

CHAPTER ONE: INTRODUCTION.....	1
STUDY BACKGROUND	1
STUDY GOALS AND OBJECTIVES.....	1
INTENDED AUDIENCE.....	2
SCOPE AND FORMAT OF REPORT	2
INFORMATION SOURCES AND METHODOLOGY.....	3
ANALYST CREDENTIALS.....	3
RELATED BCC RESEARCH REPORTS.....	3
BCC ONLINE SERVICES.....	4
DISCLAIMER	5
CHAPTER TWO: EXECUTIVE SUMMARY.....	6
<i>SUMMARY TABLE GLOBAL CONSUMPTION OF THERMAL</i>	
<i>INTERFACE MATERIALS, THROUGH 2016 (\$ MILLIONS)</i>	6
<i>SUMMARY FIGURE GLOBAL THERMAL INTERFACE MATERIALS</i>	
<i>PRODUCT SEGMENTS, 2010–2016 (% OF TOTAL CONSUMPTION)</i>	7
EXECUTIVE SUMMARY.....	8
CHAPTER THREE: OVERVIEW	9
GENERAL DESCRIPTION OF THERMAL INTERFACE MATERIALS.....	9
DEFINITION.....	9
PROPERTIES.....	9
<i>TABLE 1 PROPERTIES OF THERMAL INTERFACE MATERIALS</i>	9
Thickness	10
Viscosity	10
Dielectric Strength	10
Thermal Conductivity.....	11
Thermal Contact Resistance	11
Thermal Impedance.....	11
Modulus.....	12
Coefficient of Thermal Expansion.....	12
Operating Temperature	12
TYPES OF THERMAL INTERFACE MATERIAL	13
<i>TABLE 2 TYPES OF THERMAL INTERFACE MATERIAL</i>	13
THERMAL GREASES	13
THERMAL COMPOUNDS	14
THERMAL PADS.....	15
THERMAL TAPES.....	15
EPOXIES	16
PHASE-CHANGE MATERIALS	16
OTHER MATERIALS	17
END USES	17
<i>TABLE 3 WORLD THERMAL MANAGEMENT MARKET BY END USE,</i>	
<i>THROUGH 2016 (\$ MILLIONS)</i>	17

COMPUTERS.....	18
FIGURE 1 GLOBAL PC SHIPMENTS, 2010–2016 (MILLION UNITS).....	18
FIGURE 2 COMPUTER-RELATED MARKET FOR ALL THERMAL MANAGEMENT TECHNOLOGIES, 2006–2010 (\$ MILLIONS).....	19
TELECOMMUNICATIONS	20
FIGURE 3 GLOBAL SHIPMENTS OF MOBILE PHONE HANDSETS, 2010–2016 (MILLION UNITS).....	20
FIGURE 4 GLOBAL SPENDING ON MOBILE TELECOMMUNICATIONS INFRASTRUCTURE, 2010–2016 (\$ MILLIONS).....	21
FIGURE 5 TELECOMMUNICATIONS-RELATED MARKET FOR ALL THERMAL MANAGEMENT TECHNOLOGIES, 2010–2016 (\$ MILLIONS).....	22
AUTOMOTIVE.....	23
FIGURE 6 GLOBAL MOTOR VEHICLE PRODUCTION, 2010–2016 (MILLION UNITS).....	23
FIGURE 7 MOTOR VEHICLE–RELATED MARKET FOR ALL THERMAL MANAGEMENT TECHNOLOGIES, 2010–2016 (\$ MILLIONS).....	24
CONSUMER PRODUCTS	25
FIGURE 8 GLOBAL CONSUMER ELECTRONICS SALES, 2010–2016 (\$ MILLIONS).....	25
FIGURE 9 CONSUMER PRODUCT–RELATED MARKET FOR ALL THERMAL MANAGEMENT TECHNOLOGIES, 2010–2016 (\$ MILLIONS).....	26
MEDICAL/OFFICE ELECTRONICS.....	27
FIGURE 10 GLOBAL SALES OF MEDICAL AND OFFICE ELECTRONICS, 2010–2016 (\$ MILLIONS).....	27
FIGURE 11 MEDICAL AND OFFICE ELECTRONICS–RELATED MARKET FOR ALL THERMAL MANAGEMENT TECHNOLOGIES, 2010–2016 (\$ MILLIONS).....	28
INDUSTRIAL/MILITARY ELECTRONICS	29
FIGURE 12 GLOBAL SALES OF INDUSTRIAL AND MILITARY ELECTRONICS, 2010–2016 (\$ MILLIONS).....	29
FIGURE 13 OTHER INDUSTRIAL AND MILITARY MARKETS FOR ALL THERMAL MANAGEMENT TECHNOLOGIES, 2010–2016 (\$ MILLIONS).....	30
GEOGRAPHICAL MARKETS	31
TABLE 4 WORLD THERMAL MANAGEMENT MARKET, BY REGION, THROUGH 2016 (\$ MILLIONS).....	31
AMERICAS.....	31
EUROPE.....	31
ASIA-PACIFIC	32
JAPAN	32

MARKET SIZE AND SEGMENTATION	32
MARKET SIZE AND GROWTH TRENDS	32
FIGURE 14 TRENDS IN GLOBAL MARKET FOR THERMAL INTERFACE PRODUCTS, 2010–2016 (\$ MILLIONS)	33
MATERIAL TYPE	33
TABLE 5 GLOBAL MARKET FOR THERMAL INTERFACE PRODUCTS BY TYPE OF MATERIAL, THROUGH 2016 (\$ MILLIONS)	34
FIGURE 15 GLOBAL MARKET FOR THERMAL INTERFACE PRODUCT SEGMENTS, 2010–2016 (%).....	35
END USES	35
TABLE 6 GLOBAL MARKET FOR THERMAL INTERFACE PRODUCTS BY END USE, THROUGH 2016 (\$ MILLIONS)	36
FIGURE 16 GLOBAL MARKET FOR THERMAL INTERFACE PRODUCTS END-USE SEGMENTS, 2010–2016 (%).....	37
GEOGRAPHICAL MARKETS.....	37
TABLE 7 MAJOR GEOGRAPHICAL MARKETS FOR THERMAL INTERFACE PRODUCTS, THROUGH 2016 (\$ MILLIONS).....	38
FIGURE 17 GLOBAL MARKET FOR THERMAL INTERFACE PRODUCTS BY GEOGRAPHICAL SEGMENTS, 2010–2016 (%).....	39
CHAPTER FOUR: THE IMPORTANCE OF THERMAL MANAGEMENT.....	40
THE IMPORTANCE OF THERMAL MANAGEMENT.....	40
FIGURE 18 MAJOR CAUSES OF ELECTRONIC FAILURE (% OF OCCURRENCES).....	41
THE IMPORTANCE OF THERMAL ... (CONTINUED).....	42
THE IMPORTANCE OF THERMAL ... (CONTINUED).....	43
ENVIRONMENTAL AND REGULATORY FACTORS IN THERMAL MANAGEMENT.....	44
GLOBAL AND REGIONAL MARKET TRENDS FOR THERMAL MANAGEMENT.....	44
TABLE 8 WORLD THERMAL MANAGEMENT MARKET, THROUGH 2016 (\$ MILLIONS).....	45
FIGURE 19 TRENDS IN THE GLOBAL MARKET FOR THERMAL MANAGEMENT TECHNOLOGIES, 2010–2016 (\$ MILLIONS).....	45
TABLE 9 GLOBAL THERMAL MANAGEMENT MARKET BY PRODUCT TYPE, THROUGH 2016 (\$ MILLIONS).....	46
FIGURE 20 GLOBAL THERMAL MANAGEMENT REVENUE BY PRODUCT SEGMENT, 2010 VS. 2016 (%).....	46
FIGURE 20 (CONTINUED)	47
CHAPTER FIVE: THERMAL INTERFACE MATERIALS.....	48
POLYMER COMPOSITES.....	48
POLYMERS.....	49
Silicone.....	49

Polyurethane.....	49
Acrylate.....	50
Epoxy.....	50
FILLERS.....	51
<i>TABLE 10 THERMAL PROPERTIES OF THERMAL INTERFACE</i>	
<i>FILLER MATERIALS</i>	51
Ceramics.....	52
Alumina (Al ₂ O ₃).....	52
Aluminum Nitride (AlN).....	52
Beryllium Oxide (BeO).....	52
Other Ceramic Fillers.....	53
Metals.....	53
Carbonaceous Materials.....	53
Carbon Fibers.....	53
Diamond.....	54
Graphene.....	54
Carbon Nanotubes.....	55
PHASE-CHANGE MATERIALS.....	56
TYPES OF PHASE-CHANGE MATERIALS.....	57
Paraffin.....	57
Non-Paraffin Organic PCMs.....	57
Salt Hydrates.....	57
Eutectic Salts.....	58
Advantages and Disadvantages of Different PCMs in	
Electronic Applications.....	58
<i>TABLE 11 SOLID-LIQUID PCM PROPERTIES</i>	58
ENCAPSULATION SYSTEMS.....	59
METALS.....	60
SOLDER.....	60
<i>TABLE 12 THERMAL SOLDERS</i>	60
METAL MATRIX COMPOSITES.....	61
OTHER METAL INTERFACE MATERIALS.....	62
Liquid Metal.....	62
Soft Metal Alloy.....	62
CARBON MATRIX COMPOSITES.....	62
DISPENSING.....	63
MANUAL DISPENSING.....	63
SILK-SCREENABLE INTERFACE MATERIALS.....	63
AUTOMATED DISPENSING.....	64
CHAPTER SIX: THERMAL GREASES.....	65
SUMMARY.....	65
<i>FIGURE 21 GLOBAL MARKET FOR THERMAL GREASES, 2010–2016</i>	
(\$ MILLIONS).....	65
TECHNOLOGIES.....	66

GENERAL DESCRIPTION	66
MATERIALS.....	66
Matrix Materials.....	66
Filler Materials.....	67
Ceramics.....	67
<i>TABLE 13 CERAMIC FILLERS USED IN THERMAL GREASES.....</i>	<i>68</i>
Metals.....	68
<i>TABLE 14 METAL FILLERS USED IN THERMAL GREASES.....</i>	<i>68</i>
Carbon.....	68
APPLICATIONS AND END USES.....	69
<i>FIGURE 22 THERMAL GREASE END-USER SEGMENTS, 2010 (%).....</i>	<i>69</i>
SUPPLIERS	70
<i>TABLE 15 THERMAL GREASE SUPPLIERS</i>	<i>70</i>
MARKETS.....	70
<i>TABLE 16 GLOBAL CONSUMPTION OF THERMAL GREASES,</i>	
<i> THROUGH 2016 (\$ MILLIONS).....</i>	<i>71</i>
PRODUCT SEGMENTS	71
<i>FIGURE 23 THERMAL GREASE CONSUMPTION BY TYPE OF</i>	
<i> FILLER MATERIAL, 2010 (% OF TOTAL).....</i>	<i>72</i>
<i>TABLE 17 GLOBAL CONSUMPTION OF THERMAL GREASES BY</i>	
<i> TYPE OF FILLER MATERIAL, THROUGH 2016 (\$ MILLIONS).....</i>	<i>73</i>
<i>FIGURE 24 THERMAL GREASE PRODUCT SEGMENTS, 2010–2016</i>	
<i> (%).....</i>	<i>73</i>
END-USER SEGMENTS.....	74
<i>TABLE 18 GLOBAL MARKET FOR THERMAL GREASES BY END</i>	
<i> USE, THROUGH 2016 (\$ MILLIONS).....</i>	<i>74</i>
<i>FIGURE 25 THERMAL GREASE END-USE SEGMENTS, 2010–2016 (%).....</i>	<i>75</i>
GEOGRAPHICAL SEGMENTS	75
<i>FIGURE 26 THERMAL GREASE CONSUMPTION BY MAJOR</i>	
<i> GEOGRAPHICAL MARKETS, 2010 (% OF TOTAL).....</i>	<i>76</i>
<i>TABLE 19 GLOBAL CONSUMPTION OF THERMAL GREASES BY</i>	
<i> MAJOR GEOGRAPHICAL MARKETS, THROUGH 2016 (\$</i>	
<i> MILLIONS).....</i>	<i>77</i>
<i>FIGURE 27 GLOBAL THERMAL GREASE MARKET BY</i>	
<i> GEOGRAPHICAL SEGMENTS, 2010–2016 (%).....</i>	<i>78</i>
CHAPTER SEVEN: THERMAL COMPOUNDS.....	79
SUMMARY.....	79
<i>FIGURE 28 GLOBAL MARKET FOR THERMAL COMPOUNDS, 2010–</i>	
<i> 2016 (\$ MILLIONS).....</i>	<i>79</i>
TECHNOLOGIES	80
GENERAL DESCRIPTION	80
TYPES OF THERMAL COMPOUND	80
APPLICATIONS AND END USES.....	80

<i>FIGURE 29 THERMAL COMPOUND CONSUMPTION BY END-USER SEGMENT, 2010 (% OF TOTAL)</i>	81
SUPPLIERS	81
<i>TABLE 20 THERMAL ELASTOMER SUPPLIERS</i>	82
MARKETS	82
<i>TABLE 21 GLOBAL CONSUMPTION OF THERMAL COMPOUNDS, THROUGH 2016 (\$ MILLIONS)</i>	82
END-USER SEGMENTS.....	82
<i>TABLE 22 GLOBAL MARKET FOR THERMAL COMPOUNDS BY END USE, THROUGH 2016 (\$ MILLIONS)</i>	83
<i>FIGURE 30 THERMAL COMPOUNDS END-USER SEGMENTS, 2010– 2016 (%)</i>	84
MAJOR GEOGRAPHICAL MARKETS	84
<i>FIGURE 31 THERMAL COMPOUND CONSUMPTION BY MAJOR GEOGRAPHICAL MARKET, 2010 (% OF TOTAL)</i>	85
<i>TABLE 23 GLOBAL CONSUMPTION OF THERMAL COMPOUNDS BY MAJOR GEOGRAPHICAL MARKET, THROUGH 2016 (\$ MILLIONS)</i>	86
<i>FIGURE 32 THERMAL COMPOUNDS BY GEOGRAPHICAL MARKET SEGMENTS, 2010–2016 (%)</i>	86
<i>FIGURE 32 (CONTINUED)</i>	87
 CHAPTER EIGHT: THERMAL PADS	 88
SUMMARY	88
<i>FIGURE 33 GLOBAL MARKET FOR THERMAL PADS, 2010–2016 (\$ MILLIONS)</i>	88
TECHNOLOGIES	89
GENERAL DESCRIPTION	89
MATERIALS.....	89
Elastomers	89
Fillers	89
Matrix Materials.....	89
USING THERMAL PADS.....	90
APPLICATIONS AND END USERS	90
<i>FIGURE 34 THERMAL PAD END-USER SEGMENTS, 2010 (% OF TOTAL MARKET)</i>	91
SUPPLIERS	92
<i>TABLE 24 THERMAL PAD SUPPLIERS</i>	92
MARKETS.....	92
END-USE SEGMENTS	92
<i>TABLE 25 GLOBAL MARKET FOR THERMAL PADS BY END USE, THROUGH 2016 (\$ MILLIONS)</i>	93
<i>FIGURE 35 THERMAL PAD END-USE SEGMENTS, 2010–2016 (%)</i>	94
MAJOR GEOGRAPHICAL MARKETS	94
<i>FIGURE 36 GLOBAL THERMAL PADS MARKET GEOGRAPHICAL SEGMENTS, 2010 (% OF TOTAL)</i>	95

<i>TABLE 26 GLOBAL CONSUMPTION OF THERMAL PADS BY MAJOR GEOGRAPHICAL MARKET, THROUGH 2016 (\$ MILLIONS)</i>	96
<i>FIGURE 37 THERMAL PADS BY GEOGRAPHICAL MARKET SEGMENTS, 2010–2016 (%)</i>	97
CHAPTER NINE: THERMAL ADHESIVE TAPES	98
SUMMARY.....	98
<i>FIGURE 38 GLOBAL MARKET FOR THERMAL ADHESIVE TAPES, 2010–2016 (\$ MILLIONS)</i>	98
TECHNOLOGIES	99
GENERAL DESCRIPTION	99
MATERIALS.....	99
Carbon Nanotube Tapes.....	99
USING THERMAL ADHESIVE TAPE.....	100
APPLICATIONS AND END USES.....	100
<i>FIGURE 39 THERMAL ADHESIVE FILM AND TAPE END-USE SEGMENTS, 2010 (% OF TOTAL MARKET)</i>	101
SUPPLIERS	101
<i>TABLE 27 THERMAL ADHESIVE FILM AND TAPE SUPPLIERS</i>	102
MARKETS.....	102
END-USE SEGMENTS	102
<i>TABLE 28 GLOBAL MARKET FOR THERMAL ADHESIVE FILM AND TAPE BY END USE, THROUGH 2016 (\$ MILLIONS)</i>	103
<i>FIGURE 40 THERMAL ADHESIVE FILM AND TAPE END-USE SEGMENTS, 2010–2016 (%)</i>	104
MAJOR GEOGRAPHICAL MARKETS	104
<i>FIGURE 41 GLOBAL THERMAL ADHESIVE FILM AND TAPE MARKET BY GEOGRAPHICAL SEGMENTS, 2010 (% OF TOTAL)</i>	105
<i>TABLE 29 GLOBAL CONSUMPTION OF THERMAL ADHESIVE FILM AND TAPE BY MAJOR GEOGRAPHICAL MARKET, THROUGH 2016 (\$ MILLIONS)</i>	106
<i>FIGURE 42 THERMAL ADHESIVE FILM AND TAPE BY GEOGRAPHICAL MARKET SEGMENTS, 2010–2016 (%)</i>	107
CHAPTER TEN: EPOXY THERMAL INTERFACE MATERIALS	108
SUMMARY.....	108
<i>FIGURE 43 GLOBAL MARKET FOR EPOXY THERMAL INTERFACE MATERIALS, 2010–2016 (\$ MILLIONS)</i>	108
<i>FIGURE 43 (CONTINUED)</i>	109
TECHNOLOGIES	109
GENERAL DESCRIPTION	109
MATERIALS.....	110
Resins and Hardeners	110
Fillers	110
Other Ingredients	110

APPLYING THERMAL EPOXIES.....	111
APPLICATIONS	111
<i>FIGURE 44 THERMAL ADHESIVE FILM AND TAPE END-USE</i>	
<i>SEGMENTS, 2010 (% OF TOTAL MARKET)</i>	112
SUPPLIERS	112
<i>TABLE 30 THERMAL EPOXY SUPPLIERS</i>	113
MARKETS.....	113
END-USE SEGMENTS	113
<i>TABLE 31 GLOBAL MARKET FOR THERMAL EPOXY BY END USE,</i>	
<i>THROUGH 2016 (\$ MILLIONS)</i>	114
<i>FIGURE 45 THERMAL EPOXY BY END-USE SEGMENTS, 2010–2016</i>	
<i>(%)</i>	114
<i>FIGURE 45 (CONTINUED)</i>	115
MAJOR GEOGRAPHICAL MARKETS	115
<i>FIGURE 46 GLOBAL THERMAL EPOXY MARKET BY</i>	
<i>GEOGRAPHICAL SEGMENTS, 2010 (% OF TOTAL)</i>	115
<i>FIGURE 46 (CONTINUED)</i>	116
<i>TABLE 32 GLOBAL CONSUMPTION OF THERMAL EPOXY BY</i>	
<i>MAJOR GEOGRAPHICAL MARKET, THROUGH 2016 (\$ MILLIONS)</i>	116
<i>FIGURE 47 THERMAL EPOXY GEOGRAPHICAL MARKET</i>	
<i>SEGMENTS, 2010–2016 (%)</i>	117
CHAPTER ELEVEN: PHASE-CHANGE MATERIALS	118
SUMMARY.....	118
<i>FIGURE 48 GLOBAL MARKET FOR PHASE-CHANGE THERMAL</i>	
<i>INTERFACE MATERIALS, 2010–2016 (\$ MILLIONS)</i>	118
TECHNOLOGIES	119
GENERAL DESCRIPTION	119
MATERIALS.....	119
APPLICATIONS AND END USES.....	119
<i>FIGURE 49 PHASE-CHANGE THERMAL INTERFACE MATERIAL BY</i>	
<i>END-USE SEGMENTS, 2010 (% OF TOTAL MARKET)</i>	120
SUPPLIERS	120
<i>TABLE 33 PHASE-CHANGE MATERIAL SUPPLIERS</i>	121
MARKETS.....	121
END USERS.....	121
<i>TABLE 34 GLOBAL MARKET FOR PCM THERMAL INTERFACE</i>	
<i>MATERIALS BY END USE, THROUGH 2016 (\$ MILLIONS)</i>	122
<i>FIGURE 50 PCM THERMAL INTERFACE MATERIALS BY END-USE</i>	
<i>SEGMENTS, 2010–2016 (%)</i>	122
<i>FIGURE 50 (CONTINUED)</i>	123
MAJOR GEOGRAPHICAL MARKETS	123
<i>FIGURE 51 PCM THERMAL INTERFACE MATERIALS MARKET BY</i>	
<i>GEOGRAPHICAL SEGMENTS, 2010 (% OF TOTAL)</i>	124

<i>TABLE 35 GLOBAL CONSUMPTION OF PCM THERMAL INTERFACE MATERIALS BY MAJOR GEOGRAPHICAL MARKET, THROUGH 2016 (\$ MILLIONS)</i>	125
<i>FIGURE 52 PCM THERMAL INTERFACE MATERIALS GEOGRAPHICAL MARKET SEGMENTS, 2010–2016 (\$ MILLIONS)</i>	126
CHAPTER TWELVE: METALLIC THERMAL INTERFACE MATERIALS	127
SUMMARY.....	127
<i>FIGURE 53 GLOBAL MARKET FOR METAL THERMAL INTERFACE MATERIALS, 2010–2016 (\$ MILLIONS)</i>	127
TECHNOLOGIES	128
SOLDER	128
Materials	128
Application	129
Reflow Soldering	129
Solder Preforms.....	129
METAL MATRIX COMPOSITES.....	129
Materials	129
Aluminum-Matrix Composites	129
Copper-Matrix Composites.....	130
OTHER METAL INTERFACE MATERIALS	130
Liquid Metals.....	130
Soft Metal Alloys.....	131
APPLICATIONS AND END USES.....	131
<i>FIGURE 54 METALLIC THERMAL INTERFACE MATERIAL BY END-USE SEGMENTS, 2010 (% OF TOTAL MARKET)</i>	132
SUPPLIERS	132
<i>TABLE 36 METAL INTERFACE MATERIAL SUPPLIERS</i>	133
MARKET	133
PRODUCT SEGMENTS	133
<i>FIGURE 55 METAL THERMAL INTERFACE MATERIALS MARKET SHARES, 2010 (%)</i>	134
<i>TABLE 37 GLOBAL MARKET FOR METAL THERMAL INTERFACE MATERIALS BY TYPE OF MATERIAL, THROUGH 2016 (\$ MILLIONS)</i>	135
<i>FIGURE 56 GLOBAL MARKET FOR METAL THERMAL INTERFACE MATERIALS PRODUCT SEGMENTS, 2010–2016 (%)</i>	136
END-USE SEGMENTS	136
<i>TABLE 38 GLOBAL MARKET FOR METAL THERMAL INTERFACE MATERIALS BY END USE, THROUGH 2016 (\$ MILLIONS)</i>	137
<i>FIGURE 57 METAL THERMAL INTERFACE MATERIAL BY END-USE SEGMENTS, 2010–2016 (%)</i>	138
MAJOR GEOGRAPHICAL MARKETS	138
<i>FIGURE 58 THERMAL GREASE CONSUMPTION BY MAJOR GEOGRAPHICAL MARKET, 2010 (% OF TOTAL)</i>	139

<i>TABLE 39 GLOBAL CONSUMPTION OF METAL THERMAL INTERFACE MATERIALS BY MAJOR GEOGRAPHICAL MARKET, THROUGH 2016 (\$ MILLIONS)</i>	140
<i>FIGURE 59 METAL THERMAL INTERFACE MATERIALS BY GEOGRAPHICAL MARKET SEGMENTS, 2010–2016 (\$ MILLIONS)</i>	141
CHAPTER THIRTEEN: INDUSTRY STRUCTURE	142
MARKET SHARES	142
<i>TABLE 40 GLOBAL THERMAL MANAGEMENT INTERFACE MARKET LEADERS, 2010 (\$ MILLIONS/%)</i>	142
<i>FIGURE 60 GLOBAL THERMAL MANAGEMENT INTERFACE MARKET SHARES, 2010 (\$ MILLIONS)</i>	143
MARKET SHARES (CONTINUED).....	144
APPENDIX A: COMPANY PROFILES	145
3M CO.....	145
AAVID THERMALLOY LLC.....	145
AEGIS TECHNOLOGY	145
AI TECHNOLOGY.....	146
AKASA CORP.	146
AMETEK SPECIALTY METAL PRODUCTS, INC.	146
AOS THERMAL COMPOUNDS	147
ARCTIC SILVER INC.	147
BERGQUIST CO.....	147
CAST-COAT, INC.	147
CHOMERICS (DIVISION OF PARKER HANNIFIN)	148
COOKSON ELECTRONICS ASSEMBLY MATERIALS.....	148
COOL POLYMERS, INC.	148
COOLABORATORY	149
COOLER MASTER CO. LTD.	149
DOW CORNING	149
ENERDYNE SOLUTIONS.....	150
EPIC RESINS	150
EPOXIES ETC.	150
HENKEL CORP.....	150
HONEYWELL INTERNATIONAL.....	151
INDIUM CORP.	151
INNOVATION COOLING LLC.....	151
LAIRD TECHNOLOGIES	152
LORD CORP.....	152
MASTER BOND.....	152
MATERION.....	153
MC-21, INC.	153
METAL MATRIX CAST COMPOSITES.....	153
MG CHEMICALS	154

MOMENTIVE	154
NUSIL TECHNOLOGY LLC	154
PARKER HANNIFIN	154
POLYCAST INDUSTRIES, INC.	155
ROGERS CORP.....	155
RUBBERCRAFT	155
SEAL KING INDUSTRIAL CO., LTD.	156
SEMICONDUCTOR PACKAGING MATERIALS, INC.....	156
SHELDAHL	156
SHENZHEN WESTERN HEMISPHERE TECHNOLOGY CO.....	157
SHIN-ETSU CMEMICAL CO., LTD.....	157
STOCKWELL ELASTOMERICS, INC.	157
T-GLOBAL TECHNOLOGY CO. LTD.....	157
THERMAL TRANSFER COMPOSITES	158
TIMTRONICS	158
UNIVERSAL SCIENCE	158
VANGUARD PRODUCTS CORP.....	159
WAKEFIELD SOLUTIONS, INC.	159
ZALMAN TECH CO.....	159
APPENDIX B: PATENT ANALYSIS	160
TYPES OF THERMAL INTERFACE MATERIAL	160
<i>FIGURE 61 U.S. THERMAL INTERFACE MATERIAL PATENTS BY</i> <i>TYPE OF MATERIAL (PERCENTAGE/NUMBER OF PATENTS</i> <i>ISSUED THROUGH 4/15/2011)</i>	161
MATERIAL VS. APPLICATION-RELATED PATENTS	161
<i>FIGURE 62 U.S. THERMAL INTERFACE MATERIAL PATENTS BY</i> <i>TYPE OF TECHNOLOGY (NUMBER OF PATENTS)</i>	162
PATENT TRENDS OVER TIME	162
<i>FIGURE 63 U.S. THERMAL INTERFACE MATERIAL PATENT</i> <i>TRENDS OVER TIME (NUMBER OF PATENTS ISSUED PER YEAR)</i>	163
NATIONALITY OF PATENT HOLDERS	164
<i>FIGURE 64 U.S. THERMAL INTERFACE MATERIAL PATENTS BY</i> <i>INVENTOR/ ASSIGNEE NATIONALITY (NUMBER OF PATENTS</i> <i>ISSUED THROUGH 4/15/2001)</i>	164