Sensors for Wearable Electronics & Mobile Healthcare
# Sensors for Wearable Electronics and Mobile Healthcare

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WHO SHOULD BE INTERESTED IN THIS REPORT?

Integrators
- Understand the system level technology trends and requirements for each application
- Evaluate market potential for your components depending on performance and technology
- Understand the differentiated value of your products and technologies
- Identify new business opportunities and partners
- Monitor and benchmark your competitor’s advancements

OEM, integrators
- Evaluate the market potential of your product portfolio
- Define diversification strategies on new applications
- Find the best technologies to integrate and the best suppliers depending on your target markets
- Identify new business opportunities and partners
- Have an exhaustive analysis of the competition on a broad range of IMU field

Material supplier, manufacturing service companies
- Spot new business opportunities and prospects
- Understand the level of activity of your customers
- Understand what are the applications that will drive the volumes in 2017

Government agencies
- Find the best technologies to integrate and the best suppliers depending on your target markets
- Understand what will be the future applications to develop and benefit from the recent advances in inertial technologies
- Define technology roadmap / evaluate the benefits of using new technologies in end systems, design architectures for the next generation of systems
- Screen potential new suppliers able to provide new functionalities, or cost and size savings

R&D centers
- Evaluate market potential of future technologies and products for new applicative markets
- Identify the best candidates for technology transfer

Financial & strategic investors
- Understand the structure and value chain of the high-end inertial industry
- Estimate the potential of new technologies (tactical/inertial navigation MEMS, navigation-grade HRG…)
- Get the list of main key players and emerging start-ups of this industry worldwide

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INTRODUCTION

2015, starting year for wearable?

This document is an all new report of Yole Développement, about current trends in wearable and mobile care devices. This report will cover technology trends, applications trends, and will provide all the data and insights required to understand the market of wearable and mobile care.

Applications are described in a synthetic way in order to provide rapid access to key information (functions, specification, technical solution, geography, trends, and market evolution) and graphical representation of the industrial chain.

This report combines the best of Yole’s knowledge in the consumer sensor industry and in the medical sector. Yole regularly participates in industry conferences and tradeshows worldwide, and has close relations with most market leaders. This report synthetizes the status of the 2015 sensor industry for wearable and mobile care and also future trends.
THE RISE OF THE WEARABLE ELECTRONIC

Recent advances in telecommunications, microelectronics, sensor manufacturing and data analysis techniques have opened up new opportunities for using wearable technology in daily life to achieve a range of health outcomes.

Why do we note such interest in wearable technologies and why do we see now such interest on the consumer market and not before?

Many factors are converging to ease wearable technology integration including expanded wireless capacity (Bluetooth, Wi-Fi, WiMAX, and LTE), cellular market expansion who slows down and the need for technological companies to establish new revenue streams, in the continuously decreasing cost of data, and the significant backing from huge companies including Google, Apple, and others. However, in the past, the size of sensors and front-end electronics made it too difficult and offered inaccuracy data to use them in wearable tech to gather physiological and inertial data.

With the advent of sensors integrated in smartphones initiated in 2007, wearable simply benefits from the smooth evolution of accurate technologies already integrated in smartphones.

Today, with smaller circuits, microcontroller functions, sensor fusion and wireless data transmission, wearable sensors are now ready to flood the market...
Two markets are mature to perform well.
MEMS & SENSORS ROADMAP

From More than Moore towards Beyond Law

MEMS & Sensors enable key functionalities...

Current battleground of the industry

Industry competition
Moore

Processing
Information age

Industry competition
More than Moore

Sensing
Interaction age

Industry Competition
Beyond Moore

Actuating
Enhancement age

Telekinesis

Robotic Servants

Autonomous vehicles

Drones

Quantified self

Smart homes

Smartphones

Tablets

Laptop

Personal Computers

1980  2010  2030  2040

Acceleration

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WEARABLE: PART OF INTERNET OF THINGS WAVE

The human is a connected object

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<th>Analyze + Services</th>
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An industrial chain similar to IoT chain…
MEMS & SENSORS : THE 5 SENSES…

MEMS & sensors devices bring increased functionalities…
MARKET SEGMENTATION

THREE PURPOSES

- Manage Health
- Manage Illness
- Manage Productivity

Manage Health
Manage Illness
Manage Productivity

Healthcare/Medical
Patient monitoring
...

Wellness
...
Professional sport
...

Soldier/Worker
...
safety
...

Soldier/Worker
...
productivity
...

Infotainment
Life style
...

Consumer
...
Workload
management
...

Industrial / Defense

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ADOPTION ON THE CONSUMER MARKET

Google Glass didn’t cross the small chasm…

Fitness trackers will experiment the big chasm very soon… whereas smartwatches are expected to cross the big chasm thanks to smartphones.

Pre-chasm : requires an ambidextrous approach to product development alongside marketing to achieve product-market fit.

Making the transition between visionaries (early adopters) and pragmatists (early majority).
Many sensors are growing, and even more are emerging...
KEY ATTRIBUTES OF WEARABLE TECH PRODUCTS

6 key attributes that make a big difference

Hands-Free
Development Platform

Voic/Gesture recognition

Always-On

Low Power consumption
Instant wake
Background working/sensing

Environment-Aware

Accelerometer
Gyroscope
IMU
Compass
Camera
Microphone
Environmental sensor

Connected

Wi-Fi
Cellular
Bluetooth
NFC

3rd party apps
API partners
Accessories

Attention-Gaining

Less distracting with notifications
Short interaction

Source: MIT, KPCB
MAPPING OF A TYPICAL 2015 SMARTWATCH

2015 Golden rule: Smaller sensors for a bigger battery

Available space and battery size limit sensor’s integration…

Power Circuit Management

Wi-Fi
Bluetooth
GPS

Battery

HRM

MCU/AP

IMU

Heart Rate Monitoring

Average component size:
6-Axis IMU : 3x3x0.8 mm³
9DOF : 3x3x1 mm³
Until 2014, healthcare application has mainly driven the wearable market with more than 10M units in 2013 and reaching 16M units in 2014.

The consumer has taken the lead in 2014 with the emergence of smart bands and smartwatches. We expect a nice growth in 2015 with more than 60M units. Especially in China, with a new entrant, Xiaomi, selling smart bands at low price, $15.

Industrial market is in its infancy, applications require reliability and efficiency, which is not the case for now. We expect an early growth in 2018/2019.
SMARTWATCHES MARKET IN 2013, 2014 & 2015

And Apple disrupted the market…

2013 Smartwatches market share (Munits)

Total: 3.5 Munits

- Samsung 26%
- Sony 15%
- Pebble 11%
- Others, Counterfeit & Unlicensed 48%

2014 Smartwatches market share (Munits)

Total: 5.7 Munits

- Samsung 22%
- Others, Counterfeit & Unlicensed 33%
- Pebble 12%
- Motorola (Google) 15%
- Sony 18%

2015 Smartwatches market share (Munits) (Forecast)

Total: 26 Munits

- Samsung 8%
- Apple 72%
- Others, Counterfeit & Unlicensed 7%
- Pebble 4%
- Sony 4%
- Motorola (Google) 5%
Fitness tracker is a fragmented and competitive market

2013 Fitness tracker market share (Munits)
- Fibbit: 61%
- Nike: 15%
- Jawbone: 14%
- Misfit: 5%
- Others, Counterfeit & Unlicensed: 5%

Total: 7.4 Munits

2014 Fitness tracker market share (Munits)
- Fibbit: 64%
- Jawbone: 18%
- Others, Counterfeit & Unlicensed: 6%
- Misfit: 9%
- Nike: 3%

Total: 17.1 Munits

2015 Fitness tracker market share (Munits) (Forecasts)
- Fibbit: 63%
- Jawbone: 15%
- Others, Counterfeit & Unlicensed: 8%
- Xiaomi: 5%
- Misfit: 9%

Total: 39.1 Munits
We already highlighted the similarities between the wearables and the smartphones, but they also shared technical challenges, with an additional challenge for the wearable: allocated space is much smaller than ever.

Four challenges:

- Size
- Power consumption
- Connectivity
- Accuracy
Wearable devices are very close to smartphones...

Source: ABI Research/Chipworks
Pictures courtesy of Apple Inc.
The market is still dominated by IDMs: STMicroelectronics and Bosch Sensortec.

Many newcomers choose a fabless business model. They follow the success of InvenSense.

Growth of MEMS product portfolio is also driving new strategies:

MEMS players are still very specialized in one type of device.
Only few players have been able to be more diversified:
- STMicroelectronics and Bosch mainly.
- Others are very focused. Indeed the expertise is very different from one MEMS device to another. All players are trying to get market share with new sensors but industrial processes are very complex.
- Some large MEMS players claim that their objective is to become large and diversify MEMS vendors. But it will not be easy, as each type of sensor/actuator is very different to another and as it takes time to bring it to the commercialization level (with good quality and good yield to offer low prices…).

There are different strategies that are employed by MEMS players: Internal development. But it takes time and it is not easy for a new component:

- Partnership with a specialist. e.g., STMicroelectronics with Omron for microphone.
- Acquisition of existing development and expertise; e.g., InvenSense purchased the MEMS microphone business line of Analog Devices Inc. (ADI) for $100M.
STMICROELECTRONICS IMU LSM6DS3

STMicroelectronics reduced the footprint of their latest IMU by 50% to fit with wearable requirements.

RELATED REPORTS

MEMS and Sensors for Mobile Phones and Tablets

Huge MEMS for Cellphones and Tablets Market Reaching $6.2B by 2015. Non-MEMS sensors are also exploding!

Sensors & Technologies for The Internet of Things

Businesses & Market Trends 2014 - 2024

May 2014

The Internet of Things (IoT) provides big opportunities for technologies. The device business will reach $64B in 2024, contributing to a total IoT market of $850B.

Sensors for Home Health Care

Market & Technology Analysis

Reverse Costing Analysis

STMicroelectronics LSM6DS3
6-Axis MEMS IMU

Bosch Sensortec BME280
Integrated Environmental Sensor

More reports on www.i-micronews.com

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Wearable electronics is one of the consumer market’s hottest topics. Giants like Apple, Samsung, Xiaomi, and Huawei are now competing for a slice of a very promising pie. Regarding our report’s analysis, we estimate that the wearable industry will reach 295M units by 2020, with a market value of $90B. Three markets will drive this impressive growth: consumer, healthcare, and industrial. Wearable technology is expected to be part of the IoT revolution, bringing useful information directly to the user in a more natural and friendly way than with traditional electronic devices. We expect the consumer market, which is mostly comprised of fitness bands and smart watches to grow faster than the other two. The healthcare market, which covers devices like hearing aids, blood pressure monitors, and back monitor sensors, is expected to grow at a lower rate, since this market has already been growing for many years. Regarding the industrial market, we expected slow, steady growth through 2019, with a significant uptick commencing in 2020. Until recently, wearable electronics were often associated with the healthcare market - typically, bulky medical devices with only a few features and not optimized for “customer-friendly” usage. Often times, these devices (i.e. hearing aids and blood pressure monitors) perform a single task and are solely dedicated to patient monitoring and/or well-being. They are not “smart devices” - their only mission is to accurately complete a single task. We believe that a large part of the healthcare market will evolve in association with the consumer market, eventually blurring the lines between healthcare and consumer devices. In fact, we think that the healthcare market will slowly merge with the consumer one, resulting in personalized medicine that involves self-monitoring of one’s health with smart and reliable devices. However, these kind of devices, which require a highly accurate, highly reliable tracking of biological signs in a non-invasive fashion, are not expected for another few years.
wave of smart bands appeared in 2008, fueled by new players like Fitbit and Jawbone; this new generation mimics the smartphone approach in that they use MEMS technologies to reduce size, increase performance and decrease power consumption. These smart devices were only able to track and digitalize the body’s real-time activity via an accelerometer, which delivered little added value to the customer. Moreover, some technical and reliability issues led to a chaotic experience for the first batch of customers. Recently, a new tech wave occurred three years ago with players like Samsung and Pebble pushing the smartwatch market, but they failed to reach a mass market due to a one-sided technological approach. Apple, the latest entrant in the wearable landscape with its Apple watch, is expected to sell 16 - 20M units this year, which would quadruple the total number of devices that its competitors sold last year (4.7M units in 2014). Why could the Apple watch achieve success? This report discusses three factors: mature technology, ecosystem, and marketing.

Regarding the industrial market, we believe that smart glasses/HUD and smart clothing will be well-suited for industrial and military applications. Virtual reality HUD and smart clothing will enhance workers’ and soldiers’ capabilities, increasing productivity and security. Such a market is evaluated at around $4B by 2020.

Wearable is certainly a promising industry – but who will profit? Wearable electronics’ market value is likely to grow from $22B in 2015 to more than $90B by 2020, with a CAGR of 28%. All these evolutions will probably lead to a mass-market adoption, here we expect more than 134M, smartwatches by 2018, along with 1.3M smart glasses/HUD by 2018. In this report, we’ll analyze the current wearable industry, what the landscape is like, who the key players, and how the industry will evolve.

The wearable industry greatly interests big companies seeking a new revenue source once the smartphone business levels off. This report highlights the expected sensors as of today, and the upcoming technologies which can sustain such developments.

MEMS ENABLER FOR SMART DEVICES WITH SENSOR FUSION AND CONTEXT AWARENESS

Today, the MEMS sensors industry has acquired from the smartphone market a strong experience in inertial sensors, microphones, and pressure or environmental sensors. Based on this experience, the MEMS players have pushed the boundaries of performance and size. Sensors are now small enough, reliable enough, and accurate enough to be included in a pocket-sized device of only 9cm³, while delivering a performance comparable to a smartphone from 2013! These sensors are the ones that we’ll find in our wearable devices until 2018. The integration of biosensors (HRM, sweat sensor, skin temperature) is more difficult due to lack of experience, and technical challenges. Moreover, battery limitation is pushing the industry towards more optimization, even on the hardware side, through either packaging innovation or new designs with lower power consumption.

Software is another area that’s acquiring value, with sensor fusion creating smarter sensors. Such improvements have led to sublime new features like context awareness or “always-on” sensors, which has increased device intelligence. All these improvements will lead the global sensors market for wearable from 112M units in 2014, to 835M units by 2020, which is proof that this market is still in its infancy.
OBJECTIVES OF THE REPORT

300+ slides, providing:

• Market data on sensors dedicated to wearable and mobile healthcare
• Unit shipments and revenue by sensor type
• Average selling price analysis and expected evolution
• Application focus on key existing markets and the most promising emerging ones
• Functions used, critical specification requirements, assembly level, and technology choices
• What are the major drivers? What will the market look like in 2020?
• An analysis of the major technology trends Evolution expected for current technologies: efficiency, price, etc.
• A deep understanding of sensors for the wearable industry, infrastructure, and players for the different business
• An extensive list of sensor manufacturers worldwide, and their technology offer
• A list of key integrators worldwide

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Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media in addition to corporate finance services. With a strong focus on emerging applications using silicon and/or micro manufacturing (technology or process), Yole Développement group has expanded to include more than 50 associates worldwide covering MEMS, Compound Semiconductors, LED, Image Sensors, Optoelectronics, Microfluidics & Medical, Photovoltaics, Advanced Packaging, Manufacturing, Nanomaterials and Power Electronics.
The group supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to develop their business.

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Branch code: 00170
Account number: 010 200 1565 87
BIC or SWIFT code: CCFRPFRP
IBAN: FR72 3005 6600 0120 0516 587

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4.2 The Seller shall only be liable for (i) direct and (ii) foreseeble pecuniary loss resulting from non-conformity of the Products or arising from a material breach of this agreement.

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a) damages of any kind, including without limitation, incidental or consequential damages (including, but not limited to, damages for loss of profits, business interruption and loss of program or data), for breach of warranty or for inability to use the Seller’s website or the Products, or any information provided on the website, or in the Products;

b) any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.

4.4 All the information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information, which cannot be guaranteed to be free from errors.

4.5 All the Products that the Seller sells may, upon prior notice to the Buyer from time to time be modified or be substituted with similar Products meeting the needs of the Buyer. This modification or substitution of these Products without prior notice to the Buyer, provided that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.6 The Buyer, upon its own inspection, it is acknowledged that the Products' defects, the Seller undertakes to replace the defective products as far as the supplies allow and without indemnities or compensation of any kind for labor costs, delays, interest in arrears, and loss of profit. The replacement is guaranteed for a maximum of two months starting from the delivery date. Any replacement is excluded for any event as set out by the Product's report, description.

4.7 The deadlines that the Seller is asked to state for the mailing of the Products are given for information only and are not guaranteed. The Seller is not held responsible for any delays, will not lead the Buyer to any damages or cancellations of the orders, except for non acceptable delays exceeding (4) months from the stated deadline, without information from the Seller. In such case only, the Buyer shall be entitled to ask for a reimbursement of its first down payment to the exclusion of any further damages.

4.8 The Seller does not make any warranties, express or implied, including, without limitation, those of sale ability and fitness for a particular purpose, with respect to the Products. Although the Seller has taken all reasonable and diligent precautions for infection of viruses, worms, Trojan horses or other codes containing malicious or destructive properties before mailing the Products, the Seller cannot guarantee that any Product will be free from infection.

5. FORCE MAJEURE

The Seller shall not be liable for any delay in performance directly or indirectly caused by or resulting from any event beyond the Seller’s control and/or arising from the Buyer's acts of nature, flood, fire, accident, riot, war, government intervention, embargoes, strikes, labor difficulties, equipment failure, late deliveries by suppliers or other difficulties which are beyond the control, and not the fault of the Seller.

6. PROTECTION OF THE SELLER's IPR

6.1 All the IPR attached to the Products are and remain the property of the Seller and its licensors, the Seller French and international copyright law and conventions.

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it, to any third party other than employees of the company. The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use the Product for purposes such as:

- Information storage and retrieval systems;
- Recordings and reproduction over any network (including any local area network);
- Use in any time-sharing, service bureau, bulletin board or similar arrangement or public display;
- Post any Product to any other online service (including bulletin boards or the Internet);
- Licensing, leasing, selling, offering for sale or assigning the Product.

6.3 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from its employee or from any person to whom the Buyer has sent the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

6.4 The Buyer shall define its company point of contact for the needs of the contract. This person will be the recipient of any report from the Seller. The Buyer shall be responsible for respect of the copyrights and will guaranty that the Products are not disseminated out of the company.

6.5 In the event of any other breach of contract, the person of contact shall decide who within the Buyer, shall be entitled to access on line the reports on 1-microwaves.com. In this respect, the Seller will give the Buyer a maximum of 10 passwords, unless the multiple sites organization of the Buyer requires more passwords. The Seller reserves the right to check from time to time the correct use of this password.

6.6 In the case of a multiple site organization, only the employee of the Buyer can access the report or the employee of the companies in which the Buyer have 100% shares. As a matter of the Buyer of a company, the joint venture done with a third party etc..cannot access the report and should pay a full license price.

7. TERMINATION

7.1 If the Buyer cancels the order in whole or in part or postpones the date of mailing, the Buyer shall indemnify the Seller for the entire costs that have been incurred as at the date of notification by the Buyer of such delay or cancellation. This may also apply for any other direct or indirect consequential consequences.

7.2 In the event of breach by one Party under these conditions or the order, the non-breaching Party may send a notification to the other by recorded delivery letter upon which, after a period of thirty (30) days without solving the problem, the non-breaching Party shall be entitled to terminate all the pending orders, without being liable for any compensation.

8. MISCELLANEOUS

8.1 All the terms and conditions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to assert and enforce these provisions against the Buyer.

Any modification of these Terms and Conditions shall be given in writing. They shall be effective upon receipt by the other Party. The Seller may, from time to time, update these Terms and Conditions and the Buyer shall add and adhere to the new version of these terms and conditions, provided they have been communicated to it in due time.

9. GOVERNING LAW AND JURISDICTION

9.1 Any dispute arising out of or linked to these terms and Conditions or any contract under these terms and conditions cannot be settled by the parties themselves.

9.2 French law shall govern the relation between the Buyer and the Seller, in accordance with these Terms and Conditions.
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  • Strategy consulting
  • Reverse engineering & costing
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- Sensors and Data Management for Autonomous Vehicles
- AlN Thin Film Markets And Applications
- Sensors for Wearable Electronics And Mobile Healthcare
- Status of the MEMS Industry
- Uncooled IR Imagers
- IR Detectors
- High End Gyro, Accelerometers and IMU
- Non-Volatile Memory
- MEMS for RF filters and Antenna Switches - BAW / SAW

IMAGING & OPTOELECTRONICS
- Camera Module Packaging (Vol 1 : Market & Technology Trends / Vol 2 Teardowns & Reverse Engineering)
- Uncooled IR Imagers
- Wafer Level Optics
- Status of the CMOS Image Sensors
- Machine Vision

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

COMPOUND SEMICONDUCTORS
- High Purity Alumina (HPA)
- Sapphire
- Wide Bandgap Materials For Power Electronics: SiC, GaN (and also Ga2O3, AlN, Diamond, Graphene… as a trend)

LED
- LED Module
- OLED for Lighting
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- LED Phosphors Market

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- Power Packaging
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- Energy Management For Smart Grid And Smart Cities
- Status of Chinese Power Electronics Industry
- New Technologies For Data Center
- Inverter Market Trends For 2013 – 2020 And Major Technology Changes*
- IGBT Markets And Application Trends
- Power Electronics for HEV/EV*
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- Advanced Packaging in Emerging Markets in China
- Status of the Advanced Packaging Industry
- Supply Chain Readiness for Panel Manufacturing in Packaging
- WLCSP*
- Flip Chip Business Update
- 2.5D & 3DIC Business Update
- Fan-Out and Embedded Business Update

MANUFACTURING
- Lithography for MEMS, Advanced Packaging and LED
- Thinning & Dicing Equipment for Advanced Packaging, MEMS, Photovoltaics, LED, CMOS Image Sensors
- Non-Volatile Memory

* Reports to be decided within 2015
OUR 2015 REPORTS PLANNING

PATENT ANALYSIS by KnowMade
- Patent Infringement (crossed analysis based on KnowMade and System Plus Consulting analysis expertise)
  - MEMS Microphone Applications
  - Infrared Imaging
- Patent Investigation (crossed analysis based on KnowMade & Yole Développement expertise)
  - Power GaN
  - MEMS Gyroscope
  - 6-axis & 9-axis Inertial MEMS IMUs
  - Microbatteries
  - Embedded Active & Passive Packages
  - Interposer
  - Phosphors for LED

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MARKET & TECHNOLOGY REPORTS
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o MEMS & SENSORS
  - Technologies & Sensors for the Internet of Things: Businesses & Market Trends 2014-2024
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  - Inertial MEMS Manufacturing Technical Trends
  - New Detection Principles & Technical Evolution for MEMS & NEMS
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o IMAGING & OPTOELECTRONICS
  - Status of the CMOS Image Sensor Industry
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o ADVANCED PACKAGING
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- GaN on Si Patent Investigation (LED, Power devices and RF Devices)
- New MEMS Devices Patent Investigation
- Non Volatile Memory Patent Investigation

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