

GLOBAL MARKETS AND TECHNOLOGIES FOR NANOFIBERS



NAN043C
May 2013

Margareth Gagliardi
Project Analyst

ISBN: 1-56965-418-2

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	2
STUDY GOALS AND OBJECTIVES	2
REASONS FOR DOING THIS STUDY	2
INTENDED AUDIENCE	3
SCOPE OF REPORT	4
METHODOLOGY AND INFORMATION SOURCES	5
RELATED BCC RESEARCH STUDIES	6
ANALYST CREDENTIALS	7
BCC ONLINE SERVICES	8
DISCLAIMER	8
CHAPTER 2 EXECUTIVE SUMMARY	10
<i>SUMMARY TABLE GLOBAL MARKET FOR NANOFIBER PRODUCTS, THROUGH 2017 (\$ MILLIONS)</i>	11
<i>SUMMARY FIGURE GLOBAL MARKET FOR NANOFIBER PRODUCTS, 2010-2017 (\$ MILLIONS)</i>	12
CHAPTER 3 OVERVIEW	14
NANOFIBERS AND THE NANOTECHNOLOGY INDUSTRY	14
NANOFIBERS	14
<i>TABLE 1 NANORODS, NANOFIBERS AND NANOWIRES</i>	14
THE NANOTECHNOLOGY INDUSTRY	14
<i>TABLE 2 THE NANOTECHNOLOGY INDUSTRY, 2013</i>	15
<i>TABLE 3 GLOBAL NANOTECHNOLOGY REVENUES BY SEGMENT, THROUGH 2017 (\$ BILLIONS)</i>	17
<i>FIGURE 1 GLOBAL NANOTECHNOLOGY MARKET SHARE BY SEGMENT, 2012 (%)</i>	17
MILESTONES IN THE HISTORY OF NANOFIBERS AND RECENT EVENTS	18
<i>TABLE 4 NANOFIBERS- TECHNOLOGICAL MILESTONES</i>	18
<i>FIGURE 2 WORLDWIDE NANOFIBER PATENT APPLICATIONS AND PATENTS ISSUED SINCE 1990</i>	18
CURRENT AND EMERGING APPLICATIONS FOR NANOFIBERS	20
ELECTRONICS	20
Established Applications	20
Semiconductor Devices	20
Optoelectronic Devices	20
Advanced Displays	21
Hard Disk Drives and Magnetic Devices	21
EMI Shielding and Anti-Static Products	21
Others	21
Emerging Applications	22
<i>TABLE 5 NANOFIBER APPLICATIONS IN ELECTRONICS, 2013</i>	23
MECHANICAL/CHEMICAL	23
Established Applications	23
Filtration and Separation	24
Catalysts and Photocatalysts	24
Reinforcing Agents and Adhesives	24

TOPIC	PAGE NO.
Dispersing Agents	24
Others	25
Emerging Applications	25
<i>TABLE 6 NANOFIBER APPLICATIONS IN THE MECHANICAL/ CHEMICAL SEGMENT, 2013</i>	26
SENSORS AND INSTRUMENTATION	26
Established Applications	26
Sensors	26
Instrumentation	26
Others	27
Emerging Applications	27
<i>TABLE 7 NANOFIBER APPLICATIONS FOR SENSORS AND INSTRUMENTATION, 2013</i>	27
ENERGY	28
Established Applications	28
Batteries	28
Electrochemical Capacitors	28
Fuel Cells	28
Photovoltaic Cells	28
Others	29
Emerging Applications	29
<i>TABLE 8 NANOFIBER APPLICATIONS IN THE ENERGY SEGMENT, 2013</i>	29
MEDICAL/BIOLOGICAL/PHARMACEUTICAL	29
Established Applications	29
Tissue Engineering	30
Surgical Treatments, Wound Treatments, Drug Delivery Systems and Pharmaceuticals	30
Cellular Membranes	30
Others	30
Emerging Applications	31
<i>TABLE 9 NANOFIBER APPLICATIONS IN THE MEDICAL, BIOLOGICAL AND PHARMACEUTICAL SEGMENT, 2013</i>	31
AUTOMOTIVE AND AEROSPACE	32
Established Applications	32
Lightweight and High-Strength Parts	32
Antistatic Components and Conductive Paints	32
Others	32
Emerging Applications	32
<i>TABLE 10 NANOFIBER APPLICATIONS IN THE AUTOMOTIVE AND AEROSPACE SEGMENT, 2013</i>	33
THERMAL AND ACOUSTIC INSULATION	33
Established Applications	33
Residential, Commercial and Industrial Thermal Insulation	33
Acoustic Panels	33
Emerging Applications	33
<i>TABLE 11 NANOFIBER APPLICATIONS FOR THERMAL AND ACOUSTIC INSULATION, 2013</i>	34
CONSUMER	34
Established Applications	34

TOPIC	PAGE NO.
Textiles	34
Absorbent Articles	34
Others	34
Emerging Applications	34
<i>TABLE 12 NANOFIBER APPLICATIONS IN THE CONSUMER SEGMENT, 2013</i>	35
DEFENSE AND SECURITY	35
Established Applications	35
Anticounterfeiting Products	35
Chemical and Biological Warfare	35
Lightweight Protective Clothing	36
Others	36
Emerging Applications	36
<i>TABLE 13 NANOFIBER APPLICATIONS IN THE DEFENSE AND SECURITY SEGMENT, 2013</i>	36
OTHER APPLICATIONS	37
Established Applications	37
Emerging Applications	37
CHAPTER 4 NANOFIBER TECHNOLOGY	39
INTRODUCTION	39
NANOFIBER MATERIALS	39
MATERIAL TYPES	39
<i>TABLE 14 NANOFIBER MATERIALS, 2013</i>	40
Trends Related to Polymeric Nanofibers	43
Trends Related to Ceramic Nanofibers	43
Trends Related to Composite Nanofibers	44
LATEST TECHNOLOGICAL DEVELOPMENTS, 2010 TO PRESENT	44
Polysulfone/Poly(N-vinyl lactam) Alloys	44
Carbon/Lithium Nanofibers	45
Composite Polymeric/Bimetallic Nanofibers	45
Surface-Modified Polymeric Nanofibers	45
PRODUCTION METHODS	46
<i>TABLE 15 TRADITIONAL NANOFIBER FABRICATION METHODS, 2013</i>	47
LATEST TECHNOLOGICAL DEVELOPMENTS, 2010 TO PRESENT	48
Self-Assembled Plastic Nanofibers	48
Bowl Electrospinning	48
Rotary Spinning	49
APPLICATIONS OF NANOFIBERS BY MATERIAL TYPE	49
POLYMERIC NANOFIBERS	49
<i>TABLE 16 APPLICATIONS FOR POLYMERIC NANOFIBERS BY SEGMENT, 2013</i>	50
CARBON NANOFIBERS	51
<i>TABLE 17 APPLICATIONS FOR CARBON NANOFIBERS BY SEGMENT, 2013</i>	52
CERAMIC NANOFIBERS	53
<i>TABLE 18 APPLICATIONS FOR CERAMIC NANOFIBERS BY SEGMENT, 2013</i>	54
GLASS NANOFIBERS	54
<i>TABLE 19 APPLICATIONS FOR GLASS NANOFIBERS BY SEGMENT, 2013</i>	55
METALLIC NANOFIBERS	55
<i>TABLE 20 APPLICATIONS FOR METALLIC NANOFIBERS BY SEGMENT, 2013</i>	56

TOPIC	PAGE NO.
COMPOSITE NANOFIBERS	56
<i>TABLE 21 APPLICATIONS FOR COMPOSITE NANOFIBERS BY SEGMENT, 2013</i>	57
OTHER RELEVANT R&D ACTIVITIES	57
<i>TABLE 22 OTHER RELEVANT R & D ACTIVITIES, 2013</i>	58
CHAPTER 5 GLOBAL MARKETS	60
ANALYSIS OUTLINE	60
GLOBAL MARKET SUMMARY	60
<i>TABLE 23 GLOBAL MARKET FOR NANOFIBER PRODUCTS, THROUGH 2017 (\$ MILLIONS)</i>	62
<i>FIGURE 3 GLOBAL MARKET FOR NANOFIBER PRODUCTS, 2010-2017 (\$ MILLIONS)</i>	62
CURRENT MARKET STATUS	62
CURRENT MARKET SUMMARY	63
<i>TABLE 24 GLOBAL MARKET FOR NANOFIBER PRODUCTS, THROUGH 2012 (\$ MILLIONS)</i>	63
<i>FIGURE 4 GLOBAL MARKET FOR NANOFIBER PRODUCTS, 2010-2012 (\$ MILLIONS)</i>	63
REVENUES BY MATERIAL TYPE	63
<i>TABLE 25 GLOBAL NANOFIBER REVENUES BY MATERIAL TYPE, THROUGH 2012 (\$ MILLIONS)</i>	64
<i>FIGURE 5 GLOBAL NANOFIBER MARKET SHARE BY TYPE, 2012 (%)</i>	64
REVENUES BY APPLICATION	65
<i>TABLE 26 GLOBAL NANOFIBER REVENUES BY APPLICATION, THROUGH 2012 (\$ MILLIONS)</i>	66
<i>FIGURE 6 GLOBAL NANOFIBER MARKET SHARE BY APPLICATION, 2012 (%)</i>	66
REVENUES BY REGION	67
<i>TABLE 27 NANOFIBER REVENUES BY REGION, THROUGH 2012 (\$ MILLIONS)</i>	68
<i>FIGURE 7 NANOFIBER MARKET SHARE BY REGION, 2012 (%)</i>	69
MARKET GROWTH TRENDS	69
INDUSTRY GROWTH AND TECHNOLOGICAL TRENDS	69
Mechanical/Chemical	70
Filtration and Separation	70
<i>TABLE 28 GLOBAL FILTRATION REVENUES, THROUGH 2017 (\$ MILLIONS)</i>	70
Chemical Additives	71
Catalysts	71
<i>TABLE 29 GLOBAL CATALYSTS AND PHOTOCATALYSTS REVENUES, THROUGH 2017 (\$ MILLIONS)</i>	72
Electronics	72
Semiconductors and Circuit Devices	73
<i>TABLE 30 SEMICONDUCTORS REVENUES BY REGION, THROUGH 2017 (\$ BILLIONS)</i>	73
MEMS and NEMS	73
<i>TABLE 31 GLOBAL MEMS AND NEMS REVENUES BY TYPE, THROUGH 2017 (\$ BILLIONS)</i>	74
Flexible Printed Circuits	74
Advanced Displays	75
<i>TABLE 32 ADVANCED DISPLAYS GLOBAL REVENUES BY TYPE, THROUGH 2017 (\$ BILLIONS)</i>	75
Paper-thin and Flexible Displays	76
Hard Disk Drives	77

TOPIC	PAGE NO.
<i>TABLE 33 HARD DISK DRIVES GLOBAL PRODUCTION BY TYPE, THROUGH 2017 (MILLION UNITS)</i>	77
Optical Waveguides	77
<i>TABLE 34 OPTICAL FIBER MARKET, THROUGH 2017 (\$ MILLIONS/MILLIONS OF KILOMETERS)</i>	78
Energy	78
Batteries	78
Fuel Cells	78
<i>TABLE 35 GLOBAL FUEL CELLS REVENUES BY TYPE, THROUGH 2017 (\$ MILLIONS)</i>	79
Supercapacitors	79
Energy-Harvesting Devices	79
Consumer	80
Medical/Biological/Pharmaceutical	80
Tissue Engineering Scaffolds	80
Wound Treatment Products and Biomembranes	80
Automotive and Aerospace	81
<i>TABLE 36 GLOBAL LIGHTWEIGHT MATERIALS AND COMPOSITES FOR TRANSPORTATION REVENUES, THROUGH 2017 (\$ BILLIONS)</i>	81
<i>TABLE 37 GLOBAL AEROSPACE REVENUES BY REGION, THROUGH 2017 (\$ BILLIONS)</i>	82
Other Industry Sectors	82
UNIT PRICE TRENDS	82
REGIONAL TRENDS	82
MARKET FORECAST	83
REVENUES BY MATERIAL TYPE	83
<i>TABLE 38 GLOBAL NANOFIBER PRODUCTS REVENUES BY MATERIAL TYPE, THROUGH 2017 (\$ MILLIONS)</i>	84
<i>FIGURE 8 GLOBAL NANOFIBER PRODUCTS MARKET SHARE BY TYPE, 2017 (%)</i>	84
REVENUES BY APPLICATION	85
<i>TABLE 39 GLOBAL NANOFIBER PRODUCTS REVENUES BY APPLICATION, THROUGH 2017 (\$ MILLIONS)</i>	86
<i>FIGURE 9 GLOBAL NANOFIBER PRODUCTS MARKET SHARE BY APPLICATION, 2017 (%)</i>	86
REVENUES BY REGION	87
<i>TABLE 40 NANOFIBER PRODUCTS REVENUES BY REGION, THROUGH 2017 (\$ MILLIONS)</i>	88
<i>FIGURE 10 NANOFIBER PRODUCTS MARKET SHARE BY REGION, 2017 (%)</i>	88
CHAPTER 6 GLOBAL INDUSTRY STRUCTURE	90
LEADING SUPPLIERS OF NANOFIBER PRODUCTS	90
<i>TABLE 41 LEADING SUPPLIERS OF NANOFIBER PRODUCTS, 2013</i>	90
<i>TABLE 42 LEADING SUPPLIERS OF NANOFIBER PRODUCT BY MATERIAL, 2013</i>	93
<i>TABLE 43 LEADING SUPPLIERS OF NANOFIBER PRODUCTS, BY MATERIAL AND REGION, 2013</i>	95
OTHER PLAYERS IN THE NANOFIBER INDUSTRY	95
<i>TABLE 44 OTHER RELEVANT INDUSTRY PLAYERS, 2013</i>	96
COMPANY PROFILES	97
APPLIED SCIENCES	97
ARGONIDE	98

TOPIC	PAGE NO.
ASAHI KASEI	99
CATALYTIC MATERIALS	100
DAICEL FINECHEM	101
DONALDSON	101
DU PONT DE NEMOURS	103
ESPIN TECHNOLOGIES	104
FINETEX ENE	104
GE ENERGY	106
GRUPO ANTOLIN	106
HOLLINGSWORTH & VOSE	107
JAPAN VILENE	108
JOHNS MANVILLE	108
NANOVAL	109
READE	109
SHOWA DENKO	110
TEIJIN	111
TORAY INDUSTRIES	113
WOOREE NANOPHIL	114
CHAPTER 7 U.S. PATENT ANALYSIS	116
INTRODUCTION	116
SUMMARY OF PATENTS AWARDED FROM 2010 THROUGH 2012	116
TABLE 45 U.S. NANOFIBER PATENTS, 2012	117
TABLE 46 U.S. NANOFIBER PATENTS, 2011	122
TABLE 47 U.S. NANOFIBER PATENTS, 2010	127
GENERAL TRENDS	129
TABLE 48 U.S. NANOFIBER PATENT TRENDS, 2000-2012	129
FIGURE 11 U.S. NANOFIBER PATENT TRENDS, 2000-2012 (NUMBER OF PATENTS)	129
TRENDS BY COUNTRY AND REGION	130
FIGURE 12 SHARES OF U.S. NANOFIBER PATENTS BY REGION, 2010-2012 (%)	131
FIGURE 13 NANOFIBER PATENTS BY COUNTRY, 2010-2012 (NUMBER)	132
TRENDS BY ASSIGNEE	132
TABLE 49 ASSIGNEES OF U.S. NANOFIBER PATENTS, 2010-2012	133
FIGURE 14 SHARES OF U.S. NANOFIBER PATENTS BY ORGANIZATION TYPE, 2010-2012 (%)	136
TRENDS BY PATENT CATEGORY	137
FIGURE 15 SHARES OF U.S. NANOFIBER PATENTS BY CATEGORY, 2010-2012 (%)	137
TRENDS BY APPLICATION	138
FIGURE 16 SHARES OF U.S. NANOFIBER PATENTS BY APPLICATION, 2010-2012 (%)	139
TRENDS BY MATERIAL	140
FIGURE 17 SHARES OF U.S. NANOFIBER PATENTS BY MATERIAL TYPE, 2010-2012 (%)	141

LIST OF TABLES

TABLE HEADING	PAGE NO.
SUMMARY TABLE GLOBAL MARKET FOR NANOFIBER PRODUCTS, THROUGH 2017 (\$ MILLIONS)	11
TABLE 1 NANORODS, NANOFIBERS AND NANOWIRES	14
TABLE 2 THE NANOTECHNOLOGY INDUSTRY, 2013	15
TABLE 3 GLOBAL NANOTECHNOLOGY REVENUES BY SEGMENT, THROUGH 2017 (\$ BILLIONS)	17
TABLE 4 NANOFIBERS- TECHNOLOGICAL MILESTONES	18
TABLE 5 NANOFIBER APPLICATIONS IN ELECTRONICS, 2013	23
TABLE 6 NANOFIBER APPLICATIONS IN THE MECHANICAL/ CHEMICAL SEGMENT, 2013	26
TABLE 7 NANOFIBER APPLICATIONS FOR SENSORS AND INSTRUMENTATION, 2013	27
TABLE 8 NANOFIBER APPLICATIONS IN THE ENERGY SEGMENT, 2013	29
TABLE 9 NANOFIBER APPLICATIONS IN THE MEDICAL, BIOLOGICAL AND PHARMACEUTICAL SEGMENT, 2013	31
TABLE 10 NANOFIBER APPLICATIONS IN THE AUTOMOTIVE AND AEROSPACE SEGMENT, 2013	33
TABLE 11 NANOFIBER APPLICATIONS FOR THERMAL AND ACOUSTIC INSULATION, 2013	34
TABLE 12 NANOFIBER APPLICATIONS IN THE CONSUMER SEGMENT, 2013	35
TABLE 13 NANOFIBER APPLICATIONS IN THE DEFENSE AND SECURITY SEGMENT, 2013	36
TABLE 14 NANOFIBER MATERIALS, 2013	40
TABLE 15 TRADITIONAL NANOFIBER FABRICATION METHODS, 2013	47
TABLE 16 APPLICATIONS FOR POLYMERIC NANOFIBERS BY SEGMENT, 2013	50
TABLE 17 APPLICATIONS FOR CARBON NANOFIBERS BY SEGMENT, 2013	52
TABLE 18 APPLICATIONS FOR CERAMIC NANOFIBERS BY SEGMENT, 2013	54
TABLE 19 APPLICATIONS FOR GLASS NANOFIBERS BY SEGMENT, 2013	55
TABLE 20 APPLICATIONS FOR METALLIC NANOFIBERS BY SEGMENT, 2013	56
TABLE 21 APPLICATIONS FOR COMPOSITE NANOFIBERS BY SEGMENT, 2013	57
TABLE 22 OTHER RELEVANT R &D ACTIVITIES, 2013	58
TABLE 23 GLOBAL MARKET FOR NANOFIBER PRODUCTS, THROUGH 2017 (\$ MILLIONS)	62
TABLE 24 GLOBAL MARKET FOR NANOFIBER PRODUCTS, THROUGH 2012 (\$ MILLIONS)	63
TABLE 25 GLOBAL NANOFIBER REVENUES BY MATERIAL TYPE, THROUGH 2012 (\$ MILLIONS)	64
TABLE 26 GLOBAL NANOFIBER REVENUES BY APPLICATION, THROUGH 2012 (\$ MILLIONS)	66
TABLE 27 NANOFIBER REVENUES BY REGION, THROUGH 2012 (\$ MILLIONS)	68
TABLE 28 GLOBAL FILTRATION REVENUES, THROUGH 2017 (\$ MILLIONS)	70
TABLE 29 GLOBAL CATALYSTS AND PHOTOCATALYSTS REVENUES, THROUGH 2017 (\$ MILLIONS)	72
TABLE 30 SEMICONDUCTORS REVENUES BY REGION, THROUGH 2017 (\$ BILLIONS)	73
TABLE 31 GLOBAL MEMS AND NEMS REVENUES BY TYPE, THROUGH 2017 (\$ BILLIONS)	74
TABLE 32 ADVANCED DISPLAYS GLOBAL REVENUES BY TYPE, THROUGH 2017 (\$ BILLIONS)	75
TABLE 33 HARD DISK DRIVES GLOBAL PRODUCTION BY TYPE, THROUGH 2017 (MILLION UNITS)	77

TABLE HEADING	PAGE NO.
TABLE 34 OPTICAL FIBER MARKET, THROUGH 2017 (\$ MILLIONS/MILLIONS OF KILOMETERS)	78
TABLE 35 GLOBAL FUEL CELLS REVENUES BY TYPE, THROUGH 2017 (\$ MILLIONS)	79
TABLE 36 GLOBAL LIGHTWEIGHT MATERIALS AND COMPOSITES FOR TRANSPORTATION REVENUES, THROUGH 2017 (\$ BILLIONS)	81
TABLE 37 GLOBAL AEROSPACE REVENUES BY REGION, THROUGH 2017 (\$ BILLIONS)	82
TABLE 38 GLOBAL NANOFIBER PRODUCTS REVENUES BY MATERIAL TYPE, THROUGH 2017 (\$ MILLIONS)	84
TABLE 39 GLOBAL NANOFIBER PRODUCTS REVENUES BY APPLICATION, THROUGH 2017 (\$ MILLIONS)	86
TABLE 40 NANOFIBER PRODUCTS REVENUES BY REGION, THROUGH 2017 (\$ MILLIONS)	88
TABLE 41 LEADING SUPPLIERS OF NANOFIBER PRODUCTS, 2013	90
TABLE 42 LEADING SUPPLIERS OF NANOFIBER PRODUCT BY MATERIAL, 2013	93
TABLE 43 LEADING SUPPLIERS OF NANOFIBER PRODUCTS, BY MATERIAL AND REGION, 2013	95
TABLE 44 OTHER RELEVANT INDUSTRY PLAYERS, 2013	96
TABLE 45 U.S. NANOFIBER PATENTS, 2012	117
TABLE 46 U.S. NANOFIBER PATENTS, 2011	122
TABLE 47 U.S. NANOFIBER PATENTS, 2010	127
TABLE 48 U.S. NANOFIBER PATENT TRENDS, 2000-2012	129
TABLE 49 ASSIGNEES OF U.S. NANOFIBER PATENTS, 2010-2012	133

LIST OF FIGURES

FIGURE TITLE	PAGE NO.
SUMMARY FIGURE GLOBAL MARKET FOR NANOFIBER PRODUCTS, 2010-2017 (\$ MILLIONS)	12
FIGURE 1 GLOBAL NANOTECHNOLOGY MARKET SHARE BY SEGMENT, 2012 (%)	17
FIGURE 2 WORLDWIDE NANOFIBER PATENT APPLICATIONS AND PATENTS ISSUED SINCE 1990	18
FIGURE 3 GLOBAL MARKET FOR NANOFIBER PRODUCTS, 2010-2017 (\$ MILLIONS)	62
FIGURE 4 GLOBAL MARKET FOR NANOFIBER PRODUCTS, 2010-2012 (\$ MILLIONS)	63
FIGURE 5 GLOBAL NANOFIBER MARKET SHARE BY TYPE, 2012 (%)	64
FIGURE 6 GLOBAL NANOFIBER MARKET SHARE BY APPLICATION, 2012 (%)	66
FIGURE 7 NANOFIBER MARKET SHARE BY REGION, 2012 (%)	69
FIGURE 8 GLOBAL NANOFIBER PRODUCTS MARKET SHARE BY TYPE, 2017 (%)	84
FIGURE 9 GLOBAL NANOFIBER PRODUCTS MARKET SHARE BY APPLICATION, 2017 (%)	86
FIGURE 10 NANOFIBER PRODUCTS MARKET SHARE BY REGION, 2017 (%)	88
FIGURE 11 U.S. NANOFIBER PATENT TRENDS, 2000-2012 (NUMBER OF PATENTS)	129
FIGURE 12 SHARES OF U.S. NANOFIBER PATENTS BY REGION, 2010-2012 (%)	131
FIGURE 13 NANOFIBER PATENTS BY COUNTRY, 2010-2012 (NUMBER)	132
FIGURE 14 SHARES OF U.S. NANOFIBER PATENTS BY ORGANIZATION TYPE, 2010-2012 (%)	136
FIGURE 15 SHARES OF U.S. NANOFIBER PATENTS BY CATEGORY, 2010-2012 (%)	137
FIGURE 16 SHARES OF U.S. NANOFIBER PATENTS BY APPLICATION, 2010-2012 (%)	139
FIGURE 17 SHARES OF U.S. NANOFIBER PATENTS BY MATERIAL TYPE, 2010-2012 (%)	141