

CHAPTER ONE: INTRODUCTION.....	1
STUDY GOALS AND OBJECTIVES.....	1
REASONS FOR DOING THE STUDY	2
SCOPE OF THE REPORT	3
INTENDED AUDIENCE.....	4
METHODOLOGY AND INFORMATION SOURCES.....	4
ABOUT THE AUTHOR.....	5
BCC ONLINE SERVICES.....	5
DISCLAIMER	6
 CHAPTER TWO: SUMMARY.....	 7
<i>SUMMARY TABLE A GLOBAL MARKET FOR DIELECTRICS AND SUBSTRATES TO SEMICONDUCTOR FOUNDRIES AND IDMS, THROUGH 2014 (\$ MILLIONS)</i>	 7
<i>SUMMARY FIGURE GLOBAL MARKET FOR DIELECTRICS AND SUBSTRATES TO SEMICONDUCTOR FOUNDRIES AND IDMS, 2007-2014 (\$ MILLIONS)</i>	 7
<i>SUMMARY TABLE B GLOBAL DIELECTRICS MARKET SHARE IN SALES BY MATERIAL TYPE, 2007–2014 (%)</i>	 8
<i>SUMMARY TABLE C GLOBAL DIELECTRICS MARKET SHARE IN KGS BY MATERIAL TYPE, 2007–2014 (%)</i>	 9
<i>SUMMARY TABLE D GLOBAL SUBSTRATES MARKET SHARE IN VALUE SALES BY MATERIAL TYPE, 2007–2014 (%)</i>	 9
<i>SUMMARY TABLE E GLOBAL SUBSTRATES MARKET SHARE IN MSI BY MATERIAL TYPE, 2007–2014 (%)</i>	 10
 CHAPTER THREE: OVERVIEW	 11
THE STATE OF THE ART IN SUBSTRATES AND DIELECTRICS.....	11
<i>TABLE 1 GLOBAL MARKET FOR DIELECTRICS AND SUBSTRATES TO SEMICONDUCTOR FOUNDRIES AND IDMS, BY VOLUME, THROUGH 2014 (KG MILLIONS / MSI)</i>	 12
INTRODUCTION TO END-USE APPLICATION MARKETS.....	12
TELECOMMUNICATIONS DEVICES.....	12
COMPUTING DEVICES	12
CONSUMER ELECTRONIC DEVICES	13
INDUSTRIAL, SCIENTIFIC, AND OTHER DEVICES.....	13
<i>TABLE 2 GLOBAL DIELECTRICS AND SUBSTRATES MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	 13
<i>TABLE 3 GLOBAL DIELECTRICS AND SUBSTRATES MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS)</i>	 14
THE CHEMISTRY OF SEMICONDUCTORS	14
SEMICONDUCTORS AND THE PERIODIC TABLE	14
THE CARBON FAMILY	15
What Makes Semiconductors Different?	15
Silicon and Other Semiconductors.....	16

THE TITANIUM FAMILY	16
THE BORON FAMILY	17
SOME IMPORTANT DEFINITIONS	17
GATE DEFINITION METHODOLOGY	17
Transistor-Transistor Logic (TTL).....	17
CMOS	18
Field Effect Transistor (FET).....	18
MISFET/MOSFET.....	18
BiCMOS	18
Metal Semiconductor Field Effect Transistor (MESFET)	19
High Electron Mobility Transistor (HEMT).....	19
Hetero-Junction Bipolar Transistor (HBT)	19
FABRICATION PROCESSES	19
Rapid Thermal Processing (RTP).....	20
Chemical Mechanical Planarization (CMP)	20
Damascening.....	20
OTHER ALLIED DEFINITIONS	20
Double Data Rate (DDR)-Synchronous Dynamic Random Access Memory (SDRAM)	20
Design for Manufacturability (DFM).....	21
Design for Test (DFT).....	21
Dynamic Random Access Memory (DRAM)	21
Design Rule Check (DRC)	21
Electronic Design Automation (EDA).....	21
International Technology Roadmap for Semiconductors (ITRS).....	22
THE MECHANICS OF SEMICONDUCTORS.....	23
ELECTRONIC DEVICE MANUFACTURING PROCESS	23
<i>FIGURE 1 ELECTRONIC DEVICE MANUFACTURING PROCESS</i> <i>FLOW.....</i>	24
ELECTRONIC DEVICE MANUFACTURING ...CONTINUED/	25
DIELECTRICS.....	26
MARKET METRICS	26
<i>TABLE 4 GLOBAL DIELECTRICS MARKET BY END-USE</i> <i>APPLICATION, THROUGH 2014 (\$ MILLIONS).....</i>	26
<i>FIGURE 2 GLOBAL DIELECTRICS MARKET BY END-USE</i> <i>APPLICATION, 2007-2014 (\$ MILLIONS).....</i>	27
<i>TABLE 5 GLOBAL MARKET VOLUME FOR DIELECTRICS BY END-</i> <i>USE APPLICATION, THROUGH 2014 (KG MILLIONS)</i>	27
<i>TABLE 6 GLOBAL DIELECTRICS MARKET BY GEOGRAPHICAL</i> <i>REGION, THROUGH 2014 (\$ MILLIONS)</i>	28
<i>FIGURE 2 GLOBAL DIELECTRICS MARKET BY GEOGRAPHICAL</i> <i>REGION, 2007-2014 (\$ MILLIONS).....</i>	28

<i>TABLE 7 GLOBAL MARKET VOLUME FOR DIELECTRICS BY GEOGRAPHICAL REGION, THROUGH 2014 (KG MILLIONS)</i>	29
DEFINITION AND OPERATING PRINCIPLES	29
Definition and Operating Principles (Continued)	30
USE CASES IN SEMICONDUCTOR MANUFACTURING	31
Interconnects	31
Gates	31
Memory	32
PREVALENT DOMINANT METHODOLOGY	32
SUBSTRATES.....	33
MARKET METRICS	33
<i>TABLE 8 GLOBAL SUBSTRATES MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	34
<i>FIGURE 3 GLOBAL SUBSTRATES MARKET BY END-USE APPLICATION, 2007-2014 (\$ MILLIONS)</i>	34
<i>TABLE 9 GLOBAL MARKET VOLUME OF SUBSTRATES BY END-USE APPLICATION, THROUGH 2014 (MSI)</i>	35
<i>TABLE 10 GLOBAL SUBSTRATES MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS)</i>	35
<i>FIGURE 4 GLOBAL SUBSTRATES MARKET BY GEOGRAPHICAL REGION, 2007-2014 (\$ MILLIONS)</i>	36
<i>TABLE 11 GLOBAL MARKET VOLUME OF SUBSTRATES BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI)</i>	36
DEFINITIONS AND OPERATING PRINCIPLES.....	37
Clarification on Packaging Substrates	37
USE CASES IN SEMICONDUCTOR MANUFACTURING	38
The Dielectric-Substrate Interplay in SOI	39
The Dielectric-Substrate ... (Continued)	40
PREVALENT DOMINANT METHODOLOGY	41
Revisiting Wafers	41
Revisiting Wafers (Continued)	42
Revisiting Wafers (Continued)	43
 CHAPTER FOUR: CHALLENGES AND NEW APPROACHES IN DIELECTRICS AND SUBSTRATES	 44
DIELECTRICS.....	44
MARKET METRICS FOR SILICON DIOXIDE	44
<i>TABLE 12 GLOBAL VALUE AND VOLUME SALES OF SILICON DIOXIDE TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/KG MILLIONS)</i>	45
<i>TABLE 13 GLOBAL SILICON DIOXIDE SALES BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	45
<i>TABLE 14 GLOBAL VOLUME SALES OF SILICON DIOXIDE BY END-USE APPLICATION, THROUGH 2014 (KG MILLIONS)</i>	46
CHALLENGES.....	46

Electrical Leakages	46
High-Speed Operations	47
Power Consumption Considerations.....	47
Decreasing Form Factors	47
IMPLICATIONS FOR DIELECTRICS	47
Modifications in Deposition Processes.....	48
ALTERNATIVE APPROACHES – THE HIGH-K AND THE	
LOW-K DIELECTRICS	49
Market Metrics for High-k and Low-k Dielectrics –	
Salient Trends	49
Overview of Alternative Approaches	50
High-k Dielectrics	50
High-k Dielectrics (Continued).....	51
High-k Dielectrics (Continued).....	52
Low-k Dielectrics	53
Low-k Dielectrics (Continued).....	54
ALTERNATIVE HIGH-K MATERIALS	55
Market Metrics for High-k Dielectrics.....	55
<i>TABLE 15 GLOBAL VALUE AND VOLUME SALES OF HIGH-K</i>	
<i>DIELECTRICS TO SEMICONDUCTOR DEVICE</i>	
<i>MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/KG MILLIONS).....</i>	<i>55</i>
<i>TABLE 16 GLOBAL HIGH-K DIELECTRICS SALES BY END-USE</i>	
<i>APPLICATION, THROUGH 2014 (\$ MILLIONS).....</i>	<i>56</i>
<i>TABLE 17 GLOBAL VOLUME SALES OF HIGH-K DIELECTRICS BY</i>	
<i>END-USE APPLICATION, THROUGH 2014 (KG MILLIONS).....</i>	<i>57</i>
Hafnium Oxide	57
Background	57
Use Cases	57
Benefits.....	57
Challenges.....	58
Titanium Dioxide.....	58
Background	58
Use Cases	59
Benefits.....	59
Challenges.....	59
Zirconium Oxide	60
Background	60
Use Cases	60
Benefits.....	60
Challenges.....	61
Silicon Nitride.....	61
Background	61
Use Cases	61
Benefits.....	61

Challenges.....	62
ALTERNATIVE LOW-K MATERIALS.....	62
Market Metrics for Low-k Dielectrics.....	63
<i>TABLE 18 GLOBAL VALUE AND VOLUME SALES OF LOW-K DIELECTRICS TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/KG MILLIONS).....</i>	<i>63</i>
<i>TABLE 19 GLOBAL LOW-K DIELECTRICS MARKET BY END-USE APPLICATIONS, THROUGH 2014 (\$ MILLIONS).....</i>	<i>64</i>
<i>TABLE 20 GLOBAL MARKET VOLUME FOR LOW-K DIELECTRICS BY END-USE APPLICATION, THROUGH 2014 (KG MILLIONS).....</i>	<i>64</i>
Black Diamond.....	65
SiLK.....	65
Polyimide.....	66
Teflon.....	66
Diethoxymethylsilanes (DEMS)-Based Polymer.....	66
Hydrogen Silsesquioxane (HSQ).....	67
SUBSTRATES.....	68
MARKET METRICS FOR SILICON DIOXIDE.....	68
<i>TABLE 21 GLOBAL VALUE AND VOLUME SALES OF SILICON TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/MSI).....</i>	<i>68</i>
<i>TABLE 22 GLOBAL SILICON MARKET BY END-USE APPLICATION, 2007-2014 (\$ MILLIONS).....</i>	<i>68</i>
<i>TABLE 23 GLOBAL MARKET VOLUME OF SILICON BY END-USE APPLICATION, THROUGH 2014 (MSI).....</i>	<i>69</i>
CHALLENGES.....	69
ALTERNATIVE APPROACHES AND MATERIALS.....	70
Market Metrics for Alternative Substrate Material –	
Salient Trends.....	70
Market Metrics for Alternative ... (Continued).....	71
GaAs.....	72
Market Metrics.....	72
<i>TABLE 24 GLOBAL VALUE AND VOLUME SALES OF GALLIUM ARSENIDE TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/MSI).....</i>	<i>72</i>
<i>TABLE 25 GLOBAL GALLIUM ARSENIDE MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS).....</i>	<i>73</i>
<i>TABLE 26 GLOBAL MARKET VOLUME OF GALLIUM ARSENIDE BY END-USE APPLICATION, THROUGH 2014 (MSI).....</i>	<i>73</i>
Background.....	74
Use Cases.....	74
Benefits.....	74
Challenges.....	74
GaN.....	75

Market metrics.....	75
<i>TABLE 27 GLOBAL VALUE AND VOLUME SALES OF GALLIUM NITRIDE TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/MSI)</i>	75
<i>TABLE 28 GLOBAL GALLIUM NITRIDE MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	76
<i>TABLE 29 GLOBAL MARKET VOLUME OF GALLIUM NITRIDE BY END-USE APPLICATION, THROUGH 2014 (MSI)</i>	76
Background	77
Use Cases	77
Benefits.....	77
Challenges.....	77
Indium Phosphide.....	78
Market Metrics.....	78
<i>TABLE 30 GLOBAL VALUE AND VOLUME SALES OF INDIUM PHOSPHIDE TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/MSI)</i>	78
<i>TABLE 31 GLOBAL INDIUM PHOSPHIDE MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	79
<i>TABLE 32 GLOBAL MARKET VOLUME OF INDIUM PHOSPHIDE BY END-USE APPLICATION, THROUGH 2014 (MSI)</i>	79
Background	80
Silicon Carbide.....	80
Market Metrics.....	80
<i>TABLE 33 GLOBAL VALUE AND VOLUME SALES OF SILICON CARBIDE TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/MSI)</i>	80
<i>TABLE 34 GLOBAL SILICON CARBIDE MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	81
<i>TABLE 35 GLOBAL MARKET VOLUME OF SILICON CARBIDE BY END-USE APPLICATION, THROUGH 2014 (MSI)</i>	82
Background	82
Sapphire.....	82
Market Metrics.....	82
<i>TABLE 36 GLOBAL VALUE AND VOLUME SALES OF SAPPHIRE TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/MSI)</i>	83
<i>TABLE 37 GLOBAL SAPPHIRE MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	83
<i>TABLE 38 GLOBAL MARKET VOLUME OF SAPPHIRE BY END-USE APPLICATION, THROUGH 2014 (MSI)</i>	84
Background	84
Germanium	85
Market Metrics.....	85

<i>TABLE 39 GLOBAL VALUE AND VOLUME SALES OF GERMANIUM TO SEMICONDUCTOR DEVICE MANUFACTURERS, THROUGH 2014 (\$ MILLIONS/MSI)</i>	85
<i>TABLE 40 GLOBAL GERMANIUM MARKET BY END-USE APPLICATION, THROUGH 2014 (\$ MILLIONS)</i>	86
<i>TABLE 41 GLOBAL MARKET VOLUME OF GERMANIUM BY END-USE APPLICATION, THROUGH 2014 (MSI)</i>	86
Background	87

CHAPTER FIVE: DIELECTRICS AND SUBSTRATES SUPPLY CHAIN

ANALYSIS	88
PLAYER CATEGORIZATION	88
RAW MATERIAL PROVIDERS	88
Roles	88
Drivers.....	88
Challenges.....	89
Initiatives.....	89
SEMICONDUCTOR MAJORS	89
Roles	89
Drivers.....	89
Challenges.....	89
Initiatives.....	90
FOUNDRY OWNERS	90
Roles	90
Drivers.....	90
Challenges.....	90
Challenges (Continued)	91
Initiatives.....	92
FABLESS PLAYERS	92
Roles	92
Drivers.....	92
Challenges.....	92
Initiatives.....	93
OEMS AND ENGINEERING MANUFACTURING SERVICE (EMS) PROVIDERS	93
REGIONAL DYNAMICS	93
REGIONAL BACKGROUND	93
SALIENT FEATURES OF METRICS.....	94
REGIONAL DISTRIBUTION METRICS.....	94
<i>TABLE 42 GLOBAL MARKET SHARE OF ALTERNATIVE SUBSTRATE MATERIALS, 2007–2014 (%)</i>	95
<i>TABLE 43 GLOBAL MARKET VOLUME SHARE OF ALTERNATIVE SUBSTRATE MATERIALS, 2007–2014 (%)</i>	95
<i>TABLE 44 GLOBAL SILICON DIOXIDE MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS)</i>	96

TABLE 45 GLOBAL MARKET VOLUME OF SILICON DIOXIDE BY GEOGRAPHICAL REGION, THROUGH 2014 (KG MILLIONS).....	97
TABLE 46 GLOBAL HIGH-K DIELECTRICS MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS).....	97
TABLE 47 GLOBAL MARKET VOLUME OF HIGH-K DIELECTRICS BY GEOGRAPHICAL REGION, THROUGH 2014 (KG MILLIONS).....	98
TABLE 48 GLOBAL LOW-K DIELECTRICS MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS).....	99
TABLE 49 GLOBAL MARKET VOLUME OF LOW-K DIELECTRICS BY GEOGRAPHICAL REGION, THROUGH 2014 (KG MILLIONS).....	99
TABLE 50 GLOBAL SILICON MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS).....	100
TABLE 51 GLOBAL MARKET VOLUME OF SILICON BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI).....	101
TABLE 52 GLOBAL GALLIUM ARSENIDE MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS).....	101
TABLE 53 GLOBAL MARKET VOLUME OF GALLIUM ARSENIDE BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI).....	102
TABLE 54 GLOBAL GALLIUM NITRIDE MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS).....	103
TABLE 55 GLOBAL MARKET VOLUME OF GALLIUM NITRIDE BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI).....	103
TABLE 56 GLOBAL INDIUM PHOSPHIDE MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS).....	104
TABLE 57 GLOBAL MARKET VOLUME OF INDIUM PHOSPHIDE BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI).....	105
TABLE 58 GLOBAL SILICON CARBIDE MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS).....	105
TABLE 59 GLOBAL MARKET VOLUME OF SILICON CARBIDE BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI).....	106
TABLE 60 GLOBAL SAPPHIRE MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS)	107
TABLE 61 GLOBAL MARKET VOLUME OF SAPPHIRE BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI).....	107
TABLE 62 GLOBAL GERMANIUM MARKET BY GEOGRAPHICAL REGION, THROUGH 2014 (\$ MILLIONS)	108
TABLE 63 GLOBAL MARKET VOLUME OF GERMANIUM BY GEOGRAPHICAL REGION, THROUGH 2014 (MSI).....	109
CYCLICALITY	109
KEY COMPANY ACTIVITY SUMMARY	109
AMD	109
General Background.....	110
Initiatives Related to Dielectrics	110
Initiatives Related to Substrates	111

Outlook and Analysis	111
AMERICAN ELEMENTS	111
General Background.....	111
Initiatives Related to Dielectrics	112
Initiatives Related to Substrates	112
Outlook and Analysis	112
ANADIGICS	113
General Background.....	113
Initiatives Related to Substrates	113
Outlook and Analysis	114
APPLIED MATERIALS.....	114
General Background.....	114
Initiatives Related to Dielectrics	114
Initiatives Related to Substrates	115
Outlook and Analysis	115
ASML.....	115
General Background.....	115
Initiatives Related to Substrates	115
Outlook and Analysis	116
CHARTERED SEMICONDUCTOR.....	116
General Background.....	116
Initiatives Related to Dielectrics	116
Initiatives Related to Substrates	117
Outlook and Analysis	117
DOW CHEMICAL	117
General Background.....	117
Initiatives Related to Dielectrics	118
Outlook and Analysis	118
DOW CORNING.....	118
General Background.....	118
Initiatives Related to Dielectrics	119
Outlook and Analysis	119
FUJITSU MICROELECTRONICS.....	119
General Background.....	120
Initiatives Related to Dielectrics	120
Initiatives Related to Substrates	120
Outlook and Analysis	120
IBM	121
General Background.....	121
Initiatives Related to Dielectrics	121
Initiatives Related to Substrates	122
Outlook and Analysis	122
INTEL.....	122
General Background.....	122

Initiatives Related to Dielectrics	122
Outlook and Analysis	123
LSI LOGIC.....	123
General Background.....	123
Initiatives Related to Dielectrics	123
Outlook and Analysis	123
MEMC ELECTRONIC MATERIALS.....	124
General Background.....	124
Initiatives Related to Substrates	124
Outlook and Analysis	124
NEC ELECTRONICS.....	124
General Background.....	125
Initiatives Related to Dielectrics	125
Outlook and Analysis	125
NEWWAY SEMICONDUCTOR	125
General Background.....	125
Initiatives Related to Substrates	126
Outlook and Analysis	126
SAMSUNG ELECTRONICS.....	126
General Background.....	126
Initiatives Related to Dielectrics	126
Initiatives Related to Substrates	127
Outlook and Analysis	127
SHIN ETSU CHEMICAL CO., LTD.....	127
General Background.....	127
Initiatives Related to Dielectrics	128
Initiatives Related to Substrates	128
Outlook and Analysis	128
SILICON SENSE	128
General Background.....	128
Initiatives Related to Substrates	128
Outlook and Analysis	129
SILTRONIC.....	129
General Background.....	129
Initiatives Related to Substrates	129
Outlook and Analysis	130
ST MICROELECTRONICS	130
General Background.....	130
Initiatives Related to Dielectrics	130
Initiatives Related to Substrates	130
Outlook and Analysis	130
STANFORD MATERIALS.....	131
General Background.....	131
Initiatives Related to Dielectrics	131

Initiatives Related to Substrates	131
Outlook and Analysis	131
SUMITOMO METAL INDUSTRIES LTD./SUMCO	132
General Background.....	132
Initiatives Related to Substrates	132
Outlook and Analysis	132
TEXAS INSTRUMENTS	133
General Background.....	133
Initiatives Related to Dielectrics	133
Outlook and Analysis	134
TOSHIBA.....	134
General Background.....	134
Initiatives Related to Dielectrics	135
Initiatives Related to Substrates	135
Outlook and Analysis	136
TAIWAN SEMICONDUCTOR MANUFACTURING CO. (TSMC)....	136
General Background.....	136
Initiatives Related to Dielectrics	136
Initiatives Related to Substrates	137
Outlook and Analysis	137
UMC.....	137
General Background.....	137
Initiatives Related to Dielectrics	138
Initiatives Related to Substrates	138
Outlook and Analysis	138
CHAPTER SIX: U.S. PATENT ANALYSIS.....	139
INTRODUCTION	139
TRENDS BY FUNCTIONAL CATEGORIES	140
TRENDS BY FUNCTIONAL CATEGORIES (CONTINUED).....	141
TRENDS BY FUNCTIONAL CATEGORIES (CONTINUED).....	142
<i>TABLE 64 NUMBER OF U.S. PATENTS IN ALTERNATIVE DIELECTRICS AND SUBSTRATES BY CATEGORY, 1976– SEPTEMBER 2009.....</i>	<i>143</i>
<i>TABLE 64 (CONTINUED).....</i>	<i>144</i>
TRENDS BY YEAR.....	144
<i>TABLE 65 U.S. PATENT TRENDS IN ALTERNATIVE DIELECTRICS AND SUBSTRATES BY YEAR OF GRANT, 1976–SEPTEMBER 2008 (NUMBER).....</i>	<i>145</i>
TRENDS BY COUNTRY	145
<i>TABLE 66 SHARES OF U.S. PATENTS ON ALTERNATIVE DIELECTRICS AND SUBSTRATES- BY COUNTRY, 1976– SEPTEMBER 2009.....</i>	<i>146</i>
TRENDS BY ASSIGNEE	146

<i>TABLE 67 LIST OF ASSIGNEES FOR U.S. PATENTS ON ALTERNATIVE DIELECTRICS AND SUBSTRATES, 1976– SEPTEMBER 2009</i>	147
<i>TABLE 67 (CONTINUED)</i>	148
<i>TABLE 68 ASSIGNEES OF TEN OR MORE U.S. PATENTS ON ALTERNATIVE DIELECTRICS AND SUBSTRATES, 1976– SEPTEMBER 2009</i>	149
<i>TABLE 68 ASSIGNEES OF TEN OR MORE U.S. PATENTS ON ALTERNATIVE DIELECTRICS AND SUBSTRATES, 1976– SEPTEMBER 2009 (CONTINUED)</i>	150