

WinterGreen Research, Inc.

**Mid IR Sensors: Market Shares, Strategies, and Forecasts, Worldwide,
2013 to 2019**

**Mid IR Sensors Drive Next Generation Measurement of Chemical
Composition Of Materials And Gas**

Mountains of Opportunity



Picture by Susan Eustis

WinterGreen Research, Inc.

Lexington, Massachusetts

www.wintergreenresearch.com

781 853 5078

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

CHECK OUT THESE KEY TOPICS

Mid Infrared (IR) Sensors
Electro-magnetic spectrum
QC laser technology
Spectrometer hardware
Wireless Sensor Network
Wireless Nodes
Homeland security
Military communications
Infrared countermeasures
Chemical warfare agent
detection
Explosives detection
Medical diagnostics
Industrial process controls
Remote gas leak detection
Pollution monitoring
Real-time combustion
controls

Mid IR sensor
Microcontroller
Energy Harvesting
Vibration-Based Wireless
Energy
Piezoelectric Energy
Harvesters
Thermoelectrics
Generating Power From Heat
Smart Computing
Wireless Sensor Networks
Smart Cities
Smart Buildings
Military Remote Energy
Applications
Off-Grid Special Sensors
Pipeline Monitoring
Navigational aids

Thermoelectric cooling
Automotive Sensors
Sensor Lighting
Manganese dioxide
Nanoparticles,
Nanotechnology Graphene
Self-assembly,
Nanostructured Thin Films
Microgenerator Sensors
Vibration Sensors
Piezoelectricity
Solid State Technology
Microgenerator
Power Source Of Sensor
Sensor node

Mid IR Sensors Strategy: Measuring Chemical Composition Of Materials And Gas Enabled Technology

Mid IR Sensors: Market Shares, Strategies, and Forecasts, Worldwide, 2013-2019

Next Generation Mid IR Sensors

LEXINGTON, Massachusetts (October 1, 2013) – WinterGreen Research announces that it has published a new study **Mid IR Sensors: Market Shares, Strategy, and Forecasts, Worldwide, 2013 to 2019**. Next generation Mid IR Sensors are leveraging new technology. The 2013 study has 818 pages, 340 tables and figures. Worldwide mid IR sensor markets are poised to achieve significant growth as the Internet of things creates demand for sensors.

Mid IR sensors can measure chemical composition of materials and gas. The efficiency is unmatched by any other technology, cost is increasingly competitive. Mid IR is extending use beyond military applications to commercial systems, including the Internet of things where sensors become part of network systems.

Mid-IR QCL systems have achieved price performance levels that are increasingly attractive. Vendors bring sensing capabilities to a broad range of applications, including: spectroscopic and bio-medical imaging; materials

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

characterization; standoff explosive detection; microscopy; and non-destructive testing. Spectroscopy and imaging measurements are easier, faster and more cost-effective leveraging advances in Mid IR sensing.

Quantum Cascade Laser (QCL) technology is very promising. Mid-infrared sensors and imaging applications depend on quantum cascade laser (QCL) technology. Daylight Solutions quantum cascade laser (QCL) technology has been delivered to more systems for more customers in more applications than all other QCL-based solutions combined.

Advances in QC laser technology and spectrometer hardware are combined with spectroscopic techniques.

Intra pulse spectroscopy and similar techniques provide a major step change in sensitivity, speed of operation, fingerprinting capability, size and cost. They offer a major improvement on methods of gas detection. Recent advances in spectrometer hardware relate to QC gas sensors. Advances exploit recent technological advances including miniaturized integrated electronic systems, plug and play interfaces and micro optics. These will progressively replace unwieldy, fragile and expensive instrumentation.

The lasing wavelength for QCL's is determined by the choice of semiconductor material. By adjusting the physical thickness of the semiconductor layers new functionality is achieved. This removes the material barriers associated with conventional semiconductor laser technology.

An infrared spectroscopic laser source has no need for cryogenic cooling, provides high output powers, has large spectral coverage, provides excellent spectral quality, and has good tuneability.

Homeland security, military communications, infrared countermeasures, chemical warfare agent detection, explosives detection, medical diagnostics, imaging and industrial process controls, fire detection and remote gas leak detection, pollution monitoring, and real-time combustion controls are uses for the mid IR sensors.

According to Susan Eustis, "Taking mid-IR QCL systems to new price to performance levels, vendors bring new capabilities to a broad range of applications. Applications anticipated to gain market traction include: spectroscopic and bio-medical imaging; materials characterization; standoff explosive detection; microscopy; and non-destructive testing. Spectroscopy and imaging measurements are now easier, faster and more cost-effective than ever before.

Mid IR sensor markets at \$789 million in 2012 are anticipated to reach \$7 billion by 2019 as price performance increases and unit costs decrease from \$3,000 per unit to \$300 and even to \$8 or less per unit on average drive further interest from commercial buyers. The decrease in size of units from bench size devices to portable units makes them more useful across the board in every industry.

WinterGreen Research is an independent research organization funded by the sale of market research studies all over the world and by the implementation of ROI models that are used to calculate the total cost of ownership of equipment, services, and software. The company has 35 distributors worldwide, including Global Information Info Shop, Market Research.com, Research and Markets, Bloomberg, electronics.ca, and Thompson Financial.

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

WinterGreen Research is positioned to help customers facing challenges that define the modern enterprises. The increasingly global nature of science, technology and engineering is a reflection of the implementation of the globally integrated enterprise. Customers trust wintergreen research to work alongside them to ensure the success of the participation in a particular market segment.

WinterGreen Research supports various market segment programs; provides trusted technical services to the marketing departments. It carries out accurate market share and forecast analysis services for a range of commercial and government customers globally. These are all vital market research support solutions requiring trust and integrity.

Keywords: Mid Infrared (IR) Sensors, electro-magnetic spectrum, QC laser technology, spectrometer hardware, Wireless Sensor Network, Wireless Nodes, Homeland security, military communications, infrared countermeasures, chemical warfare agent detection, explosives detection, medical diagnostics, industrial process controls, remote gas leak detection, pollution monitoring, real-time combustion controls, mid IR sensor, sMicrocontroller, Energy Harvesting, Vibration-Based Wireless Energy, Piezoelectric Energy Harvesters, Thermoelectrics, Generating Power From Heat, Smart Computing, Power Community, Wireless Sensor Networks, Smart Cities, Smart Buildings, Military Remote Energy Applications, Off-Grid Special Energy, Energy harvesters, Powering Pipeline Monitoring Stations, Navigational aids energy, Spacecraft energy, Thermoelectric cooling Automotive Energy, Lighting Community, Manganese dioxide, Nanoparticles, Nanotechnology Graphene, Self-assembly, Nanostructured Thin Films, Microgenerator Transforms Mechanical Energy, Vibration Electricity, Pressure Of A Finger, Piezoelectricity, Solid State Technology, Microgenerator, Power Source Of Sensor, Sensor node, Vibration Energy Harvesting, Photovoltaics, Piezoelectrics, Thermovoltaics, Energy Scavenging, Power Harvesting, Capture Of Ambient Energy, Algorithmic Control, Energy Harvesters, Sensors Based On Magnetic Materials, Powering Current Sensors, http

Companies Profiled

Market Leaders

FLIR
Daylight Solutions
Structured Materials Industries
Maxion Technologies

SenseAir
Sofradir
Cascade Technologies

Market Participants

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

AdTechoptics
Aerocrine
Alpes Lasers / ALTechnologies
Block Engineering
Bosch
Cymbet
Northrop Grumman
Digi International
Directed Vapor Technology
Dust Networks
EnOcean GmbH
Ekips Technologies
Elliot Scientific
Finmeccanica
SELEX Galileo Inc.
Ferro Solutions
Flexible Electronics Concepts

Sensors5
General Electric
Hamamatsu
II-VI incorporated / Marlow
Industries
ILX Lightwave
IPG Photonics
Sensor Products
Johnson Controls
JonDeTech
Kidde Products Limited / Airsense
Technology
Lockheed-Martin
M Squared
MIRTHE (Mid-Infrared
Technologies for Health and the

Environment) National Science
Foundation
Mirthe Mid IR Sensor Breath
Analyzers
Nanophase Technologies
Opto Solutions
PNNL Electronics and Systems
Integration
Power Technology
Raytheon
Sensor Switch
Sentinel Photonics
Thermo Fischer Scientific /
NovaWave Technologies
VIASPACE / Ionfinity

Mid IR Sensors: Market Shares, Strategies, and Forecasts, Worldwide, 2013 to 2019

Report Methodology

This is the 572nd report in a series of primary market research reports that provide forecasts in communications, telecommunications, the Internet, computer, software, telephone equipment, health equipment, and energy. Automated process and significant growth potential are priorities in topic selection. The project leaders take direct responsibility for writing and preparing each report. They have significant experience preparing industry studies. Forecasts are based on primary research and proprietary data bases.

The primary research is conducted by talking to customers, distributors and companies. The survey data is not enough to make accurate assessment of market size, so WinterGreen Research looks at the value of shipments and the average price to achieve market assessments.

Our track record in achieving accuracy is unsurpassed in the industry. We are known for being able to develop accurate market shares and projections. This is our specialty.

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

The analyst process is concentrated on getting good market numbers. This process involves looking at the markets from several different perspectives, including vendor shipments. The interview process is an essential aspect as well. We do have a lot of granular analysis of the different shipments by vendor in the study and addenda prepared after the study was published if that is appropriate.

Forecasts reflect analysis of the market trends in the segment and related segments. Unit and dollar shipments are analyzed through consideration of dollar volume of each market participant in the segment. Installed base analysis and unit analysis is based on interviews and an information search. Market share analysis includes conversations with key customers of products, industry segment leaders, marketing directors, distributors, leading market participants, opinion leaders, and companies seeking to develop measurable market share.

Over 200 in depth interviews are conducted for each report with a broad range of key participants and industry leaders in the market segment. We establish accurate market forecasts based on economic and market conditions as a base. Use input/output ratios, flow charts, and other economic methods to quantify data. Use in-house analysts who meet stringent quality standards.

Interviewing key industry participants, experts and end-users is a central part of the study. Our research includes access to large proprietary databases. Literature search includes analysis of trade publications, government reports, and corporate literature.

Findings and conclusions of this report are based on information gathered from industry sources, including manufacturers, distributors, partners, opinion leaders, and users. Interview data was combined with information gathered through an extensive review of internet and printed sources such as trade publications, trade associations, company literature, and online databases. The projections contained in this report are checked from top down and bottom up analysis to be sure there is congruence from that perspective.

The base year for analysis and projection is 2010. With 2010 and several years prior to that as a baseline, market projections were developed for 2011 through 2017. These projections are based on a combination of a consensus among the opinion leader contacts interviewed combined with understanding of the key market drivers and their impact from a historical and analytical perspective.

The analytical methodologies used to generate the market estimates are based on penetration analyses, similar market analyses, and delta calculations to supplement independent and dependent variable analysis. All analyses are displaying selected descriptions of products and services.

This research includes referencde to an ROI model that is part of a series that provides IT systems financial planners access to information that supports analysis of all the numbers that impact management of a product launch or large and complex data center. The methodology used in the models relates to having a

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

sophisticated analytical technique for understanding the impact of workload on processor consumption and cost.

WinterGreen Research has looked at the metrics and independent research to develop assumptions that reflect the actual anticipated usage and cost of systems. Comparative analyses reflect the input of these values into models.

The variables and assumptions provided in the market research study and the ROI models are based on extensive experience in providing research to large enterprise organizations and data centers. The ROI models have lists of servers from different manufacturers, Systems z models from IBM, and labor costs by category around the world. This information has been developed from WinterGreen research proprietary data bases constructed as a result of preparing market research studies that address the software, energy, healthcare, telecommunications, and hardware businesses.

YOU MUST HAVE THIS STUDY

Mid IR Sensors: Market Shares, Strategy, and Forecasts, 2013 to 2019

Table of Contents

, Mid IR Sensors Executive Summary

The study is designed to give a comprehensive overview of Mid IR Sensors market segments. Research represents a selection from the mountains of data available of the most relevant and cogent market materials, with selections made by the most senior analysts. Commentary on every aspect of the market from independent analysts creates an independent perspective in the evaluation of the market. In this manner the study presents a comprehensive overview of what is going on in this market, assisting managers with designing market strategies likely to succeed.

Mid IR Sensors Executive Summary	50
Mid-Infrared (IR) Laser Sensor Systems	57
Quantum Cascade Laser (QCL)	58
High-Performing Tunable External Cavity Tunable Laser	59
Mid IR Sensor Market Driving Forces	60
Mid IR Sensor Market Shares	64
Mid IR Sensor Market Forecasts	66

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

, Mid IR Sensors Market Description and Market Dynamics

1. MID IR SENSOR MARKET DESCRIPTION AND MARKET DYNAMICS	68
1.1 Infrared Spectroscopy	69
1.1.1 FTIR Spectroscopy Used To Establish Purity Of Chemical Compounds	69
1.1.2 Applications of Infrared Sensing Thermopiles	70
1.1.3 Process Controls Using Mid IR Sensors: Preventive and Predictive Maintenance	71
1.1.4 Residential Control Systems	71
1.1.5 White Goods (Home Appliances)	72
1.1.6 Medical and Health	72
1.1.7 Industrial Process Control	73
1.1.8 Security and Surveillance	73
1.1.9 Mid-Infrared Sensor Applications	73
1.1.10 IBM Integrated Product Change Management	75
1.2 Mid IR Sensors	80
1.2.1 Daylight Solutions and Partner Northrop Grumman Complete Major Design Review With US Army	80
1.2.2 Mid IR Sensor Target Acquisition Minefield Detection System	81
1.2.3 Positioned To Provide Wavelength Tunability And High Optical Power	82
1.2.4 ECqCL Expressed As A QC Semiconductor Chip	83
1.2.5 Advances Of Mid-Infrared Based Trace Gas Sensor	84
1.3 Semiconductor Diode Lasers Operating At Midwave-Infrared (Mid-IR) Wavelengths	85
1.4 Infrared Semiconductor Lasers	87
1.4.1 Test Applications For Mid IR Sensors	89
1.5 Smart Sensors Replace Expensive Building Control Systems	90
1.5.1 Building Control Standardization	91
1.6 Biomedical And Chemical Mid-IR SPR Based Sensor	91
1.6.1 Development Of Mid-Infrared Surface Plasmon	92
1.6.2 Sensors Utilizing Surface Plasmon Resonance (SPR)	92
1.7 Miniaturized Mid-Infrared Sensor Technologies Trends	93
1.8 Nanotechnology Is Significant	94
1.8.1 Mid IR Waveguides	97
1.8.2 Miniaturized IR Gas Sensors	97
1.9 Emerging New Fields of Mid IR Sensor Application And Outlook	99
1.10 Sol-Gel-Coated Mid-Infrared Fiber-Optic Sensors	100
1.11 Magnetic Nanoparticle Mid-Infrared Pathogen Sensor for Food Matrixes	103

, Mid IR Sensors Market Shares and Market Forecasts

WinterGreen Research, Inc.

This section selectively describes market shares, forecasts, segments, and regional revenue. Numbers are the result of primary research in all cases. Selected companies are described from an independent analyst perspective with a thumbnail sketch or analysis of their market numbers or commentary on their strengths and weaknesses. Some of the analysis is focused on looking at the topic segment by segment, including company descriptive analyses by segment and subsegment.

2. MID IR SENSORS MARKET SHARES AND MARKET FORECASTS	105
2.1 Mid-Infrared (IR) Laser Sensor Systems	105
2.1.1 Quantum Cascade Laser (QCL)	105
2.1.2 High-Performing Tunable External Cavity Tunable Laser	106
2.1.3 Mid IR Sensor Market Driving Forces	108
2.2 Mid IR Sensor Market Shares	111
2.2.1 Mid IR Sensor Market Share	115
2.2.2 FLIR Systems Multi-Sensor Mission Equipment	116
2.2.3 FLIR Mid IR Sensors	116
2.2.4 FLIR Building Inspection	116
2.2.5 FLIR Infrared Detector Design Manufacturing	117
2.2.6 FLIR Sensing Materials	117
2.2.7 SenseAir	117
2.2.8 SenseAir Carbon Dioxide Sensors	118
2.2.9 Senseair Test & Measurement Carbon Dioxide Sensors	120
2.2.10 SenseAir(Non-Dispersive Infra-Red) Technology	120
2.2.11 Structured Materials Industries	121
2.2.12 Daylight Solutions FTIR Spectroscopy	121
2.2.13 Daylight Solutions Broadly Tunable, Room-Temperature, Mid-IR Laser	121
2.2.14 Sofradir	122
2.2.15 Sofradir	122
2.2.16 Sofradir	123
2.2.17 JonDeTech	124
2.2.18 JonDeTech AB Applications of Infrared Sensing Thermopiles	125
2.2.19 ThorLabs / Maxion Technologies	132
2.2.20 Thermo Fischer Scientific / NovaWave Technologies	133
2.2.21 Thermo Fischer Scientific / NovaWave	134
2.2.22 Power Technology Quantum-Cascade Mid IR Lasers	135
2.2.23 Agiltron	135
2.2.24 Aerocrine	136
2.2.25 Bosch 137	
2.2.26 Block Engineering	138
2.2.27 II-VI Incorporated (NASDAQ: IIVI)	138

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

2.2.28	MIRTHE Center	139
2.2.29	Infrared Fiber Systems Infrared Transmitting Fibers Medical Market	140
2.2.30	M Squared Next-Generation Bio-Medical Lasers Firefly-IR	141
2.2.31	Raytheon and Lockheed Drone Mid-Infrared Lasers	142
2.2.32	Ulis 142	
2.2.33	Market Consolidation of Mid IR Sensor Companies	143
2.3	Mid IR Sensor Market Forecasts	144
2.3.1	Mid IR Sensors, High End, Units, Shipments	148
2.3.2	Mid IR Sensors Market Forecasts, Mid-Range Units	149
2.3.3	Mid IR Sensors Market Forecasts, Low End, Units	150
2.3.4	Mid IR Sensors, Total Units, Shipments	150
2.3.5	Mid IR Sensors: Dollars and Units, High End, Mid Range, and Low End, Shipments, Worldwide, 2013-2019	152
2.3.6	Mid-Infrared (IR) Laser Sensors Remotely Measure Change In Device Condition, Chemistry, and Temperature	152
2.3.7	Mid IR Spectrum	153
2.3.8	Military Mid IR Sensors	153
2.3.9	Military Mid IR Sensor Market Forecasts	154
2.3.10	Military / Airline / Space / Defense Mid Infrared (IR) Sensors Market Forecasts	155
2.3.11	Imaging and Process Control Commercial Mid IR Sensors	158
2.3.12	Healthcare Screening Using Commercial Mid IR Sensors	160
2.3.1	Healthcare Mid IR Sensor Breath Analysis Market Forecasts	162
2.3.2	Turnkey Mid-Infrared Laser Sensor Systems Are Based On Technology That Goes From 3-12 m	165
2.3.3	Fire Detection and Smart Building Mid Infrared (IR) Sensor Markets	165
2.3.4	FLIR Building Inspection	169
2.3.5	Mid IR sensors Smart Grid and Smart Building Market Forecasts	172
2.3.6	Sensors and Automation	174
2.3.7	Applications and Benefits	175
2.3.8	MID IR Sensor Analysis	177
2.3.9	Security and Homeland Security Mid IR Sensors	179
2.3.10	Law Enforcement Mid IR Sensor Market Forecasts,	183
2.3.11	Smart Electrical Grid Moves to Electronics and Sensors from Purely Mechanical Infrastructure	183
2.3.12	Carbon Dioxide Gas Sensing	184
2.3.13	Smart Grid Networking	185
2.3.14	Mid Infrared IR Sensor Technologies Basis For IR Sensing	187

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

2.3.15	Nanoparticles The Base For Mid IR Sensor Evolution	188
2.3.16	Miniaturization Significant For The Development Of Mid IR Applications	189
2.4	Mid IR Sensor Forecast and Market Opportunity Overview	189
2.4.1	Mid IR Sensors: Dollars and Units, Military, Security, Imaging, Fire Detection, and Healthcare Segments	190
2.4.2	Mid IR Sensors: Dollars and Units, High End, Mid Range, and Low End, Shipments, Worldwide, 2013-2019	192
2.4.3	Power Technology Mid IR Sensor Applications	193
2.4.4	Molecular Responses Across the MIR Spectrum	198
2.4.5	Technology Options Available in Mid IR	199
2.4.6	Diagrams To Illustrate The Technologies	202
2.4.7	Comparison of Technology Options	207
2.4.8	Products, In Which MIR Sensors Are Actually Deployed	207
2.4.9	Market Trends & Key Companies	208
2.4.10	Key Applications/Products Used By The Military	209
2.4.11	Potential Technologies and Applications of MIR Sensors	211
2.4.12	Uncooled IR Cameras	213
2.4.13	Key Developments Are Required To Make The Potential Applications Into Real Markets	214
2.4.14	Characteristics Required	216
2.4.15	Building a Robust Data Sensor Network Integration Layer	217
2.5	Smarter Planet Market Shares and Forecasts	218
2.5.1	IBM Imperatives For A Smarter Planet	221
2.5.2	IBM Positions To Support Sensor Networks	224
2.5.3	IBM Jazz.net	228
2.5.4	Smarter Planet Market Forecasts	228
2.5.5	Smarter Planet Software Market Industry Segment Forecasts	230
2.5.6	Smarter Planet Market Segment Forecasts	232
2.5.7	Link Between SOA and MIR sensors	233
2.5.8	SOA Used to Connect Mid IR Sensor Information to Analytical Software	233
2.5.9	Services Oriented Architecture (SOA) Market Driving Forces	236
2.5.1	Advantages Offered By SOA	237
2.5.2	Services Oriented Architecture SOA Market Shares	240
2.5.3	IBM SOA Dominates the Industry	243
2.5.4	Building a Robust Data Sensor Network Integration Layer	243
2.5.5	SOA Network Sensor Market Segment	244
2.5.6	Mid IR Sensor Enabled Device Market Driving Forces	245
2.5.7	SOA Market Shares	247

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

2.6 Near-Infrared Optics Segment	248
2.7 Micro Sensors	248
2.8 Mid IR Sensor Sample Prices	249
2.8.1 SenseAir® NDIR (Non-dispersive Infra-Red) Technology	249
2.8.2 MIRTHE Prototype QC Laser Based Sensors	250
2.8.3 JonDeTech	252
2.8.4 Aerocrine	253
2.9 Mid IR Sensor Regional Shipments	254

Mid IR Sensors Product Description

This section describes selected companies and selected products. Products for this market segment are described with attention to the most significant aspect of features and functions in this category of product. The juxtaposition of a range of different product descriptions from a single market category provides a really good way to access market directions and achieve market competitive analysis. This section is useful because it compliments other views of innovation, providing a clear presentation of all the alternatives for positioning products in this market. Company products are described in the appropriate sections, meaning a company is mentioned several times in the chapter in different places.

3. MID IR SENSORS PRODUCT DESCRIPTION	257
3.1 FLIR	257
3.1.1 FLIR MWIR FPAs	257
3.1.2 FLIR Photon HRC	261
3.1.3 Flir Photon HRC	262
3.1.4 FLIR Thermal Imaging Predictive Maintenance Systems	262
3.1.5 FLIR Building Inspection	263
3.1.6 FLIR Gas Detection	264
3.1.7 FLIR Emerging Markets	264
3.1.8 FLIR Technology	264
3.1.9 FLIR System Design and Integration	266
3.1.10 FLIR Sensing Materials	266
3.1.11 FLIR Lasers and Laser Components	266
3.1.12 FLIR Tactical Platforms	267
3.1.13 FLIR Tau Outputs NTSC Video	269
3.1.14 FLIR Mid IR Sensors	275
3.1.15 FLIR Government Systems Airborne MEP	279
3.1.16 FLIR Government Systems Airborne - Talon	279
3.1.17 FLIR Government Systems Unmanned - Star SAFIRE QWIP	279
3.1.18 FLIR Government Systems Unmanned - Star SAFIRE III	280
3.1.19 FLIR Government Systems Unmanned TacFLIR II	280
3.1.20 FLIR Government Systems - Products - Maritime - Star SAFIRE III	281

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

3.1.21	FLIR Government Systems - Products - Maritime - SeaFLIR II	281
3.1.22	FLIR Government Systems - Products - Land - RWSS	281
3.1.23	FLIR Government Systems - Products - Land - WideEye II	282
3.1.24	FLIR Government Systems Force Protection	282
3.1.25	FLIR EO/IR	282
3.2	Daylight Solutions	283
3.2.1	Daylight Solutions MIRcat™ Ultra-Broadly Tunable Mid-IR Laser	284
3.2.2	Daylight Solutions Mid-IR QCL Systems	285
3.2.3	Daylight Solutions Modularity Brings Flexibility	287
3.2.4	Daylight Solutions Tunable Laser Fully Automated, Hands-free Operation	287
3.2.5	Daylight Solutions Enhanced-Stability CW-Mode Hop-Free Mid-IR Laser	289
3.2.6	Daylight Solutions TLS-41000-MHF Next Generation Mode Hop-Free (MHF) Lasers	289
3.2.7	Daylight Solutions Aries™ Series - High Power, Multi-Wavelength Mid-IR Laser Systems	291
3.2.8	Daylight Solutions Lasers For Gas Sensing Instrumentation	299
3.2.9	Daylight Solutions Mid-IR HgCdTe Detectors	300
3.2.10	Daylight Solutions Thermal Laser Pointers	301
3.2.11	Daylight Solutions Tunable Laser	302
3.2.12	Daylight Solutions Broadly Tunable, Room-Temperature, Mid-IR Laser	306
3.2.13	Daylight Solutions Mid-IR	310
3.2.14	Daylight Solutions Fixed Wavelength Pulsed and CW Mid-Infrared Lasers	316
3.2.15	Daylight Solutions Mid-IR HgCdTe Detectors	319
3.2.16	Daylight Solutions Room-Temperature, Low-Noise Amplified MCT	
	Detector Core Technology	321
3.2.17	Daylight Solutions Digital Object Identifier	323
3.2.18	Power Technology Applications	324
3.2.19	Daylight Solutions Power Technology Sensors Integrated With Wireless Capability	327
3.2.20	Daylight Solutions Power Technology ECqCL Used For Illumination Applications	327
3.3	SenseAir	327
3.3.1	SenseAir CO2 Engine@K30	328
3.3.2	SenseAir CO2 Engine@ BLG	330
3.3.3	Senseair Carbon Dioxide	336
3.3.4	Senseair Test & Measurement Carbon Dioxide Sensors	337
3.3.5	Senseair Temperature Proportional To Carbon Dioxide Level	338
3.3.6	SenseAir Collaborates With Ventilation Systems Suppliers	340
3.3.7	SenseAir Measurement Platform Has Intelligence	341
3.3.8	SenseAir Carbon Dioxide Sensors	341
3.3.9	SenseAir has Collaborated With Autoliv Development and Hök	

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Instrument in developing the Next Generation Of Driver Alcohol Detection Systems	342
3.4 Sensor Switch Occupancy Sensor Products	344
3.4.1 Sensor Switch WSX 2P	345
3.4.2 Sensor Switch SSD	347
3.4.3 Sensor Switch Occupancy Sensors	349
3.4.4 Sensor Switch Technology Engineering Driven Company	351
3.4.5 Sensor Switch Passive Infrared	352
3.5 Structured Materials Industries	353
3.5.1 Structured Materials Industries SpinCVDJ Metal Organic Chemical Vapor Deposition	353
3.6 Block Engineering Quantum Cascade Laser Products	354
3.6.1 Block Engineering LaserTune: Widely Tunable Mid-Infrared Laser Source	354
3.6.2 Block Engineering MCT IR Detector Module™: Spectral Acquisition Detection	357
3.6.3 Block Engineering MCT (Mercury-Cadmium-Telluride) IR (infrared) Detector Module	358
3.6.4 Block Engineering Quantum Cascade Laser (QCL) LaserScan™	364
3.6.5 Block Engineering Quantum Cascade Laser (QCL) LaserScope™	365
3.7 Sofradir	367
3.7.1 Sofradir Mid IR LEO MW 640x512	369
3.7.2 Sofradir Mid IR MARS MW 320x256	370
3.7.3 Sofradir Mid IR SCORPIO MW 640x512	371
3.7.4 Sofradir Mid IR URANUS MW 640x512	372
3.7.5 Sofradir Mid IR AQUILA JT 384x288	373
3.7.6 Sofradir Mid IR JUPITER MW 1280x1024	374
3.7.7 Sofradir Jet IR Product	377
3.7.8 Sofradir EPSILON MW	380
3.7.9 Sofradir ROIC Modes:	383
3.8 Ekips Technologies	388
3.8.1 Ekips Technologies Breathmeter	388
3.8.2 Ekips Technologies Lasers	389
3.8.3 Ekips Technologies Laser Spectrometers	390
3.8.4 Ekips Technologies Mid-Infrared Lasers	390
3.8.5 Ekips Technologies Challenge In Quantifying Chemical Molecules	392
3.9 JonDeTech AB	392
3.9.1 JonDeTech AB Applications of Infrared Sensing Thermopiles	394
3.9.2 JonDeTech AB Preventive and Predictive Maintenance	395
3.9.3 JonDeTech Thermopile Products	396
3.9.4 JonDeTech Surface Mount Plastic Thermopiles	404
3.9.5 JonDeTech Thermopiles	405

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

3.9.6	JonDeTech Horizontal Thermocouple	406
3.9.7	JonDeTech Advantage Of Nanotechnology Vertical Thermocouple	407
3.10	Micropelt Energy Harvesting:	411
3.10.1	Micropelt Thermogenerator	412
3.10.2	Micropelt Two Micro Thermogenerators In Series	415
3.10.3	Micropelt Thermoharvester	416
3.11	EnOcean	418
3.11.1	EnOcean ECO 200 - Motion Energy Harvesting	418
3.11.2	EnOcean ECT 310 - Thermo Energy Harvesting	421
3.11.3	EnOcean Energy Harvesting Wireless Sensor Solutions	423
3.12	Agiltron / SensArrayInfrared	423
3.12.1	Agiltron Infrared Detector Products	427
3.12.2	Agiltron Lead Sulfide Infrared Detector Array	432
3.12.3	Agiltron Lead Selenide Infrared Detectors	432
3.12.4	Agiltron Lead Selenide Infrared (Pbse) Detector Array	432
3.13	Mirthe Mid IR Sensor Breath Analyzers	432
3.13.1	Mirthe Engineered Systems for Mid-IR Laser Absorption Spectroscopy	433
3.13.2	Mirthe Strategic 3-Level Framework	437
3.14	Cascade Technologies	439
3.14.1	Cascade Technologies Mid Infrared Countermeasures ICM100	439
3.14.2	Cascade Technologies CT2100 - OnStack Multigas Analyser	441
3.14.3	Cascade Technologies CT3400 - Extractive Multigas Analyser	444
3.14.4	Cascade Technologies Revolutionary Technology	445
3.14.5	Cascade Technology Implementation	446
3.15	Thorlabs/ Maxion	448
3.15.1	Thorlabs Adaptive InfraRed Imaging Spectroradiometer	449
3.15.2	Thorlabs LWIR AIRIS Chemical Vapor Sensor Applications	456
3.15.3	Thorlabs IR Camera Compatibility	457
3.15.4	Maxion Technologies Infrared Semiconductor Lasers	462
3.15.5	Maxion Technologies Turn-Key Mid-IR Laser Systems	462
3.15.6	Maxion Technologies Turn-Key Mid-IR Laser Quantum Cascade (QC) and Interband Cascade (IC) Sensors	463
3.15.7	Maxion Distributed Feedback (DFB) Single-Mode and Fabry-Perot (FP) Multi-Mode Lasers	465
3.15.8	Maxion C-Mount and NS-Mount Lasers	467
3.16	VIASPACE Ionfinity	469
3.16.1	VIASPACE Ionfinity Soft Ionization Membrane	471

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

3.17 Power Technology Quantum-Cascade Lasers	472
3.17.1 Power Technology Quantum-Cascade Lasers Blue, Violet, & UV Diode Lasers	477
3.17.2 Power Technology Infrared Viewing Devices	479
3.17.3 Power Technology Laser Modules for OEM	485
3.18 M Squared Next-Generation Bio-Medical Lasers	488
3.18.1 M Squared SolsTiS cw Ti Sapphire Laser	488
3.18.2 M Squared Lasers Firefly-IR	491
3.18.3 M Squared Lasers Firefly-THz	494
3.18.4 M Squared Firefly-THz: Compact, Widely Tunable, Pulsed Terahertz Laser Source	496
3.18.5 M Squared Lasers Product Families	496
3.18.6 M Squared ICE-BLOC® Photonic Controllers	496
3.18.7 M Squared Laser Systems	497
3.18.8 M Squared Dependable Innovation	497
3.18.9 M Squared SolsTiS™: Ultracompact, Widely Tunable, Narrow Linewidth CW Ti:Sapphire Laser	497
3.19 Thermo Fischer Scientific / NovaWave Technologies	498
3.19.1 NASA Applications For Compact UV Laser-Based Sensor Instrument	499
3.19.2 Novawave Technology Mid-Infrared Laser Source Real-time, Multispecies Greenhouse Gas Sensor	499
3.19.3 Novawave Technology Canary in a Beam Line	500
3.19.4 Novawave Technology Quasi-phase-matched DFG Lasers for Sensing	501
3.20 GE Sensors	503
3.20.1 GE Wireless Sensor Networks	504
3.20.2 GE Applications for Wireless Sensor Networks	506
3.21 Pacific Northwest National Laboratory (PNNL) Electronics and Systems Integration	507
3.21.1 Pacific Northwest National Laboratory PNNL's Electronics And Systems Integration Capability	508
3.22 Hamamatsu	510
3.22.1 Hamamatsu Infrared Detector	510
3.22.2 Hamamatsu QCL for Continuous Wave Operation At Room Temperature	513
3.22.3 Hamamatsu Laser	513
3.23 AdTech Optics	515
3.24 Opto Solutions	516
3.24.1 Opto Solutions - IR Photonics	517
3.25 Sentinel Photonics	520
3.26 Newport Corporation / ILX Lightwave	523
3.27 Aerocrine	526
3.27.1 Aerocrine Expanding Into New Markets	527
3.28 Telops IR Sensors	528
3.28.1 Telops Launches New Airborne Platform For Hyperspectral Imaging	530

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

3.28.2	Telops TEL-1000 MW Infrared Camera	532
3.29	Ulis Pro Series Ulir Pico640P	534
3.29.1	Ulis Elite Series Pico1024ET	536

Mid IR Sensors Technology

4. MID IR SENSOR TECHNOLOGY	538
4.1 Infrared Technology Overview	538
4.1.1 Daylight Solutions Core Technology	539
4.1.2 Mid-Infrared Absorption Spectroscopy Based On Quantum Cascade Lasers	541
4.1.3 Quantum Cascade Laser Technology	542
4.2 Quantum Cascade Laser Linewidth & Tunability	543
4.3 Applications	547
4.4 Mid-Infrared (Mid-IR) Laser Spectroscopy	550
4.4.1 Application of Infrared Lasers to Nanosecond Time-Resolved Condensed-Phase Samples	550
4.5 Remote Detection Of Mines	550
4.6 Thermopiles	551
4.6.1 JonDeTech: Vertical VS. Horizontal Thermopile Lead Configuration	552
4.7 Nanoparticle Dispersions	555
4.7.1 Aqueous Dispersions	555
4.7.2 JonDeTechs Thermopiles Based On Nanotechnology	555
4.7.3 Nanotechnology Particle Size In The Range Of 1-100 Nanometers	558
4.7.4 Nanoparticles	558
4.7.5 Silicon In A Battery Swells As It Absorbs Lithium Atoms	560
4.7.6 Different Shapes Of The Same Material Create Different Characteristics	561
4.7.7 Optical Properties Integrated Into New Mid IR Sensor Technology	561
4.8 Mid IR Laser Emits A Narrow Range Of Wavelengths	563
4.8.1 Interband Cascade Laser (ICL) Based Spectroscopic Trace-Gas Sensor Provides For Simultaneous Detection Of Two Atmospheric Trace Gases	564
4.8.2 Narrow Band Gap Semiconductor Laser Diodes	565
4.9 IBM Microscope 100 Million Times Finer Resolution Than Current MRI	567
4.9.1 IBM Research	568
4.9.2 Technological Trends in Microscopy	569
4.10 Battery Technology for Mid IR Sensors	571
4.10.1 Battery Chemistries Technology	572
4.11 Breath Analyzers Detect Disease	574
4.12 Improving Biomaterials For Medical Implant Applications	575
4.12.1 Bioactive Materials	576

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

4.12.2	Forming A Chemical Bond With Bone	577
4.12.3	Bioactivity Increased Through Surface Modification	577
4.12.4	Biofilms Multilayered Colonies Of Bacteria	578
4.12.5	Biofilm Formation	578
4.12.6	Biofilms As A Major Contributor To Chronic Wounds	579
4.12.7	Acute or Chronic Infection in Some Biomaterial Applications	580
4.12.8	Biomaterials Research	582
4.13	QC Technology	583
4.13.1	Components of an ECqCL	584
4.14	Schematic of Mid-Infrared Trace Gas Sensor	585
4.15	Mid-IR Sensors Standards	591
4.16	Driving Forces For Building Automation	592
4.17	Near IR Night Vision Sensors	594
4.17.1	Sensor Based Threat Detection	595
4.18	Mid-IR Non-Invasive Medical Systems	597
4.19	University of Oklahoma High-Tech Breath Test	599
4.19.1	Nanotechnology Improves Laser Performance	600
4.19.2	Nanotechnology Breath Analyzer For Kidney Failure	601
4.20	Physical Vapor Nanoparticle Synthesis	601
4.20.1	Nanophase Vapor Development Process	603
4.20.2	Nanoparticle Coatings - Discrete Particle Encapsulation	605
4.20.3	Nanoparticle Vapor Organic Dispersions	606
4.21	MIRTHE Roadmap	607
4.21.1	Near IR Laser Sensors:	608

, Mid IR Sensors Company Profiles

This section selectively describes company strategies, partners, acquisitions, and revenue by segment and regional revenue when available. Companies are described by looking at what is most interesting about that company. The descriptions collectively give a sense of market directions within the industry segment. The alphabetical listing of company thumbnail sketches provides an accessible way to find out what is going on in any particular company.

5. MID INFRARED (IR) SENSORS COMPANY PROFILES	611
5.1 AdTech Optics	611
5.2 Aerocrine	612
5.3 Agiltron / SensArrayInfrared	613
5.3.1 SensArrayInfrared	614
5.4 Alpes Lasers / ALTechnologies	615
5.4.1 Laser diodes	615
5.5 Block Engineering	615

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

5.5.1	Block Positioned To Expand Commercial Markets	616
5.5.2	Block Engineering Contracts	617
5.5.3	Block Engineering LaserScan™ Analyzer	617
5.5.4	Block Engineering: Developer Of High Performance QCL and FT-IR Spectrometers	618
5.5.5	Block MEMS Receives \$4.5 Million Development Contract for MEMS Gas Sensor	619
5.6	Bosch Group	620
5.1.1	Bosch Business Overview	620
5.6.1	Bosch Consumer Goods Sales	624
5.6.2	Bosch Business Sectors	625
5.6.3	Bosch Automotive Technology Sales	626
5.6.4	Bosch Industrial Technology Sales	626
5.6.5	Bosch Group	627
5.6.6	Bosch Healthcare Supports Independent Living At Home	628
5.6.7	Bosch Security Systems Division	629
5.6.8	Robert Bosch Healthcare	629
5.6.9	Robert Bosch Remote Patient Monitoring	630
5.6.10	Bosch Healthcare Telehealth Systems	630
5.6.11	Bosch Healthcare Health Buddy System	632
5.6.12	Bosch Addresses Role of Compliance in Telehealth Adoption	633
5.6.13	Bosch North America Veterans Health Administration	633
5.6.14	Bosch / VRI	636
5.6.15	Bosch Healthcare and GreatCall Partnership	636
5.6.16	Bosch Healthcare - Telehealth And Care Solutions Join To Become The Leading Provider Of Health, Safety, And Communication	637
5.6.17	Bosch Group and Health Hero Network	638
5.6.18	Bosch eCompass BMC050 Sensortec Innovation And Quality	639
5.6.19	Bosch Building Automation	640
5.6.20	Bosch Carbon Dioxide Ventilation IR Sensors	641
5.6.21	Bosch Motion Detectors	642
5.6.22	Bosch Smart Sensors Simplify	642
5.7	Cascade Technologies	645
5.8	Cymbet	645
5.8.1	Cymbet Team:	646
5.8.2	Cymbet Investors:	646
5.8.3	Cymbet Partners, Sales and Distribution:	647
5.8.4	Cymbet Manufacturing:	647
5.8.5	Cymbet to Open World's Highest Volume Solid-State Battery Manufacturing Facility	647
5.8.6	Cymbet Partnering with X-FAB	648

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

5.8.7	Cymbet / X-FAB, Inc.	648
5.8.8	Cymbet Expanding in Minnesota	648
5.8.9	Cymbet / LEDA	649
5.8.10	Cymbet Distribution Agreement EnerChip™ Eco-friendly Solid State Batteries	649
5.8.11	Cymbet EVAL-09 Utilizes Harnessing Ambient Energy	650
5.8.12	Cymbet Secures \$31 Million in Private Financing	650
5.9	Daylight Solutions	651
5.9.1	\$15Million Equity for Daylight Includes Northrop Grumman Funds	652
5.9.2	Daylight Solutions Manufacturing Expansion	652
5.9.3	Daylight Solutions Collaborations	653
5.9.4	Daylight Solutions and Partner Northrop Grumman Complete Major Design Review With US Army	654
5.10	Digi International	655
5.10.1	Digi International Revenue	657
5.10.2	Digi International Business Highlights:	658
5.11	Directed Vapor Technology	658
5.11.1	Directed Vapor Deposition Next Generation Coating Technology	659
5.12	Dust Networks	660
5.12.1	Dust Networks Self-Powered IPV6 Wireless Sensor Network	661
5.13	EnOcean GmbH	662
5.13.1	EnOcean Technology	663
5.13.2	EnOcean Alliance	664
5.13.3	EnOcean Technology	666
5.14	Ekips Technologies	667
5.15	Elliot Scientific	668
5.16	Finmeccanica	669
5.16.1	Finmeccanica Revenues H1 2013, H1 2012	671
5.16.2	Finmeccanica / SELEX Galileo	671
5.16.3	SELEX Galileo Inc.	671
5.16.4	SELEX Galileo Technologies	672
5.17	Ferro Solutions	673
5.17.1	Ferro Solutions	676
5.18	Flexible Electronics Concepts	680
5.19	FLIR	680
5.19.1	FLIR Systems Advanced Sensing Technologies	681
5.19.2	FLIR Training	691
5.19.3	FLIR Sales and Distribution	691
5.19.4	FLIR Sensor Systems	692
5.19.5	FLIR Systems Thermography Products	693

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

5.19.6	FLIR Systems Infrared Technology	693
5.19.7	FLIR Systems	694
5.19.8	FLIR Systems	694
5.19.9	FLIR Systems	694
5.19.10	FLIR Systems Competitive Strengths	698
5.19.11	FLIR Systems Commercial Operating Model	698
5.19.12	FLIR Systems Vertically Integrated Manufacturing	699
5.19.13	FLIR Systems Industry-Leading Market Position	699
5.19.14	FLIR Systems Broad Product Line	700
5.19.15	FLIR Systems Internally-Funded Innovation	700
5.19.16	FLIR Systems Diverse Customer Base	701
5.19.17	FLIR Systems Global Distribution Capabilities	701
5.19.18	FLIR Systems Growth Strategies	702
5.19.19	FLIR Systems Continually Reduces Costs	703
5.19.20	FLIR Systems Expands Global Reach	704
5.19.21	FLIR Systems Builds Application Awareness and Brand	705
5.19.22	FLIR Systems Complement Core Competencies with Strategic Acquisitions	705
5.19.23	FLIR Acquires Aeries Photonics, LLC	706
5.19.24	FLIR Radiometry	706
5.19.25	FLIR Predictive Maintenance	706
5.19.26	FLIR Research & Development Applications	707
5.19.27	FLIR Manufacturing Process Control	707
5.19.28	FLIR Mechanical Engineering	708
5.19.29	FLIR Infrared Detector Design Manufacturing	708
5.19.30	FLIR Integrated Circuits and Electronic Design	708
5.19.31	FLIR Software Development	708
5.19.32	FLIR Motion Control Systems	709
5.19.33	FLIR Optical Design, Fabrication and Coating	709
5.19.34	FLIR Micro-Coolers	709
5.20	GE Sensors	710
5.20.1	GE Wireless Sensor Networks	711
5.20.2	GE Applications for Wireless Sensor Networks	712
5.21	Hamamatsu	714
5.21.1	Hamamatsu Electron Tube Division	714
5.21.2	Hamamatsu Solid State Division	714
5.21.3	Hamamatsu Systems Division	715
5.21.4	Hamamatsu Laser Group	715

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

5.21.5	Hamamatsu Optical Communication Group	715
5.21.6	Hamamatsu Central Research Laboratory	715
5.21.7	Hamamatsu Tsukuba Research Laboratory	715
5.21.8	Hamamatsu Sports Photonics Laboratory	715
5.21.9	Hamamatsu PET Center	716
5.21.10	Hamamatsu Revenue	716
5.22	II-VI incorporated / Marlow Industries	718
5.22.1	II-VI Incorporated (NASDAQ: IIVI)	719
5.22.2	II-VI Revenue	720
5.22.3	II-VI / Aegis Lightwave	721
5.22.4	II-VI Incorporated / Marlow Infrared And Near-Infrared Laser Optical Elements	722
5.22.5	II-VI incorporated / Marlow Production Operations	722
5.22.6	II-VI incorporated / Marlow Primary Products	722
5.22.7	II-VI incorporated / Marlow Markets	724
5.22.8	II-VI Infrared Optics Market	725
5.22.9	II-VI One-Micron Laser Market.	726
5.22.10	II-VI Near-Infrared Optics Market.	726
5.22.11	II-VI Thermoelectric Market	728
5.23	InfraTec	731
5.24	IPG Photonics	732
5.25	Johnson Controls Sensor Products	735
5.25.1	Johnson Controls Valve Products	739
5.26	JonDeTech	741
5.27	Kidde Products Limited / Airsense Technology	742
5.28	Linear Technology / Dust Networks	745
5.28.1	Dust Networks Self-Powered IPV6 Wireless Sensor Network	746
5.29	Lockheed-Martin	748
5.29.1	Lockheed Martin Corp	749
5.29.2	Lockheed Martin Customer Base:	750
5.29.3	Lockheed Martin Organization:	750
5.29.4	Lockheed Martin Financial Performance:	750
5.29.5	Lockheed Martin Receives \$260 Million M-TADS/PNVS Production Contract	751
5.29.6	Lockheed Martin F-35 Electro-Optical Targeting System	751
5.29.7	Lockheed Martin	751
5.29.8	Lockheed Martin Defense Department Positioning	753
5.29.9	US Navy awards Lockheed Martin contract to Pioneer Technology To Efficiently Manage Groups Of Unmanned Vehicles 757	
5.30	M Squared	758
5.30.1	M Squared Next-Generation Bio-Medical Lasers	759

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

5.31 Micropelt Energy Harvester	761
5.32 MIRTHE (Mid-Infrared Technologies for Health and the Environment) National Science Foundation Engineering Research Center	761
5.33 Mirthe Mid IR Sensor Breath Analyzers	762
5.33.1 Mirthe Engineered Systems for Mid-IR Laser Absorption Spectroscopy	762
5.33.2 Mirthe Strategic 5-Level Framework	766
5.34 Nanophase Technologies	767
5.34.1 Nanomaterials Technology Energy	768
5.34.2 Nanomaterials Technology Aluminum Oxide	768
5.34.3 Nanomaterials Technology	768
5.34.4 Nanomaterials Technology Third Quarter 2011 Financial Results	769
5.34.5 Nanomaterials Technology Energy	770
5.34.6 Nanomaterials Technology Aluminum Oxide	771
5.34.7 Nanomaterials Technology	771
5.35 Newport Corporation / ILX Lightwave	772
5.35.1 Newport Markets	773
5.35.2 Newport Corporation / ILX Lightwave	775
5.35.3 ILX Lightwave Product Innovation	775
5.36 Opto Solutions	776
5.37 Pacific Northwest National Laboratory PNNL Electronics and Systems Integration	777
5.38 Physical Sciences	782
5.39 Power Technology	783
5.40 Raytheon	785
5.40.1 Raytheon Innovation	788
5.40.2 Raytheon Integrated Defense Systems (IDS)	788
5.40.3 Raytheon Intelligence and Information Systems (IIS)	789
5.40.4 Raytheon Network Centric Systems (NCS)	790
5.40.5 Raytheon Technical Services Company (RTSC)	790
5.40.6 Raytheon Missile Systems (RMS)	791
5.40.7 Raytheon Space and Airborne Systems (SAS)	791
5.41 SenseAir	792
5.42 Sensor Switch	793
5.43 Sentinel Photonics	795
5.44 Sofradir	796
5.44.1 Sofradir: Leader in cooled and uncooled IR detectors	798
5.44.2 Sofradir Subsidiary ULIS SAS	799
5.44.3 Sofradir / Electrophysics	799
5.44.4 Sofradir Infrared Company	799
5.44.5 Sofradir awarded multi-million Euro MUSIS/CSO Infrared contract	801
5.45 Structured Materials Industries	802

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

5.45.1	Structured Materials SMI Products	804
5.45.2	Structured Materials SMI Customer Advantage	805
5.46	Telops	805
5.47	Thermo Fischer Scientific / NovaWave Technologies	806
5.47.1	Thermo Fisher Scientific Revenue	807
5.47.2	Thermo Fisher Scientific Acquires Laser-Based Gas Detection Company NovaWave Technologies	809
5.47.3	NovaWave Selected for CPP Participation	810
5.47.4	Thermo Fischer Scientific / NovaWave Technologies	811
5.48	Thorlabs	811
5.48.1	Thorlabs Acquires QCL Manufacturer Maxion Technologies	812
5.48.2	Maxion Technologies	813
5.48.3	Maxion and the University of Maryland, Baltimore County	815
5.49	VIASPACE / Ionfinity	815
5.49.1	VIASPACE / Ionfinity Product Focus	816
5.49.2	VIASPACE / Ionfinity Next-Generation Chemical Analysis	818

List of Tables and Figures

, Mid IR Sensors Executive Summary

Table ES-1	62
Mid IR Sensor Market Driving Forces	62
Table ES-2	63
Technologies Impacting Mid IR Sensor Market	63
Table ES-3	65
Mid IR Sensors Market Shares, Dollars, Worldwide, 2012	65
Figure ES-4	67
Mid Infrared (IR) Sensor Shipments, Market Forecasts, Dollars, Worldwide, 2013-2019	67

Mid IR Sensors Market Description and Market Dynamics

Table 1-1	76
IBM Integrated Product Change Management Market Driving Forces	76
Figure 1-2	76
IBM Definition of Smarter Computing	76
Figure 1-3	86
Interband-Cascade (IC) Lasers	86
Table 1-4	88
Commercialization Of Mid And Long-Wavelength (3-12 Microns) Infrared Semiconductor Lasers	88
Table 1-4 (Continued)	89
Commercialization Of Mid And Long-Wavelength (3-12 Microns) Infrared Semiconductor Lasers	89
Table 1-5	96
Mid IR Sensing Systems Components	96
Table 1-6	99

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Applications For Mid IR Sensing	99
Table 1-7	101
Mid-Infrared Fiber-Optic Sensor Characteristics	101

, Mid IR Sensors Market Shares and Market Forecasts

Table 2-1	109
Mid IR Sensor Market Driving Forces	109
Table 2-2	110
Technologies Impacting Mid IR Sensor Market	110
Table 2-3	112
Mid IR Sensors Market Shares, Dollars, Worldwide, 2012	112
Table 2-4	113
Mid IR Sensors Market Shares, Dollars, Worldwide, 2012	113
Figure 2-5	119
Senseair NDIR (Non-dispersive Infra-Red) technology	119
Table 2-6	126
Key Features Of The JonDeTech Thermopile	126
Table 2-7	127
JonDeTech Thermopile Sensor Flexibility	127
Table 2-8	128
JonDeTech Thermopile Sensor Characteristics	128
Figure 2-9	129
Surface Mount Plastic Thermopile Layers	129
Figure 2-10	130
Surface Mount Plastic Thermopile	130
Figure 2-11	131
Surface Mount Plastic Thermopile	131
Table 2-12	133
Maxion Technologies Mid IR Sensor Laser products Revenue Base Areas	133
Figure 2-13	145
Mid Infrared (IR) Sensor Shipments, Market Forecasts, Dollars, Worldwide, 2013-2019	145
Table 2-14	146
Mid IR Sensor Total Market Dollars, Worldwide, 2013-2019	146
Figure 2-15	147
Mid Infrared (IR) Sensor Shipments, Units, Worldwide, Market Forecasts, 2013-2019	147
Figure 2-16	148
Mid IR Sensors, High End, Units, Shipments, Worldwide, 2013-2019	148
Figure 2-17	149
Mid IR Sensors Market Forecasts, Mid-Range, Units, Worldwide, 2013-2019	149
Figure 2-18	150
Mid IR Sensors Market Forecasts, Low End, Units, Worldwide, 2013-2019	150
Table 2-19	151
Mid IR Sensors, Units, Shipments, Worldwide, 2013-2019	151
Table 2-20	152
Mid IR Sensors: Dollars and Units, High End, Mid Range, and Low End, Shipments, Worldwide, 2013-2019	152
Figure 2-21	155
Military / Airline / Space / Defense Mid Infrared (IR) Sensors Shipments Market Forecasts, Dollars, Worldwide, 2012-2018	155
Figure 2-22	159

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Mid IR Sensor Imaging and Process Control Market Forecasts, Dollars, Worldwide, 2013-2019	159
Figure 2-23	161
Mid IR Sensor Healthcare Market Forecasts, Dollars, Worldwide, 2013-2019	161
Table 2-24	166
Smart Building Mid Infrared (IR) Sensor Uses	166
Table 2-25	167
Smart Building Mid Infrared (IR) Sensor Market Segments	167
Figure 2-26	168
Mid IR Sensor Healthcare Market Forecasts, Dollars, Worldwide, 2013-2019	168
Figure 2-27	170
Smart Building Mid Infrared (IR) Sensor Shipments Market Forecasts, Worldwide, Dollars, 2012-2018	170
Figure 2-28	171
Smart City Mid IR Sensor Shipments Market Forecasts, Dollars, Worldwide, 2012-2018	171
Figure 2-29	177
MIRTHE Compound and Vibrational Absorption Analysis	177
Figure 2-30	178
Mirthe Assessment of QC Laser Based Sensor Challenges	178
Figure 2-31	182
Mid IR Sensor Security Market Forecasts, Dollars, Worldwide, 2013-2019	182
Table 2-32	190
Mid IR Sensors: Dollars and Units, Military, Security, Imaging, Fire Detection, and Healthcare Segments, Shipments, Worldwide, 2013-2019	190
Table 2-33	192
Mid IR Sensors: Dollars and Units, High End, Mid Range, and Low End, Shipments, Worldwide, 2013-2019	192
Table 2-34	193
Power Technology Mid IR Sensor Applications	193
Table 2-35	195
Technology Mid IR Sensor Applications	195
Table 2-36	196
Applications for Instrumentation That Unambiguously Detects Trace Levels Of A Targeted Compound In Real Time	196
Table 2-37	200
Mid IR Technology Quantum-Cascade Lasers Features	200
Figure 2-38	202
Daylight Solutions' Core Technology	202
Figure 2-39	203
Senseair Carbon Dioxide Sensors	203
Figure 2-40	204
Vertical Heat Flow Model Of Jondetech Thermopiles	204
Figure 2-41	205
Jondetech Thermopile Infrared Radiation Detectors Generation Flex	205
Figure 2-42	206
Mass Spectrometry vs. Mirthe Mid IR Sensors For To Measuring Trace Gas At Ppm Or Ppb Sensitivity	206
Figure 2-43	220
Smarter Planet Market Shares, Dollars, Worldwide, First Three Quarters 2011	220
Table 2-44	221
Smarter Planet Market Shares, Dollars, Worldwide, First Three Quarters 2011	221
Figure 2-45	222

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

IBM Imperatives For A Smarter Planet	222
Table 2-46	225
IBM Positions To Support Sensor Networks	225
Figure 2-47	226
IBM Describes Smarter Plant Solutions Impact on IT	226
Figure 2-48	227
IBM Strategic Vision for Innovation	227
Figure 2-49	229
Smart Computing Software Modules Market Forecasts, Dollars, Worldwide, 2011-2017	229
Table 2-50	230
Smarter Planet Software Market Total Forecast, Dollars, Worldwide, 2011-2017	230
Table 2-51	230
Smarter Planet Software Market Industry Segment Forecasts, Dollars, Worldwide, 2011-2017	230
Table 2-52	230
Smarter Planet Software Market Industry Segment Forecasts, Percent, Worldwide, 2011-2017	230
Table 2-53	235
Types of Internet Connected Devices Likely to be Using Mid IR Sensors That Need SOA Software To Achieve Connectivity	235
Table 2-54	238
Advantages Offered by SOA	238
Figure 2-55	240
Services Oriented Architecture SOA Market Shares, Dollars, Worldwide, 2012	240
Table 2-56	241
Services Oriented Architecture SOA Application Market Shares, Dollars, Worldwide, 2012	241
Table 2-57	246
Services oriented architecture (SOA) benefits	246
Table 2-58	247
Services Oriented Architecture SOA Market Driving Forces	247
Figure 2-59	251
MIRTHE Mass Spectroscopy Pricing Assessment	251
Figure 2-60	252
MIRTHE Sensor Price Per Unit Analysis	252
Figure 2-61	255
Mid Infrared (IR) Sensor Regional Market Segments, Dollars, 2012	255
Table 2-62	256
Mid IR Sensor Regional Market Segments, 2012	256

Mid IR Sensors Product Description

Figure 3-1	257
FLIR MWIR FPAs	257
Table 3-2	258
FLIR f Infrared Indium Antimonide (InSb) Component Features	258
Table 3-3	260
FLIR MWIR Arrays Advanced ROIC On-Chip Features	260
Figure 3-4	261
FLIR Photon HRC	261
Table 3-5	263
FLIR Thermal Imaging Applications	263
Table 3-6	265
FLIR Technology	265

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Table 3-7	265
FLIR Technology Systems	265
Figure 3-8	268
FLIR Commercial Vision Systems	268
Table 3-9	270
Key Features of FLIR Tau 640 Camera	270
Figure 3-10	271
FLIR Scout Thermal Night Vision	271
Figure 3-11	272
FLIR Infrared Cameras	272
Table 3-12	273
FLIR Thermal Imaging Technology -- CBRNE, Cameras, and Industrial	273



The World Leader in Thermal Imaging

	273
Table 3-13	274
FLIR Thermal Imaging Technology - Surveillance, Police, and Science	274
Figure 3-14	276
FLIR Unmanned Laser Targeting Systems	276
Figure 3-15	278
FLIR MEP Reconnaissance, Surveillance, Target Acquisition Laser Designator	
Mid IR Sensor	278
Figure 3-16	284
Daylight Solutions MIRcat™ Ultra-Broadly Tunable Mid-IR Laser	284
Table 3-17	286
Daylight Solutions Mid-IR QCL Systems Applications	286
Table 3-18	288
Daylight Solutions Tunable Laser Functions	288
Figure 3-19	289
Daylight Solutions Enhanced-Stability CW-Mode Hop-Free Mid-IR Laser	289
Table 3-20	290
Daylight Solutions TLS-41000-MHF Next Generation Mode Hop-Free (MHF) Laser Functions	290
Table 3-21	291
Daylight Solutions Enhanced-Stability CW-Mode Hop-Free Mid-IR Laser Features	291
Figure 3-22	292
Daylight Solutions Aries™ Series - High Power, Multi-Wavelength Mid-IR Laser Systems	292
Table 3-23	293
Daylight Solutions Aries™ Series - High Power, Multi-Wavelength Mid-IR Laser Systems	293
Table 3-24	294
Daylight Solutions Mid Infrared Sensor Applications	294
Figure 3-25	296
Daylight Solutions Mid IR Sensors	296
Table 3-26	297
Daylight Solutions Monitoring	297
Figure 3-27	298
Daylight Solutions Industry Specific Solutions	298
Table 3-28	301
Daylight Solutions Mid IR Detector Key Features	301
Figure 3-29	303
Daylight Solutions Tunable Laser Tuning	303

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Figure 3-30	304
Daylight Solutions Narrow Tuning	304
Table 3-31	305
Daylight Solutions Gaussian Beam Profile	305
Table 3-32	306
Daylight Solutions EC-QCL Laser Gaussian Beam Profile	306
Table 3-33	308
Daylight Solutions Tunable Mid-IR External-Cavity CW-MHF Lasers	308
Table 3-33 (Continued)	309
Daylight Solutions Tunable Mid-IR External-Cavity CW-MHF Lasers	309
Table 3-33 (Continued)	310
Daylight Solutions Tunable Mid-IR External-Cavity CW-MHF Lasers	310
Figure 3-34	310
Daylight Solutions Mid-IR	310
Figure 3-35	312
Daylight Solutions Controller	312
Figure 3-36	313
Daylight Solutions Applications	313
Figure 3-37	313
Daylight Solutions Laserhead	313
Table 3-38	315
Daylight Solutions Tunable Mid-IR External Cavity Lasers Features	315
Table 3-39	316
Daylight Solutions Tunable Mid-IR External Cavity Lasers Advantages	316
Table 3-40	316
Daylight Solutions Products	316
Figure 3-41	317
Daylight Solutions Fixed-Wavelength Mid-IR External-Cavity Lasers	317
Table 3-42	318
Daylight Solutions Fixed-Wavelength Mid-IR External-Cavity Lasers Key Features	318
Table 3-43	319
Daylight Solutions Fixed-Wavelength Mid-IR External-Cavity Lasers Applications	319
Figure 3-44	320
Daylight Solutions Mid-IR HgCdTe Detectors	320
Table 3-45	321
Daylight Solutions Mid-IR HgCdTe Detectors Key Features	321
Table 3-46	322
Daylight Solutions Core Technology	322
Figure 3-47	323
Daylight Solutions' Core Technology	323
Table 3-48	325
Daylight Solutions Power Technology Mid IR Sensor Applications	325
Table 3-48 (Continued)	326
Daylight Solutions Power Technology Mid IR Sensor Applications	326
Figure 3-49	328
SenseAir CO2 Engine®K30	328
Table 3-50	330
SenseAir CO2 Engine®K30Benefits	330
Figure 3-51	330
SenseAir CO2 Engine® BLG	330
Table 3-52	331
SenseAir CO2 Engine® BLG Benefits	331
Table 3-53	332

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

SenseAir® CO2 Sensors	332	
Table 3-54	333	
SenseAir® CO2 Energy Saving Intelligence And Comfort Sensors	333	
Table 3-55	333	
SenseAir® CO2 Process Yield And Economic Outcome Sensors	333	
Table 3-56	334	
SenseAir® CO2 personal safety Sensors	334	
Figure 3-57	335	
SenseAir Products	335	
Figure 3-58	336	
Senseair Carbon Dioxide Sensors	336	
Figure 3-59	338	
SenseAir Carbon Dioxide Sensor	338	
Figure 3-60	339	
SenseAir Circuit Board	339	
Figure 3-61	345	
Sensor Switch WSX Wall Switch Occupancy	345	
Figure 3-62	347	
Sensor Switch SSD	347	
Table3-63	348	
Sensor Switch Occupancy Detection SSD Features	348	
Table 3-64	350	
Sensor Switch Product Highlights	350	
Figure 3-65	350	
Sensor Switch Smart Buildings	350	
Table 3-66	351	
Sensor Switch Lighting Controls Technical Services	351	
Table 3-67	352	
Sensor Switch Engineering Advances	352	
Figure 3-68	354	
Block Engineering LaserTune	354	
Table 3-69	356	
Block Engineering LaserTune Key Benefits & Advantages	356	
Figure 3-70	357	
Block Engineering MCT IR Detector Module™: Spectral Acquisition Detection	357	
Table 3-71	359	
Block Engineering MCT IR Detector Module™: Spectral Acquisition Detection Key Benefits & Advantages	359	359
Figure 3-72	359	
Block Engineering Quantum Cascade Laser	359	
Table 3-73	361	
Block Engineering Tunable Mid-IR Sources Products	361	
Figure 3-74	362	
Block Engineering LaserScope Target Size	362	
Table 3-75	363	
Block Engineering Quantum Cascade Laser Products	363	
Table 3-76	363	
Block Engineering Standoff Passive FTIR Spectroscopy Products	363	
Table 3-77	364	
Block Engineering Examples of LaserScan Functions:	364	
Table 3-78	365	
Block Engineering Laserscan Product Line Functions	365	
Table 3-79	366	
Block Engineering LaserScope Functions:	366	

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Table 3-80	366
Block Engineering Quantum Cascade Laser (QCL) LaserTune™	366
Figure 3-81	367
Sofradir Products	367
Figure 3-82	369
Sofradir Mid IR LEO MW 640x512	369
Figure 3-83	370
Sofradir Mid IR MARS MW 320x256	370
Figure 3-84	371
Sofradir Mid IR SCORPIO MW 640x512	371
Figure 3-85	372
Sofradir Mid IR URANUS MW 640x512	372
Figure 3-86	373
Sofradir Mid IR AQUILA JT 384x288	373
Figure 3-87	374
Sofradir Mid IR JUPITER MW 1280x1024	374
Figure 3-88	375
Sofradir Mid IR EPSILON MW 384x288	375
Table 3-89	376
Sofradir Mid IR EPSILON MW Applications	376
Figure 3-90	377
Sofradir Jet IR Product	377
Figure 3-91	378
Sofradir Vision IR Product	378
Figure 3-92	379
Sofradir Marine IR Product	379
Figure 3-93	380
Sofradir Helicopter IR Product	380
Figure 3-94	381
Sofradir EPSILON MW 384x288	381
Table 3-95	382
Sofradir Hand-Held Thermal Imaging UAV Applications	382
Table 3-96	383
Sofradir ROIC Modes:	383
Table 3-97	385
Sofradir Development Trends In Cooled Infrared Technology	385
Figure 3-98	387
Sofradir VEGA LW 384x288 QWIP (25µm pitch)	387
Figure 3-99	389
Eikips Technologies Biomarkers in Breath	389
Table 3-100	391
Ekips Technologies Category Examples Of Laser Emission Spectra	391
Table 3-101	393
JonDeTech AB Thermopile Features	393
Figure 3-102	394
JonDeTech AB Low-Cost, Surface Mount Thermopiles	394
Table 3-103	395
JonDeTech AB Consumer Electronics Mid IR Sensors	395
Table 3-104	396
JonDeTech AB Residential Control Systems Mid IR Sensors	396
Table 3-105	397
JonDeTech's Technology Competitive Advantages	397
Figure 3-106	398

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

JonDeTech AB JIRS3 Sensor	398
Table 3-107	400
JonDeTech AB Key Features of the Thermopile	400
Figure 3-108	401
JonDeTech AB JIRS5 Sensor	401
Figure 3-109	402
JonDeTech AB Close-up of JIRS5 Sensor	402
Figure 3-110	403
JonDeTech AB Nanowire Sensors	403
Figure 3-111	404
JonDeTech AB Linear Array of IR Sensorson Polyimide Foil	404
Table 3-112	406
JonDeTech Thermopile Applications	406
Figure 3-113	408
JonDeTech AB Vertical Heat Flow Model Of Jondetech Thermopiles	408
Figure 3-114	409
JonDeTech AB Vertical Heat Flow Model	409
Figure 3-115	410
Jondetech Thermopile Infrared Radiation Tectors Generation Flex	410
Figure 3-116	412
Micropelt Energy Harvester	412
Figure 3-117	413
Micropelt Energy Thermogenerator	413
Figure 3-118	414
Micropelt Energy Thermogenerator	414
Figure 3-119	417
Micropelt Thermoharvester	417
Figure 3-120	418
EnOcean ECO 200 - Motion Energy Harvesting	418
Table 3-121	419
EnOcean ECO 200 - Motion Energy Harvesting	419
Figure 3-122	420
EnOcean ECO 100 - Motion Energy Harvesting	420
Table 3-123	421
EnOcean Energy Harvesting Motion Converter	421
Table 3-124	421
EnOcean ECT 310 Perpetuum	421
Table 3-125	422
EnOcean Thermo Converter	422
Table 3-126	423
EnOcean Energy Converters For Energy Harvesting Wireless Applications	423
Figure 3-127	425
Agiltron Room Temperature Automated Chemical Processing (ACP) Sensors	425
Figure 3- 128	426
Agiltron Typical Room Temperature Electrical Characteristics Of Automated Chemical Processing (ACP)	426
Table 3-129	427
Agiltron Response of PbS Detectors	427
Figure 3-130	428
Agiltron Infrared Detector Configurations	428
Figure 3-131	431
Agiltron Lead Sulfide Infrared (PbS) Detector Array	431
Figure 3-132	434

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Quartz Resonator Photoacoustic Sensing Cell	434
Figure 3-133	435
Mass Spectrometry vs. Mirthe Mid IR Sensors For To Measuring Trace Gas At Ppm Or Ppb Sensitivity	435
Table 3-134	436
Mirthe Impact In Environment And Homeland Security:	436
Table 3-135	437
Mirthe Impact In Health:	437
Table 3-136	437
Mirthe Impact In Industrial Outreach:	437
Figure 3-137	438
Mirthe's Strategic 3-Level Framework	438
Figure 3-138	439
Cascade Technologies Mid Infrared Countermeasures ICM100	439
Table 3-139	440
Cascade Technologies Mid Infrared Countermeasures ICM100 Features	440
Figure 3-140	441
Cascade Technologies CT2100 Analyzer	441
Table 3-141	442
Cascade Technologies CT2100 Analyzer Measurements*	442
Table 3-142	444
Cascade Technologies Analyzers	444
Figure 3-143	445
Cascade Technologies Quantum Cascade Laser (QCL),	445
Table 3-144	447
Cascade Technologies Rapid Sweep Combined With High Duty Cycles Key Advantages	447
Figure 3-145	449
ThorlabsAdaptive InfraRed Imaging Spectroradiometer	449
Table 3-146	451
Physical Sciences Adaptive InfraRed Imaging Spectroradiometer Features	451
Figure 3-147	452
ThorlabsAdaptive InfraRed Unprocessed AIRIS Image Of Atmospheric Tracer Release Viewed From Above.	452
Figure 3-148	453
ThorlabsAIRIS Processed Image Showing Detected Tracer Plume Location	453
Figure 3-149	454
ThorlabsRelease Point, Emission, and Absorption of Detected Tracer Plume:	454
Table 3-150	455
Thorlabs Detected Tracer Plume Applications:	455
Table 3-151	457
THORLABS Adaptive InfraRed Imaging Spectroradiometer Applications	457
Figure 3-152	457
Thorlabs Maxion Laser Products	457
Figure 3-153	458
Maxion Products Single Mode Lasers	459
Table 3-154	460
Thorlabs / Maxion Turn-Key Laser System Integration Benefits	460
Table 3-155	460
Maxion Single Mode Laser Device Performance	461
Table 3-156	464
Maxion Technologies Infrared Semiconductor Laser Products Solutions Areas	464
Figure 3-157	466
Maxion Multimode Lasers High Heat Load Laser Package	466

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Figure 3-158	466
Maxion Turnkey Laser System Single Mode Lasers	467
Figure 3-159	468
Maxion Linear Arrays Of IC and QC Lasers -- C-mount and NS-mount Lasers	468
Figure 3-160	468
Maxion LED in a Dewar	469
Figure 3-161	471
VIASPACE Ionfinity SIM Ionizes The Sample Without Fragmentation	471
Figure 3-162	472
Ionfinity Industrial Process Control And Environmental Monitoring	472
Table 3-163	473
Power Technology Available Wavelengths & Output Powers	474
Table 3-164	474
Power Technology Applications for an infrared viewer	475
Table 3-165	476
Power Technology Quantum-Cascade Lasers Features	476
Table 3-166	477
Power Technology Quantum-Cascade Lasers Mechanical Dimensions	477
Figure 3-167	478
Power Technology Temperature Controlled Laser Diode Modules	478
Table 3-168	479
Power Technology Mid IR Sensor Applications	479
Figure 3-169	481
Power Technology Infrared Viewers	481
Figure 3-170	482
Power Technology Mid IR Specifications	482
Table 3-171	483
Power Technology Infrared Illuminator	483
Figure 3-172	484
Power Technology. Infrared Photosensitivity	484
Table 3-173	485
Power Technology Near Infrared Viewer Power Densities	485
Figure 3-174	487
Power Technology Laser Modules for OEM	487
Figure 3-175	488
M Squared SolsTiS cw Ti Sapphire Laser	488
Figure 3-176	489
M Squared in Biomedicine Laser Device	489
Table 3-177	492
M Squared Firefly-IR Applications Positioning	492
Table 3-177 (Continued)	493
M Squared Firefly-IR Applications Positioning	494
Table 3-178	495
M Squared Firefly-THz features	496
Figure 3-179	501
Novawave Technology IRIS™ 1000 Tunable Laser System	501
Table 3-180	503
Novawave Technology System Features	503
Figure 3-181	505
GE Wireless Sensor Networks	505
Table 3-182	508
PNNL Electronics Products	508
Table 3-183	509

REPORT # SH25722114

818 PAGES

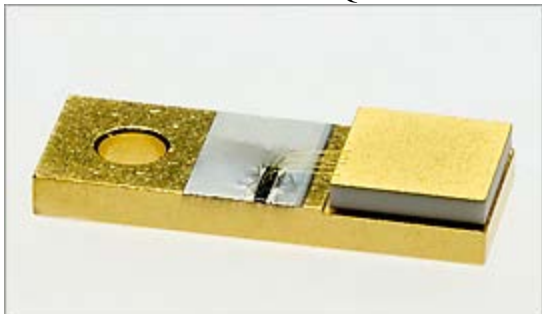
340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

PNNL System Integration	509
Figure 3-184	510
Hamamatsu Infrared Detector	510
Figure 3-185	511
Hamamatsu InGaAs Photodiodes	511
Figure 3-186	512
Hamamatsu Detectors With Sensitivity To Wavelengths	512
Figure 3-187	514
Hamamatsu Continuous-Wave QCL For Room Temperature Operation	514



	514
Table 3-188	515
Hamamatsu Laser Group Products	515
Figure 3-189	517
Opto Solutions Products	517
Table 3-190	519
Opto Solutions - IR Photonics Features and Applications	519
Figure 3-191	524
ILX Lightwave Laser Diode Instrumentation	524
Figure 3-192	526
Aerocrine NIOX MINO	526
Figure 3-193	527
Aerocrine NIOX FLEX	527
Table 3-194	529
Telops Hyper-Cam Defense and Security Applications	529
Table 3-195	529
Telops Hyper-Cam Environmental Research Applications:	529
Table 3-196	530
Telops Hyper-Cam Fundamental Research Applications:	530
Table 3-197	531
Telops Hyper-Cam New Platform Applications	531
Figure 3-198	532
Telops TEL-1000 MW Infrared Camera	532
Table 3-199	533
Telops TEL-1000 MW Infrared Camera Key Benefits	533
Table 3-200	533
Telops TEL-1000 MW Infrared Camera Applications	533
Table 3-201	534
Telops TEL-1000 MW Infrared Camera Features	534
Figure 3-202	534
Ulis Pro Series Pico640P	534
Table 3-203	535
Ulis Pico640P	535
Figure 3-204	536

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Ulis Elite Series Pico1024ET	536
Table 3-205	537
Ulis Elite Series Pico1024ET	537

Mid IR Sensors Technology

Table 4-1	540
Daylight Solutions Basic Technologies	540
Figure 4-2	545
External Cavity Quantum Cascade Laser Design	545
Figure 4-3	546
Daylight Solutions Available Tuning Ranges For cw ECqCL™. Curves In Red Have Become Available Since June, 2010	546
Figure 4-4	548
Transmission Of Light Through The Atmosphere From The Visible To The Mid-Infrared. Sources Of The Major Absorptions Are Indicated	548
Figure 4-5	549
Graphical Representation Of The Location Of Strong Absorptions Of Molecules Of Interest	549
Figure 4-6	554
Thermocouple Lead Structures Based On Nanotechnology	554
Figure 4-7	557
JonDeTechs Nanotechnology Thermopiles	557
Figure 4-8	559
Nanowire Battery Can Hold 10 Times The Charge Of Existing Lithium-Ion Battery	559
Table 4-9	569
Computerization Of Microscopic Manufacturing Procedure Benefits	569
Table 4-10	572
Battery Chemistries At The Forefront For Mid IR Sensors	572
Figure 4-11	579
Biofilm Formation	579
Figure 4-12	587
Mid IR Spectrum Wavenumber and Absorbance	587
Figure 4-13	588
Mid-Infrared Light Novel Mid-Infrared Materials	588
Figure 4-14	590
Mid-Infrared Light Sources	590
Figure 4-15	591
Mid IR Sensor Applications & Testbeds	591
Figure 4-16	599
University of Oklahoma Researchers Are Working On A High-Tech Breath Test	599
Figure 4-17	603
Physical Vapor Nanoparticle Synthesis Process	603
Figure 4-18	606
Nanophase Technologies Organic Dispersions In Manufacturing	606
Figure 4-19	607
Nanophase Technologies Organic Dispersions In Polar And Non-Polar Organic Fluids	607

, Mid IR Sensors Company Profiles

Table 5-1	620
-----------	-----

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Block Engineering LaserScope IR Microscope Key Benefits & Advantages	620
Table 5-2	643
Bosch Building Automation Sensors	643
Table 5-3	644
Bosch Building Automation Sensor Management Architecture	644
Figure 5-4	660
Directed Vapor Technology	660
Table 5-5	666
Selected Enoclean Shareholders:	666
Figure 5-6	674
Ferro Solutions Energy Harvesters And Sensors	674
Figure 5-7	675
Ferro Solutions Energy Harvesters And Sensors Target Markets	675
Table 5-8	676
Ferro Solutions Selected Clients	676
Table 5-9	677
Ferro Solutions Energy Harvester Uses	677
Table 5-10	679
Ferro Solutions FS Energy Harvester Industrial & Process Automation and Utilities	679
Table 5-11	682
FLIR Systems Advanced Sensing Technologies Benefits	682
Table 5-12	688
FLIR Systems Thermal Imaging Infrared Cameras Target Markets	688
Table 5-13	689
FLIR Systems Commercial Vision Applications	689
Table 5-14	695
FLIR Systems Sensor Applications	695
Table 5-15	696
FLIR Systems Sensor Uses	696
Table 5-16	697
FLIR Systems Sensor Market Segments	697
Table 5-17	698
FLIR Detection System Sensor Applications	698
Figure 5-18	711
GE Wireless Sensor Networks	711
Table 5-19	729
II-VI Significant Materials Capabilities	729
Table 5-20	730
II-VI Specific Growth Strategies:	730
Table 5-21	738
Johnson Controls Sensors	738
Carbon Dioxide	738
Occupancy	738
Network Sensors	738
Figure 5-22	738
Johnson Controls Sensor Products	738
Table 5-23	739
Johnson Controls Sensor Types	739
Table 5-24	740
Johnson Controls Valve Categories:	740
Figure 5-25	744
Airsense Smart Building Monitor	744
Figure 5-26	753

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

Lockheed Martin F35B In-Flight STOVL Operations	753
Figure 5-27	754
Lockheed Martin Autonomous Underwater Vehicles	754
Figure 5-28	755
Lockheed Martin C-139 J Cargo Plane	755
Figure 5-29	756
Lockheed Martin Next Generation Identification Systems	756
Figure 5-30	757
Lockheed Martin Linking Legacy Radio Waveforms to AMF JTRS	757
Figure 5-31	763
Quartz Resonator Photoacoustic Sensing Cell	763
Figure 5-32	764
Mass Spectrometry vs. Mirthe Mid IR Sensors For To Measuring Trace Gas At Ppm Or Ppb Sensitivity	764
Table 5-33	765
Mirthe Impact In Environment And Homeland Security:	765
Table 5-34	765
Mirthe Impact In Health:	765
Table 5-35	766
Mirthe Impact In Industrial Outreach:	766
Figure 5-36	767
Mirthe's Strategic Multi-level Mid IR Sensor Framework	767
Table 5-37	777
OPTO Solutions Opto 22 Systems Markets	777
Table 5-38	779
Pacific Northwest National Laboratory (PNNL) Focus	779
Table 5-39	780
Pacific Northwest National Laboratory (PNNL) Electronics Products	780
Table 5-40	781
PNNL System Integration	781
Table 5-41	784
Power Technology Laser Applications	784
Table 5-42	801
Sofradir Notable Accomplishments	801
Table 5-43	814
Maxion Technologies Laser Product Segment Positioning	814

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

ABOUT THE COMPANY

WinterGreen Research, founded in 1985, provides strategic market assessments in telecommunications, communications equipment, health care, Software, Internet, Energy Generation, Energy Storage, Renewable energy, and advanced computer technology.

Industry reports focus on opportunities that expand existing markets or develop major new markets. The reports access new product and service positioning strategies, new and evolving technologies, and technological impact on products, services, and markets. Innovation that drives markets is explored. Market shares are provided. Leading market participants are profiled, and their marketing strategies, acquisitions, and strategic alliances are discussed. The principals of WinterGreen Research have been involved in analysis and forecasting of international business opportunities in telecommunications and advanced computer technology markets for over 30 years.

The studies provide primary analytical insight about the market participants. By publishing material relevant to the positioning of each company, readers can look at the basis for analysis. By providing descriptions of each major participant in the market, the reader is not dependent on analyst assumptions, the information backing the assumptions is provided, permitting readers to examine the basis for the conclusions.

WinterGreen Research is positioned to help customers facing challenges that define the modern enterprises. The increasingly global nature of science, technology and engineering is a reflection of the implementation of the globally integrated enterprise. Customers trust wintergreen research to work alongside them to ensure the success of the participation in a particular market segment.

WinterGreen Research supports various market segment programs; provides trusted technical services to the marketing departments. It carries out accurate market share and forecast analysis services for a range of commercial and government customers globally. These are all vital market research support solutions requiring trust and integrity.

ABOUT THE PRINCIPAL AUTHORS

Ellen T. Curtiss, Technical Director, co-founder of WinterGreen Research, conducts strategic and market assessments in technology-based industries. Previously she was a member of the staff of Arthur D. Little, Inc., for 23 years, most recently as Vice President of Arthur D. Little Decision Resources, specializing in strategic planning and market development services. She is a graduate of Boston University and the Program for Management Development at Harvard Graduate School of Business Administration. She is the author of recent studies on worldwide telecommunications markets, the top ten internet equipment companies, the top ten contract manufacturing companies, and the Top Ten Telecommunications market analysis and forecasts.

Susan Eustis, President, co-founder of WinterGreen Research, is a senior analyst. She has done research in communications, healthcare equipment, and computer markets and applications. She holds several patents in microcomputing and parallel processing. She has the original patents in electronic voting machines. She has new patent applications in format varying, multiprocessing, and electronic voting. She is the author of recent studies of the Internet, Cloud Computing marketing strategies, Internet equipment, biometrics, a study of Healthcare Equipment, Worldwide Telecommunications Equipment, Top Ten Telecommunications, Digital Loop Carrier, Web Hosting, Web Services, and Application Integration markets. Ms. Eustis is a graduate of Barnard College. Ms. Eustis was named Top Woman CEO in 2012 by Who's Who Worldwide. She was named Top Woman Market Research Analyst the same year.

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING

WinterGreen Research, Inc.

ORDER FORM

Return To: WinterGreen Research, Inc.

6 Raymond Street

Lexington, MA 02421 USA

Phone: (781) 863-5078 --- Fax: (781) 863-1235 (preferred) info@wintergreenresearch.com

PLEASE ENTER MY ORDER FOR:

Mid IR Sensors: Market Shares, Strategies, and Forecasts, Worldwide, 2013-2019

-ALL REPORTS ARE AVAILABLE IN EITHER PRINT OR PDF-

_____ **PDF** _____ **PRINT**

___ ENCLOSED IS MY CHECK FOR \$3,800 FOR SINGLE COPY, \$7,600 FOR WEB SITE POSTING

___ PLEASE BILL MY COMPANY USING P.O. NUMBER _____

___ PLEASE CHARGE MY MASTERCARD/VISA/AMERICAN EXPRESS—

CARD NUMBER _____ EXP. DATE _____

If charging to a credit card use the shopping card order form on the Internet, fax, or call.

NAME _____ TITLE _____

SIGNATURE _____

COMPANY _____ DIVISION _____

ADDRESS _____

CITY _____ STATE / ZIP _____

TELEPHONE _____

FAX _____

EMAIL _____

PLEASE NOTE: RESIDENTS OF MASSACHUSETTS AND CONNECTICUT MUST INCLUDE APPROPRIATE SALES TAX

SUBSCRIBERS OUTSIDE THE UNITED STATES MUST PROVIDE PREPAYMENT IN U.S. FUNDS

REPORT # SH25722114

818 PAGES

340 TABLES AND FIGURES

2013

\$3,800 SINGLE COPY -- \$7,600 WEB SITE POSTING