHER MARKETS NANOCOMPOSITE CONSUMPTION BY TYPE, 2010 VS. 2016 (%)</i>	187
<i>FIGURE 42 (CONTINUED)</i>	188
NANOCOMPOSITE CONSUMPTION BY TYPE OF APPLICATION	188
<i>FIGURE 43 OTHER MARKETS NANOCOMPOSITE CONSUMPTION BY APPLICATION, 2010 VS. 2016 (%)</i>	189
 CHAPTER TEN: THE NANOCOMPOSITES INDUSTRY.....	190
COMPANIES	190
MARKET SHARES.....	190

FIGURE 44 NANOCOMPOSITE MARKET SHARES, 2010 (\$ MILLIONS/%)..... 191

CHAPTER ELEVEN: COMPANY PROFILES.....	192
AGILENT TECHNOLOGIES.....	192
ALCOA CLOSURE SYSTEMS INTL.....	192
ALPS ELECTRIC CO., LTD.....	193
ALTAIR NANOTECHNOLOGIES, INC.....	193
AMERICAN BOWLING SERVICE, INC.....	193
BASELL POLYOLEFINS CO. N.V.....	194
BAYER AG.....	194
CLARIANT INTERNATIONAL AG.....	194
EASTON-BELL SPORTS, INC.....	194
E. I. DU PONT DE NEMOURS AND CO.....	195
ESPIN TECHNOLOGIES, INC.....	195
EVONIK DEGUSSA GMBH.....	196
FOSTER CORP.....	196
FRONTIER CARBON CORP.....	197
GENERAL MOTORS CORP.....	197
HOLMENKOL SPORT-TECHNOLOGIES GMBH.....	197
HONEYWELL INTL., INC.....	198
HYPERION CATALYSIS INTL., INC.....	198
INFRAMAT CORP.....	198
INMAT, LLC.....	199
KABELWERK EUPEN AG.....	200
LG CHEM.....	200
MITSUBISHI CHEMICAL CORP.....	201
NANOCOR, INC.....	201
NANOGATE TECHNOLOGIES GMBH.....	202
NANOEDGE.....	202
NANOSYS, INC.....	203
NEOMAX MATERIALS CO., LTD.....	203
NOBLE POLYMERS.....	203
PANASONIC CORP.....	204
PENTRON CLINICAL TECHNOLOGIES, LLC.....	204
POLYONE CORP.....	204
RTP CO.....	205
SABIC INNOVATIVE PLASTICS, LLC.....	205
SCIPERIO, INC.....	206
SHOWA DENKO K.K.....	206
SIM COMPOSITES, INC.....	206
SOUTHERN CLAY PRODUCTS, INC.....	207
SOUTHWEST NANOTECHNOLOGIES, INC.....	207
SÜD-CHEMIE AG.....	208
UBE INDUSTRIES, LTD.....	208

UNITIKA, LTD.	208
VALSPAR CORP.	209
WILSON SPORTING GOODS CO.	209
ZYVEX CORP.	209
ZYVEX CORP. (CONTINUED)	210