Infrared detectors market
2015
From motion sensors to large arrays
Yann de Charentenay

has worked for Yole Développement in the field of MEMS, materials and compound semiconductors since 2003.

He has contributed to more than 60 marketing & technological analyses.

Since 2008, he analyses the infrared market.
## TABLE OF CONTENTS

- **Table of Contents**
- **Glossary**
- **Companies Cited in This Report**
- **Definitions**
- **Market Research Scope and Methodology**
  - **Executive Summary** p 16
  - **Overview of Infrared Detector Markets** p 39
  - **Overview of Current Infrared Detection Technologies** p 49
  - **Overview of Manufacturers Positioning and Technologies** p 77
  - **Analysis of Infrared Detector Current Applications** p 91
    - **Small detectors applications**
      - People & Motion detection
      - High-end pyrometer/ temperature measurement system
      - Low-end temperature sensors
      - Gas & fire detection
      - Spectroscopy
      - New potential application: spot thermometry for smartphones & tablets
    - **Medium arrays applications**
      - People counting for retail
      - HVAC and other medium format applications
    - **Large arrays for smart buildings**
      - Single detector vs large detectors
      - Large detectors implementation
  - **Overview of Small IR Imaging Arrays Applications** p 145
  - **General Conclusions** p 151
  - **Yole Développement Presentation** p 156

©2015 | www.yole.fr | Infrared detectors market 2015
REPORT OBJECTIVES

Report’s objectives are as follows:

1. To provide market data on key Infrared detectors market metrics & dynamics:
   - Infrared detectors sales in units & in revenue by market segment
   - Market share by player
   - Application focus on key growth areas for Infrared Technologies

2. To provide key technical insight into future technology trends and challenges.

3. To provide an in-depth understanding of IR detectors’ value chain, infrastructure and players:
   - Who are the industrial IR detectors players (IDMs, foundries, design houses) and what is their market and technological position?
   - More generally, who are the key suppliers to watch and how will the IR detector market evolve?
DEFINITIONS

• An infrared detector is a photodetector that detects infrared radiation and converts it into a signal. By using several single detection elements (called pixels), it forms an array of pixels.

• Main parts of an IR detector system:

  System
  (IR motion detector here)

  Module
  (IR motion detector here)

  Detector packaged

• IR detector systems are variable: motion detector, ear thermometer, spot thermometer, people counter…

• Modules include the packaged detector + PCB + socket + Fresnel lens option.

• Packaged detectors include: chip + ASIC + packaging + optics lens option.

• Depending on the application, ASP is mentioned for modules or detector. Overall, modules represent 20% of the sales in units except for arrays where they are dominantly used.

• Various chip size (from 1 to 80x80 pixels) and pixel pitch (from 17µ to 500µ in 2014)
MARKET RESEARCH SCOPE AND METHODOLOGY

• Market research scope
  • The report surveys uncooled infrared detectors that supply a signal to be analyzed and not an image. The detector size goes from one pixel to less than 160 by 120 pixels. The wavelengths targeted are mostly Long Wave Infrared (LWIR) from 8 to 12 microns. Some applications however use other Mid Wave Infrared (MWI) wavelengths, e.g. gas detection and spectroscopy.

  • This includes the following technologies:
    • Pyroelectric using crystal, ceramic, thin film or CMOS
    • Thermopiles
    • Microbolometers

  • An overview of small IR imager (less than 160x120) is provided in the report but Infrared imagers are covered in detail by the Uncooled Infrared Imaging market report.

  • Market estimates are done for the 2014 – 2020 time period in $ (with $1.2 = one euro conversion)
MARKET RESEARCH SCOPE AND METHODOLOGY

• Methodology:

• This research has been prepared based on:

  • Primary information sources: direct interviews with companies all along the value chain (detector manufacturers, integrators, distributors, end-users).

  • Secondary information sources: conferences, web sites, newsletters....

• All data, graphs, tables, and calculations in this report are based on Yole Développement’s investigation.
MARKET RESEARCH SCOPE AND METHODOLOGY

Sensor price vs. Sensor Resolution

4x4, 8x8, 16x16, 32x32, 64x64, 80x80, 160x120

©2015 | www.yole.fr | Infrared detectors market 2015
2015 REPORT CHANGES

New content compared to 2013 version

• Identification of current technological trends and on-going developments
• Latest industry news and analysis of the new market entrants and exits
• Introduction of linear array products used in HVAC and spectroscopy
• Removal potential applications that finally didn’t emerge: Gesture recognition and internal temperature measurement for mobiles

• In depth analysis of:
  • Mobile devices spot thermometer
  • HVAC and other medium arrays

• Changes in market forecasts
  • Specific analysis for mobiles devices spot thermometer
    • Technical challenges and supply chain analysis
    • Introduction of linear arrays in spectroscopy application
    • Higher pricing and higher market growth thanks to introduction in portable applications.
INFRARED DETECTOR MARKET FORECAST BY APPLICATION

Market forecast in revenues (in $ M)

- Motion detection is by far the dominant application in revenue along with low-end temperature sensors in 2014.

- HVAC and other medium arrays applications will become the second IR detector business in 2020 with XX% CAGR.

- First notable sales of large arrays (>32x32) for smart buildings are expected to begin in 2016, and are expected to grow at a XX % rate.

- Mobile device spot thermoter will be the other fast growth application to reach $ XX M in 2020.

CAGR 2015–2020 will be +xx % in $
**TECHNOLOGICAL ANALYSIS**

**INFRARED DETECTOR TECHNOLOGIES**

**Bosch silicon thermodiodes technology**

- The IR imaging technology has been developed by Bosch by using its high volume production MEMS pressure sensor technology:
  - 1st generation: proof of the silicon thermodiode concept (256x256 pixels) in the European ADOS project (Low Advanced Resonant Silicon Membrane, ARSM) process.
  - 2nd generation: volume production of a low-resolution (100 x 50) sensor with integrated ROIC.

2nd generation main features:
- Fully CMOS-compatible materials and processes
- New generation: developed in-house
- Boron doped silicon
- Bosch, the largest MEMS producer, is entering in the IR imaging market

**INFLUENCE OF THE OPTICS**

**Wafer Level Optics (WLO)**

- WLO are used in order to reduce optics cost. WLO are lens manufactured at the wafer level what facilitate the lenses integration into the packaging via pick and place techniques. Moreover, assembly is NOT at the wafer level, meaning that IR detector chips wafers is not assembly directly to the lenses wafers.

**SENSOR ACTIVE PIXEL AREA COMPARISON – NOT INCLUDING ROIC SURFACE**

Microbolometers have much smaller chips thanks to their small pixel pitch.

With pixel pitch reduction to 90 microns thermopile is coming close to microbolometers. Microbolometers have still much higher resolution (200s 156) but this is often not necessary to have this high resolution for smart building applications.
### Infrared Detectors Market

#### Market Share for Pyroelectric Detectors

<table>
<thead>
<tr>
<th>Year</th>
<th>Market Share 2012</th>
<th>Market Share 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Key Players

- **Pyroelectric manufacturers market share**

#### Infrared Detector Application Description

- New potential application: spot thermometry for mobile devices (smartphones, tablets, wearables).

#### Market players:

- IR detector player: Excelitas. Heimann. Hamamatsu develop InAsSb detector with high sensitivity in the 10 to 11 microns bandwidth (available before 2019).
- Integrators/users:
  - Infrared Hub with external thermometers, microphones, etc.
  - IR thermometer hub: integrated IR detector (IR sensor module).
  - Environmental hub (with Microphones, gas, pressure, humidity...)

#### Smartphone Supply Chain

- IR detectors
- Infrared Hub
- Environmental Hub
- Optical Hub

- Smartphone manufacturers
APPLICATION ANALYSIS

INFRARED DETECTOR APPLICATION DESCRIPTION

Low-end temperature sensors

- Description: Infrared detectors are already used in many low-end temperature sensor applications due to contactless temperature measurement possible with Infrared. Largest markets are medical ear and forehead thermometers. Other market is: laser printer, do-it-yourself market spot thermometer...

- 2014 IR detector market
- 2015-2020 CAGR
- Market drivers: in-house temperature measurement
- Average 2014 do-it-yourself
- Technology used
- Detector format
  - Single element
  - System price range
- Market players
  - IR detector
  - IR detector
  - Integrator
  - User
- Main market trends
  - Thermopiles

INFRARED DETECTOR APPLICATIONS

People counting for retail applications

- Description: People counting modules are used for two different people applications:
  - Store and security areas: By a crucially by
  - Queue management
- Irisys introduced infrared counting area.
- This application

INFRARED DETECTOR APPLICATIONS

Motion detection, the largest IR market, is still growing fast (+11% year thanks to increased need for energy saving and transition from dual pixels to quad detectors.

New array applications such as IP/AV, people counting have started to generate significant sales and are progressively moving to higher resolution. Emerging smart building automation will start in 2016 thanks to array size cost reduction.
APPLICATION ANALYSIS

LARGE ARRAYS FOR SMART BUILDINGS

Small detectors vs Large arrays: toward many more functions

- Dual pixel PIR motion detector
- Four pixel (Quad) Presence detector
- Medium array (4x4 – 16x16)
- Large array (32x32 – 80x80)

SMART BUILDINGS SUPPLY CHAIN

New players: Lighting manufacturers, the Trojan horse for large arrays in smart buildings?

- Lighting is the first sensor choice for smart buildings. Lighting manufacturers are natural candidates to offer smart lighting solutions.
- Moreover lighting manufacturers have a good grasp of what is the most appropriate lighting control. They can communicate directly with the users, and consequently have a better offer in smart buildings.
- Large arrays allow better positioning of the PIR arrays. A key parameter for a smart buildings application.
- Key luminaires: Osram, Sylvania (U.S.)

LARGE ARRAYS TECHNOLOGIES FOR SMART BUILDINGS APPLICATIONS

- New technologies: Infrared (thermopiles, Pyro CMOS).
- Pyro CMOS is well positioned in terms of cost and technical readiness.

Smart buildings applications:
- Cost target: the lowest is the best. Below $10 a significant threshold to reach large adoption.
- Thermopiles and large CMOS arrays are well positioned.
- Resolution target: the highest is the best. High resolution will enable wider surface coverage and more available functions.
- Thermopiles focus on 32x32 in order to reduce the cost. IR imaging technologies focus on 80x80 but they originally were present on much higher resolution. Those expensive technologies will need to reduce strongly their cost in the future to enter the market.
FIELDS OF EXPERTISE

Yole Développement’s 30 analysts operate in the following areas:

- Imaging
- Photonics
- MEMS & Sensors
- Compound Semi.
- LED
- Power Electronics
- Energy Conversion
- Advanced Packaging
- MedTech
- Manufacturing
4 BUSINESS MODELS

- **Consulting and Analysis**
  - Market data & research, marketing analysis
  - Technology analysis
  - Strategy consulting
  - Reverse engineering & costing
  - Patent analysis
  
  www.yole.fr

- **Financial services**
  - M&A (buying and selling)
  - Due diligence
  - Fundraising
  - Maturation of companies
  - IP portfolio management & optimization

  www.yolefinance.com
  www.bmorpho.com

- **Reports**
  - Market & Technology reports
  - Patent Investigation and patent infringement risk analysis
  - Teardowns & Reverse Costing Analysis
  - Cost Simulation Tool

  www.i-Micronews.com/reports

- **Media**
  - i-Micronews.com website
  - @Micronews e-newsletter
  - Technology magazines
  - Communication & webcast services
  - Events

  www.i-Micronews.com
A GROUP OF COMPANIES

Market, technology and strategy consulting
www.yole.fr

M&A operations
Due diligence
www.yolefinance.com

Fundraising
Maturation of companies
IP portfolio management & optimization
www.bmorpho.com

Manufacturing costs analysis
Teardown and reverse engineering
Cost simulation tools
www.systemplus.fr

IP analysis
Patent assessment
www.knowmade.fr
OUR GLOBAL ACTIVITY

- Paris
- Nantes
- Nice
- HQ in Lyon
- Yole Korea
- Yole Japan
- Yole Inc.

40% of our business

30% of our business

30% of our business
Custom analysis scope is defined with you to meet your information and budget needs.
Our analysts provide market analysis, technology evaluation, and business plan along the entire supply chain.
We are working across multiple industries to understand the impact of More-than-Moore technologies from system to system.

From A to Z...
• Yole Développement publishes a comprehensive collection of market & technology reports and patent analysis in:
  • MEMS & Sensors
  • Imaging
  • Medical technologies (MedTech)
  • Advanced packaging
  • Power electronics
  • Compound semiconductors
  • OLED, LED & Laser diode
  • Semiconductor Manufacturing
  • Photovoltaics
  • Batteries

• Our reports are unmatched in quality and technology depth and typically include:
  • Technology trends and evolution: costs, barriers, roadmaps, etc.
  • Supply & value chain analysis: business models, relationships, value flows, etc.
  • In-depth analysis of applications and market drivers: challenges, inflection points, etc.
  • Market data ($, units, wafer starts, etc.)

• Every year, Yole Développement, System Plus Consulting and KnowMade publish +60 reports.
• Take the full benefit from our Bundle and Annual Subscription offers.
OUR 2015 PUBLISHED REPORTS LIST

- MEMS & SENSORS
  - Sensors and Data Management for Autonomous Vehicles
  - Sensors for Wearable Electronics And Mobile Healthcare
  - Status of the MEMS Industry
  - Uncooled Infrared Imaging Technology & Market Trends
  - IR Detector and Small Size Imagers
  - High End Gyro, Accelerometers and IMU
  - Non Volatile Memory Markets and Technology Trends

- IMAGING & OPTOELECTRONICS
  - Camera Module Packaging (Vol 1: Market & Technology Trends / Vol 2 Teardowns & Reverse Engineering)
  - Uncooled Infrared Imaging Technology & Market Trends
  - Status of the CMOS Image Sensors

- MEDTECH
  - Microfluidic for Sample Preparation
  - Microfluidic Applications
  - Sensors for Wearable Electronics And Mobile Healthcare

- COMPOUND SEMICONDUCTORS
  - Sapphire Applications & Market 2015: from LED to Consumer Electronics
  - Status of Wide Band Gap Material: GaN, SiC (and also AlN, Ga2O3, Diamond as a trend)
  - GaN and SiC Devices for Power Electronics Applications

- LED
  - LED Module Technologies
  - UV LED - Technology, Manufacturing and Application Trends
  - Phosphors & Quantum Dots 2015: LED Downconverters for Lighting & Displays
  - Sapphire Applications & Market 2015: from LED to Consumer Electronics

- POWER ELECTRONICS
  - Power Packaging Technology Trends and Market Expectations
  - Thermal Management for LED and Power
  - Power Electronics for Renewable Energy
  - Energy Management for Smart Grid, Cities and Buildings: Opportunities for battery electricity storage solutions
  - Status of Chinese Power Electronics Industry
  - New Technologies and Architectures for Efficient Data Center
  - IGBT Market and Technology Trends
  - Status of Power Electronics Industry
  - Status of Wide Band Gap Material: GaN, SiC (and also AlN, Ga2O3, Diamond as a trend)
  - GaN and SiC Devices for Power Electronics Applications

- ADVANCED PACKAGING
  - Advanced Packaging in Emerging Markets in China®
  - Status of the Advanced Packaging Industry
  - Supply Chain Readiness for Panel Manufacturing in Packaging
  - Fan-in Wafer Level Packaging: Market and Technology Trends
  - Flip Chip Business Update
  - 2.5D & 3DIC Business Update®
  - Fan-Out and Embedded Die: Technologies & Market Trends

- MANUFACTURING
  - Photolithography Equipment and Materials for Advanced Packaging, MEMS and LED Applications
  - Thinning & Dicing Equipment for Advanced Packaging, MEMS, Photovoltaics, LED, CMOS Image Sensors
  - Non Volatile Memory Markets and Technology Trends

- Reports to be decided within 2015
MICRONEWS MEDIA

- **About Micronews Media**

  Micronews Media, powered by Yole Développement, ensures you the best visibility in the disruptive semiconductor community. With our services, we help you to reach your customers worldwide with the media products they prefer, including our website, e-newsletter, webcasts, and magazines. Invest in a high added-value editorial program and get access to Yole Développement’s network (48 000+ contacts).

- **Five supports and channels for your visibility**

  - A **technology magazine** to highlight your visibility with advertisements, company profiles, product descriptions and white papers
  - A **webcast** to highlight your expertise and develop your business identifying commercial leads
  - **Articles, advertisements & logo and banners** dedicated to your company, its products and expertise in @Micronews e-newsletter and on i-Micronews.com
COMMUNICATION SERVICES

• All services listed below are available on-demand.

  o i-Micronews.com, the website
    • Slider – Banners (on English or Japanese websites) – Articles – Logo and profile as sponsor
  o @Micronews, the e-newsletter
    • Headline article - Tiles
  o Custom webcast
    • Develop your dedicated event with a high added-value program. A turnkey event with Yole support (logistics, promotion, data…)
  o Technology Magazines: Custom – Co-produced
    • Increase your visibility through a dedicated technology magazine with ads, company profile, product descriptions and white papers. It can be a custom magazine: your company is the only one to benefit from it – or a co-produced one: up to 2 companies.

• Contacts:
  • Camille Veyrier (veyrier@yole.fr) and Clotilde Fabre (fabre@yole.fr), Media & Communication Coordinators.
CONTACT INFORMATION

• Consulting and Specific Analysis
  • North America: Steve LaFerriere, Director of Northern America Business Development
    Email: laferriere@yole.fr
  • Japan: Yutaka Katano, General Manager, Yole Japan & President, Yole K.K.
    Email: katano@yole.fr
  • RoW: Jean-Christophe Eloy, CEO & President, Yole Développement
    Email: eloy@yole.fr

• Report business
  • North America: Steve LaFerriere, Director of Northern America Business Development
    Email: laferriere@yole.fr
  • Europe: Fayçal El Khamassi, Headquarter Sales Coordination & Customer Service
    Email: khamassi@yole.fr
  • Japan & Asia: Takashi Onozawa, Sales Asia & General Manager, Yole K.K.
    Email: onozawa@yole.fr
  • Korea: Hailey Yang, Business Development Manager, Korean Office
    Email: yang@yole.fr

• Financial services
  • Jean-Christophe Eloy, CEO & President
    Email: eloy@yole.fr

• General
  • Email: info@yole.fr