Acoustic MEMS
(Microphone, microspeaker)
and Audio Solutions
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ACOUSTIC MEMS AND AUDIO SOLUTIONS

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OBJECTIVES OF THE REPORT

Provide a clear understanding of applications and related technologies.

Ecosystem identification and analysis:
- Determine applications range
- Technical market segmentation
- Economic requirements by segment
- Key players by market and analysis
- Market size and market forecast in $M and MUnits

Analysis and description of market and technologies involved:
- Major actors on a global basis
- Detailed applications per market segment
- Technology identification for different products and processes
- Competing technologies
- Main technical challenges
OBJECTIVES OF THE REPORT

The objectives of this report are the following:

To provide market data on MEMS microphone, microspeaker and audio solutions:
Key market metrics and dynamics
  Unit shipments and revenue by type of sensor
  Average selling price analysis and expected evolution
  Market share for each category of application, technology and performance grade

To provide application focus on key existing markets and most promising emerging ones
  Functions that are used, critical specification requirements, level of assembly and technology choices
  What are the major drivers? What will the market look like in 2021?

To provide an analysis on the major technology trends:
  Evolution expected for the current technologies: level of performance, price….
  Insight about emerging technologies

To provide a deep understanding of the value chain, infrastructure & players for the microphone and microspeaker business:
  Extensive list of sensor manufacturers worldwide and their technology offer
  List of key integrators worldwide
  Industrial chain information for each application: who supplies to whom
WHO SHOULD BE INTERESTED IN THIS REPORT?

**Integrators**
- Learn 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

**Material suppliers, manufacturing service companies**
- Spot new business opportunities and prospects
- Understand the business's activity level
- Understand which applications will drive volume

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

**OEM, integrators**
- Evaluate your product portfolio’s market potential
- 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 acoustic industry competition

**Financial & strategic investors**
- Understand the acoustic industry's structure and value chain
- See a list of the global industry's key players and emerging start-ups
Yole’s market forecast model is based on the following elementary structured blocks:
INTRODUCTION

2017 Audio MEMS Industry

This report is an update of the report “MEMS Microphone 2014” from Yole Développement, the More than Moore market and strategy research company.

More than the 5th update edition of the traditional Yole’s MEMS microphone report, this report has been enlarged to answer industry concerns about the evolution of the audio part (microphones, microspeakers and audio processing) and can be used to discover the audio MEMS market for diverse applications:

- The market is quantified for each technology and each company’s yearly shipments are estimated
- Market metrics are provided for each sensors: each application is positioned according to performance level and corresponding market size
- 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 audio MEMS industry, including microphone, microspeaker sensor/actuator and audio processing industry. Yole regularly participates in industry conferences and tradeshows worldwide, and has close relations with most market leaders. This report synthetizes the status of the 2017 audio MEMS industry in a thorough manner.
DEFINITION, AND SCOPE

Microphones, microspeakers, audio solutions

Microphone
- Transducer that converts sound into an electrical signal

Microspeaker
- Transducer that converts electrical signal into sound

Audio processing
- Specialized microprocessor for digital signal processing. Can sample, amplify, filter and/or compress continuous real-world analog signals.
MEMS
Microphone has captured the full range of consumer products and markets

MICROPHONE APPLICATIONS

Medical
- Hearing aids
- Home care/Predictive diagnosis

Industry
- Failure diagnostics (machine, pipes …)
- Business communication
- Movie/audio making industry

Automotive & Transport
- Voice command/Interface
- Shock detection

Medical
- Event localization

Military
- Office/Building surveillance
- Headset & Throat mic
- Defusing/Assault Robots

Smart Cities
- Office/Building surveillance
- Headset & Throat mic
- Defusing/Assault Robots

Low volumes

High volumes

Mobile Phones
- Voice command/Interface
- Shock detection

Smart home & Smart building
- Voice Personal Assistant (VPA)
- Access by voice command
- Sound-activated devices

Wearables
- Smart watch
- Headset (over/on/in)
- Professional headset
- Headset active noise cancellation
- Earphones (Tethered, untethered)
- HMD (AR, VR)

Smart TV, Remote, Gaming devices, robots
- Voice command/Interface
- Shock detection

PC & Tablets
- Voice command/Interface
- Shock detection

Office/Building surveillance
- Headset & Throat mic
- Defusing/Assault Robots

>1B units

>100M units

>10M units

>1M units

>1M units

>10M units

>1B units

11
HOW DO WE PERCEIVE THE EXTERNAL WORLD?

A psychological survey in 1994 by Hatwell (Hatwell, Y. (1994). Traité de psychologie expérimentale. Paris, P.U.F.) showed that 83% of our external world perception is through our vision, followed by the hearing representing 11% of our world perception.

→ Thus an high quality image is highly valued for the user – today Smartphone Bill of materials is $10 for camera module.

→ BUT the next sense we use is Hearing. Thus, we believe next innovation in MEMS & Sensors will be focus on audio for sound and voice management.

→ Gas sensors could be the next one to be valued for consumer applications.

= 7.5x
ECM and MEMS microphone markets have crossed in 2015.
MEMS MICROPHONE SNR EVOLUTION

Toward performances

Microphone SNR breakdown evolution - % - 2010/2022

- Low SNR (<60dB)
- Mid SNR (60<65dB)
- High SNR (65<70dB)
- Very High SNR (>70dB)
DIGITAL VERSUS ANALOG

Digital is gaining momentum

Analog versus Digital MEMS Microphone breakdown volume - Munits - 2010/2022
MEMS MICROPHONE VOLUME BREAKDOWN (MUNITS)

By application

Volume should keep good momentum with 11% CAGR 2017/2022 thanks to consumer market volume pull.

2010 - 2022 MEMS Microphone Market Volume Breakdown Forecast (in Munits) by applications
2016 Microphone MEMS Die Revenue Market Share by player - $M

2016 Microphone MEMS Die Volume Market Share by player - Munits

Infineon
SONY
Bosch Akustica
TSMC
Others

2016 $XXXM

2016 XXXXMu
CONSUMER MARKET TREND

Smartphones

Audio part is continuously improved step by step
Our focus: microspeakers

- **Speakers >4”**
- **Minispeakers ~2-4”**
- **Microspeakers ≤2”**

- Vibrating membrane
- Balanced Armature
Mobile drivers are pulling in different directions

- Sound Quality
  - High fidelity sound quality
  - Low distortion

- Thinner Devices
  - Reducing speaker box volume

- More Output Power with Lower Power Consumption

MOBILE MARKET TREND
μspeaker market drivers
MOVING UP THE VALUE CHAIN

AAC is one of the top player for the smartphone market

- Audio output for the phone
- Integrated by phone manufacturer

• Integrated audio package for the phone manufacturer
• Known acoustic performance
• Reduces phone manufacturing variability

Performance & Value

Integration
Imaging value chain compared to the audio value chain within a smartphone

**CURRENT VALUE**

There's room for valuable components

- **Microphone**: 
  - $1

- **ADC Amplifier DSP**: 
  - $1

- **Codec % of APU Voice processor**: 
  - $2

- **DAC Amplifier DSP**: 
  - $1

- **Stereo µSpeaker**: 
  - $3

- **Display**
  - $50

- **CIS 3x CIS auto-focus 3D imager OIS**: 
  - $20-30

- **ISP**: 
  - $4

- **% of APU/GPU**: 
  - $10

- **Display driver**: 
  - $3

- **~100**: 

(4x $0.25)
A battle to acquire value

The same battle in the smartphone field: APU vs the others

2 strategies

Combine more and more intelligence in codec / DSP discrete element

Integration of codec, DSP, algorithm within the APU

Value
System

APU
MCU
$30 - 40

Audio
Codec
$0.5 - $2

Digital
Microphone
~$0.4/sensor

Analog
Microphone
~$0.25/sensor

Audio Codec

Sensor

Courtesy of Knowles
MEMS-BASED AUDIO VALUE CHAIN

MEMS Die

- Infineon
- SONY

MEMS Microphone

- Knowles
- GoerTek
- BSE
- HOSIDEN

Audio Amplifier

- Qualcomm
- Maxim
- Texas Instruments
- Analog Devices
- Cirrus Logic
- MediaTek

Application Processor Unit

- Apple
- Samsung
- Qualcomm
- Hisilicon

Audio Codec

- FOSTER
- Knowles
- HOSIDEN

Loudspeaker

- Unisound

OEMs

- Amazon
- LG
- Asus
- Samsung
- Vivo
- Lenovo
- Oppo
- ZTE
- Xiaomi
- Coolpad
- Microsoft
- Nokia
- Gionee
- Meizu
- GoPro

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ECOSYSTEM OF THE AUDIO INDUSTRY

2017 - 2022 Forecast

The growth is expected everywhere

~$15B

2017

$4.3B

$1.7B

$8.7B

$1B CAGR +7%

$6.1B CAGR +7%

$2B CAGR +4%

~$20B CAGR ~ +6%

$12B CAGR +6.5%

$1.4B CAGR +5%

~$15B

2022

$2B CAGR +70%

$400M CAGR +70%

$1.4B CAGR +5%

$1B CAGR +7%

$8.7B

$1.7B

$4.3B

Total Audio Industry
Microphone Industry
Audio IC Industry
μSpeaker Industry
MEMS-based Microphone Industry
MEMS-based μSpeaker Industry

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Job Title: ________________________________
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City: ________________________________
State: ________________________________
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Country*: ________________________________

*VAT ID Number for EU members:

Tel: ________________________________
Email: ________________________________
Date: ________________________________

PAYMENT

BY CREDIT CARD

☐ Visa ☐ Mastercard ☐ Amex

Credit Card Number: ________________________________
Card Verification Value (3 digits except Amex: 4 digits): ________________________________
Expiration date:

BY BANK TRANSFER

BANK INFO: HSBC, 1 place de la Bourse, F-69002 Lyon, France, Bank code: 30056, Branch code: 00170
Account No: 0170 200 1565 87, SWIFT or BIC code: CCFRFRPP, IBAN: FR76 3005 6001 7001 7020 0156 587

RETURN ORDER BY

• FAX: +33 (0)472 83 01 83
• MAIL: YOLE DÉVELOPPEMENT, Le Quartz, 75 Cours Emile Zola, 69100 Villeurbanne/Lyon - France

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Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole Développement group has expanded to include more than 50 collaborators worldwide covering MEMS, Compound Semiconductors, LED, Displays, Image Sensors, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Nanomaterials, Power Electronics and Batteries & Energy Management.

The “More than Moore” company Yole and its partners System Plus Consulting, Blumorpho, KnowMade and PISEO support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to develop their business.

CONSULTING

• Market data & research, marketing analysis
• Technology analysis
• Reverse engineering & costing services
• Strategy consulting
• Patent analysis

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FINANCIAL SERVICES

• Mergers & Acquisitions
• Due diligence
• Fundraising

More information on Jean-Christophe Eloy (elay@yole.fr)

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• Collection of technology & market reports
• Manufacturing cost simulation tools
• Component reverse engineering & costing analysis
• Patent investigation

More information on www.i-micronews.com/reports

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• i-Micronews.com, online disruptive technologies website
• @Micronews, weekly e-newsletter
• Communication & webcasts services
• Events: Yole Seminars, Market Briefings…

More information on www.i-micronews.com

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9. GOVERNMENT LAW AND JURISDICTION

9.1 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into in accordance with the Seller’s Terms and Conditions shall be settled by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.

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Yole Développement

From Technologies to Market
FIELDS OF EXPERTISE

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

- Photonics
- Displays
- Solid State Lighting (LED, OLED, …)
- Compound Semi.
- Power Electronics
- Batteries / Energy Management
- Imaging
- MEMS & Sensors
- RF Devices & Techno.
- MedTech
- Manufacturing
- Advanced Packaging
- Advanced Substrates
- Solid State Lighting
- Power Electronics
- Batteries / Energy Management
- Imaging
- MEMS & Sensors
- RF Devices & Techno.
- MedTech
- Manufacturing
- Advanced Packaging
- Advanced Substrates

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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
  - Communication & webcast services
  - Events
  - www.i-Micronews.com
A GROUP OF COMPANIES

Market, technology and strategy consulting

M&A operations
Due diligences

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Innovation and business maker

www.bmorpho.com

Manufacturing costs analysis
Teardown and reverse engineering
Cost simulation tools

www.systemplus.fr

IP analysis
Patent assessment

www.knowmade.fr

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Expertise
Research & Innovation

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OUR GLOBAL ACTIVITY

40% of our business

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- Frankfurt

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- Tokyo

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- Nice

BLUMORPHO
- Paris

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- Vénissieux

PISEO
- Frankfurt

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Custom analysis scope is defined with you to meet your information and budget needs.
SERVING THE ENTIRE SUPPLY CHAIN

Our analysts provide market analysis, technology evaluation, and business plan along the entire supply chain.

Integrators and end-users

Device makers

Suppliers: material, equipment, OSAT, foundries

Financial investors, R&D centers
SERVING MULTIPLE INDUSTRIAL FIELDS

We are working across multiples industries to understand the impact of More-than-Moore technologies from device to system.

From A to Z…
Yole Développement publishes a comprehensive collection of market & technology reports and patent analysis in:

- MEMS & Sensors
- RF devices & technologies
- Imaging
- Medical technologies (MedTech)
- Photonics
- Advanced packaging
- Manufacturing
- Power electronics
- Batteries and Energy management
- Compound semiconductors
- LED
- Displays

You are looking for:

- An analysis of your product market
- A review of your competitors evolution
- An understanding of your manufacturing and production costs
- An understanding of your industry technology roadmap and related IPs
- A clear view on the evolution of the supply chain

The combined team of 50+ experts (PhDs, MBAs, industry veterans…) from Yole Développement, System Plus Consulting and KnowMade, collect information, identify the trends, the challenges, the emerging markets, the competitive environments and turn it into results to give you a complete picture of your industry landscape.

In the past 18 years, we worked on more than 1 500 projects, interacting with technology professional and high level opinion makers from the main players of the industry.

Every year, Yole Développement, System Plus Consulting and Knowmade publish +120 reports. Gain full benefit from our Bundle and Annual Subscription offers.
OUR 2017 REPORTS PLANNING (1/2)

MARKET AND TECHNOLOGY REPORTS by Yole Développement

- MEMS & SENSORS
  - Fingerprint Sensor Applications and Technologies - Consumer Market Focus 2017
  - MEMS Microphones, Speakers and Audio Solutions 2017
  - Status of the MEMS Industry 2017
  - MEMS & Sensors for Automotive 2017
  - High End Inertial Sensors for Defense and Industrial Applications 2017
  - Sensor Modules for Smart Building 2017
  - Sensing and Display for AR/VR/MR 2017 (Vol I)
  - MEMS Packaging 2017
  - Magnetic Sensors Market and Technologies 2017**
  - Microspectrometers Markets and Applications 2017**

- RF DEVICES AND TECHNOLOGIES
  - RF Components and Modules for Cellphones 2017
  - Advanced RF SiP for Cellphones 2017
  - 5G and Beyond (Vol I): Impact on RF Industry, from Infrastructure to Terminals 2017
  - 5G and Beyond (Vol 2): RF Materials Platform, from Infrastructure to Terminals 2017
  - RF Technologies for Automotive Applications 2017
  - GaN and Si LDMOS Market and Technology Trends for RF Power 2017

- IMAGING & OPTOELECTRONICS
  - 3D Imaging & Sensing 2017
  - Status of the CMOS Image Sensor Industry 2017
  - Camera Module for Consumer and Automotive Applications 2017
  - Uncooled Infrared Imaging Technology & Market Trends 2017
  - Active Imaging and LIDARS 2017 (vol I)

- MEDTECH
  - Status of the Microfluidics Industry 2017
  - Solid State Medical Imaging 2017
  - Sensors for HomeCare 2017
  - Sensors for Medical Robotics 2017
  - Organs-on-a-Chip 2017

- ADVANCED PACKAGING
  - Advanced Substrates Overview 2017
  - Status of the Advanced Packaging Industry 2017
  - Fan Out Packaging: Market & Technology Trends 2017
  - 3D Business Update: Market & Technology Trends 2017
  - Advanced QFN: Market & Technology Trends 2017**
  - Inspection and Metrology for Advanced Packaging Platform 2017**
  - Advanced Packaging for Memories 2017
  - Embedded Die Packaging: Technologies and Markets Trends 2017

- MANUFACTURING
  - Glass Substrate Manufacturing 2017
  - Equipment & Materials for Fan Out Technology 2017
  - Equipment & Materials for 3D T(X)V Technology 2017
  - Emerging Non Volatile Memories 2017

** To be confirmed
OUR 2017 REPORTS PLANNING (2/2)

- **POWER ELECTRONICS**
  - Status of Power Electronics Industry 2017
  - Power Mosfets Market and Technology Trends 2017
  - IGBT Market and Technology Trends 2017
  - Power Packaging Market and Technology Trends 2017
  - Power SiC 2017: Materials, Devices, and Applications
  - Power GaN 2017: Materials, Devices, and Applications
  - Materials Market Opportunities for Cellphone Thermal Management (Battery Cooling, Fast Charging, Data Processing, Battery Cooling, etc.) 2017
  - Gate Driver Market and Technology Trends in Power Electronics 2017
  - Power Management ICs Market Quarterly Update 2017
  - Power Electronics for Electrical Aircraft, Rail and Buses 2017
  - Thermal Management for LED and Power 2017

- **BATTERY AND ENERGY MANAGEMENT**
  - Status of Battery Industry for Stationary, Automotive and Consumer Applications 2017

- **COMPOUND SEMICONDUCTORS**
  - Power SiC 2017: Materials, Devices, and Applications
  - Power GaN 2017: Materials, Devices, and Applications
  - GaN and Si LDMOS Market and Technology Trends for RF Power 2017
  - Bulk GaN Technology Status and Market Expectations (Power, LED, Lasers) 2017

- **DISPLAYS**
  - Microdisplays and MicroLEDs 2017
  - Display for Augmented Reality, Virtual Reality and Mixed Reality 2017
  - QD for Display Applications 2017
  - Phosphors & Quantum Dots 2017 - LED Downconverters for Lighting & Displays
  - Emerging Display Technologies 2017**

- **LED**
  - UV LEDs 2017 - Technology, Manufacturing and Application Trends
  - Agricultural Lighting 2017 - Technology, Industry and Market Trends
  - Automotive Lighting 2017 - Technology, Industry and Market Trends
  - Active Imaging and Lidar 2017 (Vol 2) - IR Lighting**
  - LED Lighting Module 2017 - Technology, Industry and Market Trends
  - IR LEDs 2017 - Technology, Manufacturing and Application Trends
  - Phosphors & Quantum Dots 2017 - LED Downconverters for Lighting & Displays
  - CSP LED Module 2017
  - LED Packaging 2017

**PATENT ANALYSIS by Knowmade**
- 3D Monolithic Memory: Patent Landscape Analysis
- Microfluidic Diagnostic: Patent Landscape Analysis
- GaN Technology: Top-100 IP profiles**
- Uncooled Infrared Imaging: Patent Landscape Analysis**
- MEMS Microphone: Patent Landscape Analysis**
- MEMS Microphone: Knowles’ Patent Portfolio Analysis**
- MicroLEDs: Patent Landscape Analysis**
- Microbolometer: Patents used in products**
- Micropumps: Patent Landscape Analysis**
- Flexible batteries: Patent Landscape Analysis**

**TEARDOWN & REVERSE COSTING by System Plus Consulting**
More than 60 teardowns and reverse costing analysis and cost simulation tools to be published in 2017.

** To be confirmed
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MARKET AND TECHNOLOGY REPORTS by Yole Développement

- MEMS & SENSORS
  - Gas Sensors Technology and Market 2016
  - Status of the MEMs Industry 2016
  - Sensors for Cellphones and Tablets 2016
  - Market and Technology Trends of Inkjet Printheads 2016
  - Sensors for Biometry and Recognition 2016
  - Silicon Photonics 2016

- IMAGING & OPTOELECTRONICS
  - Status of the CMOS Image Sensor Industry 2016
  - Uncooled Infrared Imaging Technology & Market Trends 2016
  - Imaging Technologies for Automotive 2016
  - Sensors for Drones & Robots: Market Opportunities and Technology Evolution 2016

- MEDTECH
  - BioMEMS 2016
  - Point of Care Testing 2016: Application of Microfluidic Technologies

- ADVANCED PACKAGING
  - Embedded Die Packaging: Technology and Market Trends 2017
  - 2.5D & 3D IC TSV Interconnect for Advanced Packaging: Business Update 2016
  - Fan-In Packaging: Business update 2016
  - Status and Prospects for the Advanced Packaging Industry in China 2016

- MANUFACTURING
  - Thin Wafer Processing and Dicing Equipment Market 2016
  - Emerging Non Volatile Memories 2016

- COMPOUND SEMICONDUCTORS
  - Power GaN 2016: Epitaxy and Devices, Applications and Technology Trends
  - Sapphire Applications & Market 2016: from LED to Consumer Electronics
  - Power SiC 2016: Materials, Devices, Modules, and Applications

- LED
  - UV LED Technology, Manufacturing and Applications Trends 2016
  - Thermal Management Technology and Market Perspectives in Power Electronics and LEDs 2017
  - Organic Thin Film Transistor 2016: Flexible Displays and Other Applications
  - Sapphire Applications & Market 2016: from LED to Consumer Electronics
  - LED Packaging 2017: Market, Technology and Industry Landscape

- POWER ELECTRONICS
  - Power Electronics for EV/HEV 2016: Market, Innovations and Trends
  - Status of Power Electronics Industry 2016
  - Passive Components Technologies and Market Trends for Power Electronics 2016
  - Power SiC 2016: Materials, Devices, Modules, and Applications
  - Power GaN 2016: Epitaxy and Devices, Applications, and Technology Trends
  - Inverter Technologies Trends & Market Expectations 2016
  - Opportunities for Power Electronics in Renewable Electricity Generation 2016
  - Thermal Management Technology and Market Perspectives in Power Electronics and LEDs 2017

- BATTERY AND ENERGY MANAGEMENT
  - Beyond Li-ion Batteries: Present and Future Li-ion Technology Challengers 2016
  - Stationary Storage and Automotive Li-ion Battery Packs 2016
  - Opportunities for Power Electronics in Renewable Electricity Generation 2016

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PATENT ANALYSIS by Knowmade
- Microbattery Patent Landscape Analysis
- Miniaturized Gas Sensors Patent Landscape Analysis
- 3D Cell Culture Technologies Patent Landscape
- Phosphors and QDs for LED Applications Patent Landscape 2016 report
- TSV Stacked Memory Patent Landscape
- Fan-Out Wafer Level Packaging Patent Landscape Analysis

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ONSITE
Events
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