Status of the MEMS Industry 2019

Market and Technology Report - Sample
The objectives of this report are to provide:

- A global view about future for MEMS, sensors and actuators
- An understanding of the MEMS, sensors, and actuators markets and applications
- MEMS and sensor players’ dynamics and ranking
- MEMS market data in $M, units, and wafers for 2018 - 2024
- Information on future MEMS devices
- A presentation of MEMS game-changers and industry trends
- A MEMS applications overview: automotive, consumer, defense & aeronautics, medical, industrial, and telecommunications
- A MEMS financial analysis
Yole’s market forecast model is based on the matching of several sources:

**Comparison with existing data**
- Monitoring of corporate communication
- Using other market research data
- Yole analysis (consensus or not)

**Comparison with prior Yole reports**
- Recursive improvement of dataset
- Customer feedback

---

**Top-to-bottom approach**
- Aggregate of market forecasts @ System level

**Bottom-up approach**
- Ecosystem analysis
  - Aggregate of all players’ revenue @ System level

---

**Top-to-bottom approach**
- Aggregate of market forecast @ Semiconductor device level

**Bottom-up approach**
- Ecosystem analysis
  - Aggregate of key players’ revenues @ Semiconductor device level

---

**Market**

- **Volume (in Munits)**
- **ASP (in $)**
- **Revenue (in $M)**

---

**Seamless foundry activity**
- Capacity investments and equipment needs

---

**Preexisting information**

**Primary data**
- Reverse costing
- Patent analysis
- Annual reports
- Direct interviews

**Secondary data**
- Press releases
- Industry organization reports
- Conferences

**Information Aggregation**
<table>
<thead>
<tr>
<th>Glossary Acronym</th>
<th>Glossary Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADAS</td>
<td>Advanced Driver Assistance System</td>
</tr>
<tr>
<td>AF</td>
<td>Auto-Focus</td>
</tr>
<tr>
<td>AHRS</td>
<td>Attitude &amp; Heading Reference System</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AR</td>
<td>Augmented Reality</td>
</tr>
<tr>
<td>ANC</td>
<td>Active Noise Cancellation</td>
</tr>
<tr>
<td>ASIC</td>
<td>Application Specific Integrated Circuit</td>
</tr>
<tr>
<td>ASP</td>
<td>Average Selling Price</td>
</tr>
<tr>
<td>AUV</td>
<td>Autonomous Underwater Vehicle</td>
</tr>
<tr>
<td>BAP</td>
<td>Barometric Air Pressure</td>
</tr>
<tr>
<td>BAW</td>
<td>Bulk Acoustic Wave</td>
</tr>
<tr>
<td>CAGR</td>
<td>Compound Annual Growth Rate</td>
</tr>
<tr>
<td>CIS</td>
<td>CMOS Image Sensor</td>
</tr>
<tr>
<td>CMUT</td>
<td>Capacitive Micromachined Ultrasound Transducer</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>DLP</td>
<td>Digital Light Processing</td>
</tr>
<tr>
<td>DOF</td>
<td>Degree Of Freedom</td>
</tr>
<tr>
<td>DPF</td>
<td>Diesel Particulate Filter</td>
</tr>
<tr>
<td>DSP</td>
<td>Digital Signal Processing</td>
</tr>
<tr>
<td>ECG</td>
<td>ElectroCardioGram</td>
</tr>
<tr>
<td>ECM</td>
<td>Electret Condenser Microphone</td>
</tr>
<tr>
<td>ESC</td>
<td>Electronic Stability Control</td>
</tr>
<tr>
<td>FADEC</td>
<td>Full Authority Digital Engine Control</td>
</tr>
<tr>
<td>FBAR</td>
<td>Thin-Film Bulk Acoustic Resonator</td>
</tr>
<tr>
<td>GPF</td>
<td>Gasoline particulate filter</td>
</tr>
<tr>
<td>GPU</td>
<td>Graphics Processing Unit</td>
</tr>
<tr>
<td>HMD</td>
<td>Head Mounted Display</td>
</tr>
<tr>
<td>HUD</td>
<td>Heads-Up Display</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating, Ventilation &amp; Air Conditioning</td>
</tr>
<tr>
<td>IC</td>
<td>Integrated Circuit</td>
</tr>
<tr>
<td>IDM</td>
<td>Integrated Device Manufacturer</td>
</tr>
<tr>
<td>IJ</td>
<td>Ink Jet</td>
</tr>
<tr>
<td>IMU</td>
<td>Inertial Measurement Unit</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet Of Things</td>
</tr>
<tr>
<td>IP</td>
<td>Intellectual Property</td>
</tr>
<tr>
<td>IR</td>
<td>Infra Red</td>
</tr>
<tr>
<td>LWIR</td>
<td>Long Wave Infra Red</td>
</tr>
<tr>
<td>M&amp;A</td>
<td>Mergers &amp; Acquisitions</td>
</tr>
<tr>
<td>MAP</td>
<td>Manifold Air Pressure</td>
</tr>
<tr>
<td>MEMS</td>
<td>Micro Electro Mechanical Systems</td>
</tr>
<tr>
<td>MIMO</td>
<td>Multiple Input Multiple Output</td>
</tr>
<tr>
<td>MOEMS</td>
<td>Micro Opto-Electro-Mechanical Systems</td>
</tr>
<tr>
<td>MOS</td>
<td>Metal Oxide Semiconductor</td>
</tr>
<tr>
<td>NDIR</td>
<td>Non Dispersive Infra Red</td>
</tr>
<tr>
<td>NPU</td>
<td>Neural Processing Unit</td>
</tr>
<tr>
<td>OIS</td>
<td>Optical Image Stabilization</td>
</tr>
<tr>
<td>PMUT</td>
<td>Piezo Micromachined Ultrasound Transducer</td>
</tr>
<tr>
<td>PVS</td>
<td>Personal Vision Systems</td>
</tr>
<tr>
<td>PZT</td>
<td>Lead Zirconate Titanate</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>ROV</td>
<td>Remotely Operated Vehicle</td>
</tr>
<tr>
<td>SAW</td>
<td>Surface Acoustic Wave</td>
</tr>
<tr>
<td>SNR</td>
<td>Signal to Noise Ratio</td>
</tr>
<tr>
<td>SoC</td>
<td>System on Chip</td>
</tr>
<tr>
<td>SOI</td>
<td>Silicon On Insulator</td>
</tr>
<tr>
<td>TPMS</td>
<td>Tire Pressure Monitoring Systems</td>
</tr>
<tr>
<td>UAV</td>
<td>Unmanned Aerial Vehicle</td>
</tr>
<tr>
<td>UGV</td>
<td>Unmanned Ground Vehicle</td>
</tr>
<tr>
<td>V2X</td>
<td>Vehicle To Everything</td>
</tr>
<tr>
<td>VOA</td>
<td>Variable Optical Attenuator</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compound</td>
</tr>
<tr>
<td>VR</td>
<td>Virtual Reality</td>
</tr>
<tr>
<td>WLO</td>
<td>Wafer Level Optics</td>
</tr>
<tr>
<td>YoY</td>
<td>Year-on-Year</td>
</tr>
</tbody>
</table>

**GLOSSARIES**
# TABLE OF CONTENT

- Glossary and definitions 4
- Table of contents 8
- Report scope 10
- Report methodology 11
- How to use our data 12
- About the authors 13
- Companies cited in this report 14
- What we got right, What we got wrong 15
- Three-page summary 16
- Executive summary 20
- Context 37
- Market forecasts, trends, and players’ market share 58
  - Inkjet heads
  - Pressure sensors
  - Microphones
  - Inertials
  - Optical
  - Infrared
  - Si microfluidics
  - RF & oscillators
  - Environmental
  - Future
- MEMS application analysis 145
  - Consumer
  - Automotive
  - Medical
  - Defense/aeronautics
  - Industry/telecommunications
- Wafer starts (units, revenue (by market, application, device) 157
- Supply chain 162
- Focus on the Chinese market 178
- Financial analysis 184
- Technology trends 188
- Reverse Costing® – Structural, Process & Cost analyses 205
- Perspectives 211
- Appendices 215
- Yole Group - related reports 254
- About Yole Développement 258
Dr. Dimitrios Damianos, Analyst

Dimitrios Damianos joined Yole as a Technology & Market Analyst, working within the Photonics, Sensing & Display division. Dimitrios collaborates daily with his team to deliver valuable technology and market reports covering imaging, photonics, and sensors. Upon completing his research activities on theoretical and experimental quantum optics and laser light generation, Dimitrios attended Grenoble University (France) and pursued a Ph.D. in Optical and Electrical Characterization of Dielectric Materials on Silicon as well as SOI, with applications in photovoltaics, image sensors and microelectronics. Additionally, Dimitrios holds an MSc in Photonics from the University of Patras (Greece), and has authored/co-authored several scientific papers published in international peer-reviewed journals.

Contact: damianos@yole.fr
COMPANIES CITED IN THIS REPORT

WHAT WE GOT RIGHT, WHAT WE GOT WRONG

✅

- Smartphones and automotive markets are levelling off, thus lowering the growth of MEMS markets for these applications.
- MEMS mirrors are interesting for lidars.
- New applications for microphones (automotive, smart speakers)

❌

- We over estimated RF MEMS markets due to the delay of the 8x8 MIMO
- Inertial combos for automotive (ESC, roll-over) were overestimated
## DEFINITIONS: MEMS APPLICATIONS TRACKED BY YOLE (1/3)

### IJH

<table>
<thead>
<tr>
<th>Consumer and office</th>
<th>Large/wide Format Printers - for graphics and technical</th>
<th>Industrial &amp; printing (digital presse, label, ceramics, textile..)</th>
</tr>
</thead>
</table>

- Thermal disposable heads
- Thermal permanent head
- Piezoelectric permanent head

### Pressure sensors

- **MAP Power Train**
- **BAP Power Train**
- Particle filter (DPF, GPF)
- Fuel tank evaporation (EVAP)
- Exhaust gas recirculation (EGR)
- Engine Oil
- Power Train
- Automatic transmission oil Power Train
- TPMS Safety
- Brake Booster Safety
- Side airbags Safety
- Pedestrian protection Safety
- HVAC

- **Process control**
- HVAC
- Transportation

- **Smart phones & tablets**
- Drones
- Wearable
- Smart homes/building
- Electronic cigarette

- **Blood monitoring invasive**
- Respiratory
- Smart inhaler
- Others

- **Blood monitoring non invasive**

- **Air Data**
- FADEC
- Hydraulic & others

### Accelerometers

- **Cellphone**
- Tablets
- Gaming
- Remote controls
- Wearable
- Others (Home Automation, PMP, Laptop, handheld GPS, PC peripherals, toys…)

- **Standalone airbag front sensor**
- Airbag peripheral sensor
- ESC acceleration sensor
- Roll over sensing TPMS
- Other: integrated GPS, active suspension, safety, vibration, EPB

- **Seismic - Geophones**
- Antenna stabilization
- Industrial vibration monitoring
- Inclinometers
- Offshore - Directional drilling + survey
- GPS aiding, agriculture / mobile mapping
- Other industrial applications

- **AHRS Navigation**
- Other aero (vibration monitoring…)

- **Missiles, guided munitions, bombs**
- Defense stabilization systems
- Navigation and other defense applications

### Si Microphones

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Medical</th>
<th>Automotive</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellphone</td>
<td>Medical (Hearing Aids)</td>
<td>Automotive</td>
<td>Indus, defense, high end</td>
</tr>
<tr>
<td>Tablets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laptops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wearable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (Home Automation, PMP, Laptop, handheld GPS, PC peripherals, toys…)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# DEFINITIONS: MEMS APPLICATIONS TRACKED BY YOLE (2/3)

<table>
<thead>
<tr>
<th>Gyroscopes</th>
<th>Gyroscopes for Consumer</th>
<th>Gyroscopes for Automotive</th>
<th>Gyroscopes for Industrial</th>
<th>Gyroscopes for medical</th>
<th>Gyroscopes for Aeronautics</th>
<th>Gyroscopes for Defense</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>Mobile phone</td>
<td>Mobile phone (OIS)</td>
<td>Roll over ESC gyroscope</td>
<td>Stabilization systems</td>
<td>AHRS for general aviation</td>
<td>Platform stabilization</td>
</tr>
<tr>
<td>Gyroscopes</td>
<td>Tablets</td>
<td>Gaming</td>
<td>GPS navigation</td>
<td>GPS aiding - Mobile</td>
<td>/ backup instrument</td>
<td>Missiles guidance,</td>
</tr>
<tr>
<td>for</td>
<td></td>
<td>Remote controls</td>
<td></td>
<td>mapping ROVs / AUVs</td>
<td>Flight control for civil</td>
<td>Guided munitions /</td>
</tr>
<tr>
<td>Consumer</td>
<td>Wearable</td>
<td></td>
<td></td>
<td>navigation for offshore</td>
<td>helicopters and aircrafts</td>
<td>bombs</td>
</tr>
<tr>
<td></td>
<td>Others (DSC, pmp, laptop, handheld GPS, PC peripherals, toys…)</td>
<td></td>
<td></td>
<td>First responder systems</td>
<td>/ navigation for civil &amp; paramilitary UAVs / Others</td>
<td>Defense UAV &amp; UGV navigation / control, Others</td>
</tr>
<tr>
<td>Inertial</td>
<td></td>
<td></td>
<td></td>
<td>Drilling</td>
<td>Space satellites, spacecraft &amp; skyrockets</td>
<td></td>
</tr>
<tr>
<td>combos</td>
<td></td>
<td></td>
<td></td>
<td>Fall detection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other commercial</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>applications</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inertial combos</th>
<th>Consumer Accel Gyro combos</th>
<th>Consumer Accel Magneto combos</th>
<th>Consumer 9 DOF combos</th>
<th>Auto combos Accel Gyro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile phone</td>
<td>Mobile phone Tablets</td>
<td>Mobile phone Tablets Medical</td>
<td>ESC combo, rollover</td>
<td></td>
</tr>
<tr>
<td>Other applications</td>
<td>Others</td>
<td>Others (Wearables, Home Automation, PMP, Laptop…)</td>
<td>Robotic cars</td>
<td></td>
</tr>
<tr>
<td>Robotic cars</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optical MEMS</th>
<th>Optical MEMS for Telecom</th>
<th>Optical MEMS for Medical</th>
<th>Optical MEMS for Industrial</th>
<th>Optical MEMS for Automotive</th>
<th>Optical MEMS for Aeronautics</th>
<th>Optical MEMS for Consumer</th>
<th>Optical MEMS for Defense</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Switches VOAs Others</td>
<td>Microspectrometers HMDs</td>
<td>Adaptive Optics Digital Cinema</td>
<td>HUDDS</td>
<td>HUDs</td>
<td>Home cinema projector (including laser TV)</td>
<td>HMDs</td>
</tr>
<tr>
<td></td>
<td>(tunable filters, optical benches, transceivers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pico projector (stand alone and embedded)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Office projector Autofocus</td>
<td></td>
<td></td>
<td>Office projector Autofocus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetometers</td>
<td>Single Magneto-</td>
<td>Magnetometers for automotive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>meters for consumer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cell phones Tablets</td>
<td>Auto</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other consumer applications (wearables)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Definitions: MEMS Applications Tracked by Yole (3/3)

### Microbolometers

<table>
<thead>
<tr>
<th>Microbolometers for Automotive</th>
<th>Microbolometers for Industrial</th>
<th>Microbolometers for Defense</th>
<th>Microbolometers for Consumer</th>
<th>Microbolometers for Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night Vision</td>
<td>Firefighting, maritime, surveillance, thermography, PVS</td>
<td>Night Vision</td>
<td>Mobiles &amp; tablets &amp; other commercial (UAV, EVS, etc)</td>
<td>Predictive maintenance, building, process control</td>
</tr>
</tbody>
</table>

### Microfluidics

<table>
<thead>
<tr>
<th>Microdispensers &amp; Drug Delivery</th>
<th>Si biochips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalers MEMS Micropumps &amp; Microvalves Microneedles</td>
<td>POC testing Next Gen Sequencing &amp; Sample Preparation</td>
</tr>
</tbody>
</table>

### RF MEMS

<table>
<thead>
<tr>
<th>RF switches for telecom</th>
<th>RF switches for industrial</th>
<th>Switch for Space</th>
<th>RF switches for defense</th>
<th>RF MEMS for cellphones</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF switches for base stations RF switches for small cells</td>
<td>RF switches for ATE &amp; RF Instrumentation</td>
<td>Redundant Matrix Commutation Matrix Radars &amp; Communications</td>
<td>RF switches for communications RF switches for radars</td>
<td>BAW Filters &amp; Duplexers RF Switches (antenna) RF Switches (antenna)</td>
</tr>
</tbody>
</table>

### Oscillators and resonators

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Industrial</th>
<th>Automotive</th>
<th>Infrastructure &amp; telecom</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV, DSLR</td>
<td>Mobile, wearable, IoT</td>
<td>IIoT</td>
<td>Base stations, servers, routers,…</td>
</tr>
</tbody>
</table>

### Microtips

<table>
<thead>
<tr>
<th>Micro tips &amp; probes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro tips for AFM Probes for ATE</td>
</tr>
</tbody>
</table>

### Flowmeter

<table>
<thead>
<tr>
<th>Flowmeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow meter for medical and Diagnostics Flow meter for industrial</td>
</tr>
</tbody>
</table>

### Environmental MEMS

<table>
<thead>
<tr>
<th>Humidity</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combos (multi-gas, humidity, temperature, pressure)</td>
<td></td>
</tr>
</tbody>
</table>

### Others

| Micro structures, micro valves Ultra sonic finger print Micro speaker |

### PIR, thermodiodes & thermopiles

<table>
<thead>
<tr>
<th>Thermodiodes for Industrial</th>
<th>PIR arrays (1x8 to 64x64) thin films or CMOS based</th>
<th>Thermopiles arrays high end</th>
<th>Thermopiles low end</th>
<th>Thermopiles arrays (1x8 to 64x80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predictive maintenance, building, process control</td>
<td>People counting, spectrometry</td>
<td>Industrial T measure, gas &amp; fire detection</td>
<td>Wearable (spot thermometer) Medical</td>
<td>HVAC, smart buildings</td>
</tr>
</tbody>
</table>

### People counting, spectrometry

Indoor

- Predictive maintenance, building, process control
- People counting, spectrometry
- Industrial T measure, gas & fire detection
- Wearable (spot thermometer) Medical
- HVAC, smart buildings
DIFFERENT MEMS, SENSORS, AND ACTUATORS

**SENSEORS**

- **Movement**
  - Accelerometers
  - Gyrosopes
  - Magnetometers
- **Pressure**
- **Sound and ultra sonic**
- **Environment**
  - Gas
  - Humidity
  - Particles
  - Temperature
- **Optical sensors**
  - FTIR
  - Fingerprint
  - PIR & thermopiles
  - Hyperspectral
  - ALS, RGB
  - Micro bolometers
  - Vision
  - 3D sensing

**ACTUATORS**

- **Optical MEMS**
- **Microfluidics**
- **RF**
- **Micro structures**
- **Micromirrors**
- **Auto-focus**
- **Optical benches**
- **Ink jet heads**
- **Drug delivery**
- **Biochips**
- **Switch**
- **Filter**
- **Resonator**
- **Micro tips**
- **Probes**
- **Watches components**
- **Speakers**
- **Ultrasound**

**POTENTIAL INTEGRATION WITH OPTO COMBOS**

- **Possible integration with environmental combos**
- **“open” package environmental combos**
- **“closed” package 6 to 9+ DOF combos**

**EXAMPLES**

- **iavSense MPU9250**
- **ST pressure sensor**
- **Bosch BME680**
- **Infineon microphone**
- **FLIR Lepton One**
- **Apple dot projector**
- **Debiotech micro pump**
- **Avago-Broadcom FBAR Filter**
- **Ion Torrent**
- **Texas Instruments DLP**
- **Spiremax Patek Philippe**
- **polight AF**
- **Audio Beats MEMS-based speaker**
MEMS SENSORS & ACTUATORS: THE 5 SENSES AND MANY MORE

More sensors extend senses beyond human capabilities (IR, ultrasonic, RF).

- Sight
- Smell
- Focus
- Taste
- Audio
- Speech
- Body balance
- Pressure
- Touch

Not accessible to human capabilities

IR, ultrasonic, RF

CMOS Image sensor
Microbolometers
Micromirrors
Inertial systems
Microphones
Ultrasonic
Biochips
Micropumps

RF communication
Oscillators, tuners, switches & filters
Gas sensors & electronic noses for VOC, alcohol, CO, CO2, NOx

Microspeakers
Humidity sensors
Pressure sensors
Force, haptic & touch sensors

Status of the MEMS Industry 2019 | Sample | www.yole.fr | ©2019
PLAYERS STRATEGIES

2018 MEMS PLAYER RANKING: TOP 30

2018 MEMS FOUNDRIES RANKING

Remark: “Others” include Honeywell, STMicro, DPI, etc. This list includes 75 MEMS foundries.

2018 MEMS business size vs. 2017/2018 annual growth rate

Most of the MEMS players had a positive growth between 2% & 15%

THE TITANS’ RACE

Broadcom and Qorvo, had the most impressive growth over the last 5 years. There seems to be money in RF business.

Bosch continues to battle to reclaim the top spot from Broadcom.
The Puzzle of the MEMS Industry: How Will the Future Be?

**Uncertainty!**
The future is uncertain, not only for MEMS but the general semiconductor market in general.

**Trends**
- **Forecast**
  - Conservative forecasts due to smaller than expected growth of mobile phones and cars (centurion-market, component of the total MEMS market).
  - Requirements for lower price points and improved performance.
- **Foundries**
  - High-end foundries will continue to grow driven by innovation and new MEMS devices.
- **IDMs**
  - IDMs will continue to dominate in high-volume, high-mix markets while margins will improve, but competition will remain high.
- **Race to the Top**
  - Companies will continue to push the boundaries of technology and performance, with new MEMS technologies emerging.

Mobility Megatrend: Smartphones Are More and More Sensitive

- **2007**
  - 5 sensors (e.g., gyroscope, accelerometer, microphone, etc.)
- **2014**
  - 12 sensors (e.g., pressure, temperature, humidity, etc.)
- **2021**
  - 19 to 20 sensors?
ANALYSIS BY APPLICATION

MEMS for Consumer

MEMS for Industry & Telecom

MEMS for Medical

Status of the MEMS Industry 2019 | Sample | www.yole.fr | ©2019
HOW TO USE OUR DATA?

The Yole Group of Companies, including Yole Développement, System Plus Consulting, Knowmade and PISEO, are pleased to provide you a glimpse of our accumulated knowledge.

Feel free to share our data with your own network, within your presentations, press releases, dedicated articles and more. But before that, **contact our Public Relations department to make sure you get up-to-date, licensed materials.**

We will be more than happy to give you our latest results and appropriate formats of our approved content.

Your contact: Sandrine Leroy, Dir. Public Relations
Email: leroy@yole.fr
Contact our Sales Team for more information

YOLE GROUP OF COMPANIES RELATED REPORTS

And also

Ultrasound Sensing Technologies for Medical, Industrial and Consumer Applications 2018

Medical Wearables: Market and Technology Trends 2019

Inkjet Functional and Additive Manufacturing for Electronics

Chinese Microfluidics Industry 2018

Magnetic Sensor Market and Technologies 2017

High-end Inertial Sensors for Defense, Aerospace, and Industrial Applications
Contact our Sales Team for more information.

**Miniaturized Gas Sensor Comparison 2018**

- **Honeywell HG4930CA51**
  - 6-Axis MEMS Inertial Sensor

**Analog Devices ADGM1304/1004: SP4T RF MEMS Switch**

- **Epson PrecisionCore Printhead with MicroTFP Inkjet Dies**

**Honeywell HG1120CA50**
- 9-Axis MEMS Inertial Sensor

**Apple Watch 4’s PPG and ECG Health Sensors**

Status of the MEMS Industry 2019 | Sample | www.yole.fr | ©2019
YOLE GROUP OF COMPANIES RELATED REPORTS

KnowMade – Patent Landscape Analyses

- Miniaturized Gas Sensors 2018 – Patent Landscape Analysis
- STMicroelectronics ToF Proximity Sensor & Flood Illuminator in the Apple iPhone X – Patent-to-Product Mapping
- RF Front End Modules for Cellphones 2018 – Patent Landscape Analysis
- Wireless Charging Patent Landscape Analysis
- Pumps for Microfluidic Devices 2017 – Patent Landscape
- RF Acoustic Wave Filters Patent Landscape Analysis
The semiconductor market had its best year in 2018, reaching almost $470B. However, growth was slower than anticipated due to sluggish smartphone and automotive sales. MEMS, which follows the semiconductor market, also had a good year, but with a slower growth rate than anticipated. However, Yole Développpement (Yole) expects the MEMS market to experience significant growth from 2019 - 2024. Yole estimates the market will exhibit +8.3% growth in value and +11.9% growth in units, with consumer still having the biggest share (more than 60%). Some devices will benefit from new usage: for example, MEMS printheads for high-resolution printing, and microphones for more widespread adoption of voice interface. Also, regulation will favor pressure sensor growth due to the implementation of TPMS regulations in China. For inertial MEMS, automotive and consumer will continue to be a major part of the demand, focusing mostly on combos which provide better form factors and easier integration/higher functionality. Moreover, new applications are coming, such as medical (wearables) and industrial (machine health monitoring) for stand-alone inertial MEMS. Also, IMU growth will be driven by automotive (i.e. robotic vehicles). Future cars could integrate MEMS mirrors, which could find new usage in solid-state LIDAR, as well as microbolometers for night vision capabilities and situational awareness in ADAS.

Yole believes smart buildings and retail will also be the impetus for infrared sensor market prosperity. On the medical side, Si continues to be adopted by microfluidics companies that develop CMOS-based biochips. Despite a slowdown in the smartphone market, 5G will drive the demand for new chips: this is the case for RF MEMS and MEMS oscillators, which will be needed in the deployments of new base stations and for the ever-growing edge computing.

In this 2019 Status of the MEMS Industry edition, Yole has revamped its RF MEMS forecast due to a delay in the adoption of the 8 x 8 MIMO. Despite this, Yole believes BAW filters will grow from $2.3B to $4.4B from 2019 - 2024. Last but not least, emerging MEMS like environmental MEMS, microspeakers, fingerprints, and auto-focus will fuel future market growth. This will be linked to new applications for more mature MEMS devices, such as key fob signal-blocking (accelerometer), gunshot localization (microphones), AI speakers, etc. Moreover, sensor fusion coupled with AI (and eventually edge computing) could stimulate new use-cases and rejuvenate the MEMS market.
During 2018, every MEMS foundry grew: some by a little, others by a lot. However, not all MEMS device manufacturers saw their revenue grow. Competition is fierce for companies manufacturing the same devices:

**Microphones**: Knowles and Goertek have left their competitors far behind, but Knowles seems to have hit a revenue wall. The company grew fast from 2009-2013 due to wide adoption of its MEMS microphones. But since then, its revenue seems to have fluctuated around $450M. Even though Knowles might be strongly reliant on the smartphone market, the company has a diversified portfolio (i.e. with its “Ear” segment) to address other consumer applications as well. With the coming boom in the AI speaker market, and increasing microphone uses in automotive, Knowles and Goertek could profit further.

**Inkjet heads**: HP and Canon are contesting for increased sales. While Canon declined, HP recorded slightly positive year-over-year growth due to increased demand for consumer printers and also because of strong adherence to its cartridge loyalty program.

**Optical MEMS**: Texas Instruments is the uncontested leader for MEMS mirrors. However, if MEMS mirrors do not find new volume applications (in automotive, AR/VR, etc.), this market is likely to stay flat or having a modest growth. Also, there are still some niche markets where companies are doing quite well (i.e. 3D MEMS switches in optical telecom).

**RF players**: in 2018, Broadcom still held top position in MEMS, while Qorvo experienced a small decline in revenue. But even while mobile phone shipments slowed during 2018, growth continues for the RF business in general, driven by an increasing number of filters in conjunction with the front-end module’s increasing value. The introduction of 5G will further stimulate growth.

**Inertial/pressure MEMS**, with players that experienced good growth individually but inevitably formed at least two battlegrounds:
- NXP and Bosch competing in the automotive segment
- Bosch and STMicroelectronics clashing in the consumer market

Finally, the “BB” effect is evident: Broadcom/Bosch with more than $1B revenue stand apart from everyone else. Broadcom has benefited from exponential growth after 2013 - and from 2009-2014, Robert Bosch showed impressive growth too, going from $400M MEMS revenue in 2009 to $1.2B in 2014. In 2017, after two years of flat revenue, sales grew again, and then again in 2018. Bosch benefits from a manufacturing infrastructure that supports automotive and consumer markets, allowing manufacturing costs to be optimized.

Will the rapid growth of Broadcom continue in 2019, or will it be the year when Bosch retakes the throne?

MEMS are part of the More than Moore technologies. As such, they are not subject to a well-defined roadmap such as critical dimensions (CD) decrease, as for Moore’s law. Also, most MEMS manufacturing technologies are mature (i.e. bulk, surface, cavity, packaging, thick SOI, WLP), while others have virtually disappeared (i.e. XeF2 etching). However, there are still new processes/materials in development for new functionalities (i.e. piezo MEMS) and reduced size (i.e. NEMS).

Piezoelectric technology is increasing its momentum. Indeed, a revolution in MEMS technology is underway: piezoelectric MEMS. More and more gyroscopes, BAW filters, and inkjet heads are being created with this technology, and now microphones, microspeakers, autofocus, and PMUT (Piezoelectric Micromachined Ultrasonic Transducers) for fingerprint sensors, ultrasound, and gesture recognition, are underway too.

Public/mainstream interest in this technology is also reflected by the increasing amount of funding in
companies related to piezo-MEMS, in a period where MEMS M&As and funding were otherwise low. Specifically, in 2018:
- Tikitin raised $3.7M to support the launch of its MEMS piezoelectric resonator
- USound raised $19.9M for its super-small smart speakers, courtesy of Austrian VC firm eQventure
- Vesper raised $23M in series B funding, led by American Family Ventures, to scale microphone production. Vesper is also funded by Amazon, confirming the massive interest in integrating an ultra-low-power technology in smart speakers that are “always on”.
Furthermore, several MEMS foundries have already integrated a piezo process (PZT, AlN) in their fabs.

Will piezo technology be the one to rule them all in the future?

Another big trend is edge computing, with sensors and MEMS driving a new age of technology. Big data is an industry born of recent advancements in AI and machine learning, built upon and fueled by a wealth of new data from ever-expanding sensor applications. Sensors are digitizing the human experience, and as the real and virtual worlds move closer together, it will be sensors that bind them, enabling new experiences for users everywhere. Running AI at the edge, coupled with sensor fusion, will open new applications for MEMS in audio, motion, olfactometry, and imaging.

REPORT OBJECTIVES
- A global view of the future for MEMS, sensors, and actuators
- An understanding of the MEMS, sensor, and actuator markets and applications
- MEMS and sensor players’ dynamics and ranking
- MEMS market data in $M, units, and wafers for 2018 - 2024
- Information on future MEMS devices
- A presentation of MEMS game-changers and industry trends
- A MEMS applications overview: automotive, consumer, defense and aeronautics, medical, industrial, and telecommunications
- A MEMS financial analysis

COMPANIES CITED IN THE REPORT (non exhaustive list)
AAC Technologies, AKM, Alps Electric, Amphenol, ms, Analog Devices, Apple, Asia Pacific Microsystems, Boebringer Ingelheim Microparts, Bosch, Broadcom, Canon, Colibrys, Cirrus Logic, Denso, DRS Technologies, EPCOS, Epson, First Sensor Technology, FLIR Systems, FormFactor, Fujifilm Dimatix, Gettop, GlobalFoundries, Goertek, Hanking Electronics, Hewlett Packard, Honeywell, IMT, Infineon Technologies, Knowles Electronics, Maxim, Melexis, MEMSCAP, MEMSensing, MEMSIC, Micralyne, Murata, NXP, OMRON, ON Semiconductor, Panasonic, Qorvo, Qualcomm, Raytheon, ROHM Semiconductor, Samsung, Sensata, Sensiron, Si Time, Silex Microsystems, Silicon Sensing Systems, Sony, STMicroelectronics, TDK, TE Connectivity, Teledyne Dalsa, Texas Instruments, Tower Jazz, TSMC, Lynred (former ULIS), UMC, UTC Aerospace System, X-Fab and many more.

TABLE OF CONTENTS (complete content on i-Micronews.com)

| Executive summary | 20 |
| Context | 37 |
| Market forecasts, trends, and players’ market share | 58 |
| > Inkjet heads | |
| > Pressure sensors | |
| > Microphones | |
| > Inertials | |
| > Optical | |
| > Infrared | |
| > Si microfluidics | |
| > RF & oscillators | |
| > Environmental | |
| > Future | |
| MEMS application analysis | 145 |
| > Consumer | |
| > Automotive | |
| > Medical | |
| > Defense/aeronautics | |
| > Industry/telecommunications | |
| Wafer starts (units, revenue (by market, application, device) | 157 |
| Supply chain | 162 |
| Focus on the Chinese market | 178 |
| Financial analysis | 184 |
| Technology trends | 188 |
| Reverse Costing® – Structural, Process & Cost analyses | 205 |
| Perspectives | 211 |
| About Yole Développement | 258 |

RELATED REPORTS
Benefit from our Bundle & Annual Subscription offers and access our analyses at the best available price and with great advantages

- Hardware and Software for AI 2018 – Consumer focus
- Uncooled Infrared Imagers and Detectors 2019
- Gas and Particle Sensors 2018
- Piezoelectric Devices: From Bulk to Thin-Film 2019

With almost 20 years of experience in MEMS, Sensors and Photonics applications, markets, and technology analyses, Eric Mounier, PhD provides deep industry insight into current and future trends. As a Fellow Analyst, Technology & Market, MEMS & Photonics, in the Photonics, Sensing & Display division, he is a daily contributor to the development of MEMS and Photonics activities at Yole Développement, with a large collection of market and technology reports as well as multiple custom consulting projects: business strategy, identification of investments or acquisition targets, due diligences (buy/sell side), market and technology analysis, cost modelling, technology scouting, etc. Previously, Eric Mounier held R&D and Marketing positions at CEA Leti (France). He has spoken in numerous international conferences and has authored or co-authored more than 100 papers. Eric has a Semiconductor Engineering Degree and a Ph-D in Optoelectronics from the National Polytechnic Institute of Grenoble (France).
ORDER FORM
Status of the MEMS Industry 2019

BILL TO
Name (Mr/Ms/Dry/Pr):
Job Title:
Company:
Address:
City:
State:
Postal Code/Zip:
Country:
*VAT ID Number for EU members:
Tel:
Email:
Date:

PAYMENT

BY CREDIT CARD
☐ Visa  ☐ Mastercard  ☐ Amex
Name of the Card Holder:
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
• MAIL: YOLE DÉVELOPPEMENT, Le Quartz,
75 Cours Emile Zola, 69100 Villeurbanne/Lyon - France

SALES CONTACTS
• Western US & Canada - Steve Laferriere:
+ 1 310 600-8267 - laferriere@yole.fr
• Eastern US & Canada - Chris Youman:
+1 919 607 9839 – chris.youman@yole.fr
• Europe & RoW - Lizzie Levenez:
+ 49 15 123 544 182 – levenez@yole.fr
• Japan & Rest of Asia - Takashi Onozawa:
+81-80-4371-4887 – onozawa@yole.fr
• Greater China - Mavis Wang:
+886 979 336 809 – wang@yole.fr
• Korea - Peter OK:
+82 10 4089 0233 – peter.ok@yole.fr
• Specific inquiries: +33 472 830 180 - info@yole.fr

*One user license means only one person at the company can use the report.

PRODUCT ORDER - Ref YD19031
Please enter my order for above named report:
☐ One user license*: Euro 5,990
☐ Multi user license: Euro 6,490
- The report will be ready for delivery from July 11, 2019
- For price in dollars, please use the day's exchange rate. All reports are
delivered electronically at payment reception. For French customers,
add 20% for VAT

I hereby accept Yole Développement’s Terms and Conditions of Sale(1)
Signature:

(1) Our Terms and Conditions of Sale are available at
www.yole.fr/Terms_and_Conditions_of_Sale.aspx
The present document is valid 24 months after its publishing date:
June 26, 2019

SHIPPING CONTACT
First Name: Last Name:
Email:
Phone:

ABOUT YOLE DÉVELOPPEMENT
Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide covering MEMS and Image Sensors, Compound Semiconductors, RF Electronics, Solid-State Lighting, Displays, Software, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Nanomaterials, Power Electronics and Batteries & Energy Management.
The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

CONSULTING AND ANALYSIS
• Market data & research, marketing analysis
• Technology analysis
• Strategy consulting
• Reverse engineering & costing
• Patent analysis
• Design and characterization of innovative optical systems
• Financial services (due diligence, M&A with our partner)
More information on www.yole.fr

REPORTS
• Market & technology reports
• Patent investigation and patent infringement risk analysis
• Structure, process and cost analysis
• Cost simulation tool
More information on www.i-micronews.com/reports

CONTACTS
For more information about :
• Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
• Reports: David Jourdan (journan@yole.fr) Yole Group of Companies
• Press Relations & Corporate Communication: Sandrine Leroy (leroy@yole.fr)

MEDIA & EVENTS
• i-Micronews.com website & related e-newsletter
• Communication & webcast services
• Events: TechDays, forums...
More information on www.i-Micronews.com

ABOUT YOLE DÉVELOPPEMENT
Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide covering MEMS and Image Sensors, Compound Semiconductors, RF Electronics, Solid-State Lighting, Displays, Software, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Nanomaterials, Power Electronics and Batteries & Energy Management.
The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

CONSULTING AND ANALYSIS
• Market data & research, marketing analysis
• Technology analysis
• Strategy consulting
• Reverse engineering & costing
• Patent analysis
• Design and characterization of innovative optical systems
• Financial services (due diligence, M&A with our partner)
More information on www.yole.fr

REPORTS
• Market & technology reports
• Patent investigation and patent infringement risk analysis
• Structure, process and cost analysis
• Cost simulation tool
More information on www.i-micronews.com/reports

CONTACTS
For more information about :
• Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
• Reports: David Jourdan (journan@yole.fr) Yole Group of Companies
• Press Relations & Corporate Communication: Sandrine Leroy (leroy@yole.fr)

MEDIA & EVENTS
• i-Micronews.com website & related e-newsletter
• Communication & webcast services
• Events: TechDays, forums...
More information on www.i-Micronews.com
**TERMS AND CONDITIONS OF SALES**

**Definitions:** “Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in its entirety. It is done by signing the purchase order which mentions “I hereby accept Yole Développement’s Terms and Conditions of Sale”.

“Buyer”: Any business user (i.e. any person acting in the course of its business activities, for its business needs) entering into the following general conditions to the exclusion of consumers acting in their personal interests.

“Contracting Parties” or “Parties”: The Seller on one hand and the Buyer on the other hand.

“Intellectual Property Rights” or “IPR” means any rights held by the Seller in its Products, including any patents, trademarks, registered designs, copyrights, database rights, inventions, commercial secrets and know-how, technical information, company or tradenames and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not including any pending registration of one of the above mentioned rights.

“Products”: Depending on the purchase order, reports or monitors on MEMS, Imaging, SII, Advanced Packaging, MedTech, Power Electronics and more, can be bought either on a unit basis or as a bundled offer (i.e. subscription for a period of 12 calendar months).

“Report” or “Reports”: Reports are established in PowerPoint and delivered in a PDF format. A Q&A with an analyst is possible for 30 min of Q&A session (except the ones bought in one user license). More time can be allocated to the Analyst only upon payment of an additional PDF can also join it. Q&A with an Analyst is possible for the analyst extra time to compute or compare the data in the present and past events or access to new contradictory information would require for the analyst extra time to compute or compare the data in order to enable the Seller to deliver a high-quality Products.

“License”: For the reports different licenses are proposed. The buyer has to choose one license type:
- Single user license: one person at the company can use the report. Sharing is strictly forbidden.
- Multiple users: A report can be accessed by an unlimited number of users within the company, but only in the country of the primary user. Subsidiaries and Joint-Ventures are excluded.
- Sharing is strictly forbidden.

“Monitor”: Monitors are established and delivered in Excel. An unlimited number of users can access them in add-on, Excel files. 30 min of Q&A session with an analyst/author can be included for all purchased reports (except the ones bought in one user license). More time can be allocated to the Analyst only upon payment.

**2. SCOPE**

1. The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. They also apply for theعودة資訊 on any transaction unless explicitly excluded.

2.1 The Seller shall be responsible for any delay in respect of the order, including failure to deliver within the period of time indicated in the order, or failure to provide information or services agreed upon. The Buyer shall be entitled to receive the protected link that will allow the Buyer to access the Products.

2.1.1 The Buyer, shall be entitled to receive the protected link that will allow the Buyer to access the Products.

2.1.2 If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoice interest in arrears. In case of late payment, the late payment interest shall be calculated at 7 points, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...) are delivered in accordance with article L. 441-6 of the French Commercial Code.

2.2 All the Products that the Seller sells may, upon prior notice and paid; or

2.3 The deadlines that the Seller is asked to state for the mailing of the Products are guaranteed. If such deadlines are not met, it shall not lead to any damages or compensation to the Buyer itself, but also for its licensors, employees and agents.

2.4 The Seller does not make any warranties, express or implied, including, without limitation, those of sale ability and fitness for a particular purpose, the Buyer is not entitled to ask for a reimbursement of its first down payment to the exclusion of any further damages.

2.5 The Seller shall not be responsible for any delay in performance directly or indirectly caused by or resulting from acts of nature, fire, flood, accident, riot, war, government intervention, embargoes, strikes, labour difficulties, equipment failure, late deliveries by suppliers or other difficulties beyond its control.

2.6 The Seller shall take reasonable steps to screen Products for infection of viruses, worms, Trojan horses or other codes containing contaminating or destructive properties before making the Products available, the Seller cannot guarantee that any Product will be free from infection.

2.7 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 loss that may be borne by the Seller, following this cancellation.

2.8 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 or letter sent with a receipt 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

All provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents.

Any notices under 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. It is deemed to have accepted the latest version of these terms and conditions, provided they have been communicated to him in due time.

9. GOVERNING LAW AND JURISDICTION

9.1 All dispute arising out of or linked to these Terms and Conditions or to any transaction under the Contract may be decided by the French courts and tribunals. These Terms and Conditions shall be settled by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.

9.2 The Buyer shall have the right to the use of the Products solely for its own internal information purposes. In particular, the Seller shall therefore not use the Product for purposes such as: • internal storage or licensing purposes; • Recordings and re-transmissions over any network (including any local area network); • Use in any time-sharing, service bureau, bulletin board or similar arrangement or public display; • Posting any Product to any other online service (including bulletin boards or the Internet); • Licensing, leasing, selling, offering for sale or assigning the Product.

9.3 If the Buyer would like to use data coming from the Products for purposes, press articles, institutional or commercial purposes, the Buyer needs to contact Yole Développement’s Public Relations Director (info@yole.fr) to get an official authorization and verification data is up to date. In such case the Seller will make sure to provide up-to-date data under a suitable public format.

9.4 The Seller shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from the employee or suppliers or any third party working for the Seller on behalf of the Seller or its Subsidiaries.

9.5 The Buyer shall define the profile of the contact point for the needs of the contract. This person will be the recipient of each new report. This person shall also be responsible for respect for the copyrights and will guaranty that the Products are not disseminated out of the scope of the agreement. In the context of Bundle and Annual Subscriptions, the contact person shall decide who within the Buyer shall be entitled to receive the protected link that will allow the Buyer to access the Products.

6.1 All the IPR attached to the Products are and remain the property of the Seller and are protected under French and international copyright law, database rights and similar.

6.2 The Buyer agrees not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it to any other party other than employees of its company (only in the country of the primary user). The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Seller shall therefore not use the Product for purposes such as: • internal storage or licensing purposes; • Recordings and re-transmissions over any network (including any local area network); • Use in any time-sharing, service bureau, bulletin board or similar arrangement or public display; • Posting 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 If the Buyer would like to use data coming from the Products for purposes, press articles, institutional or commercial purposes, the Buyer needs to contact Yole Développement’s Public Relations Director (info@yole.fr) to get an official authorization and verification data is up to date. In such case the Seller will make sure to provide up-to-date data under a suitable public format.

6.4 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from the employee or suppliers or any third party working for the Seller on behalf of the Seller or its Subsidiaries. The Buyer shall personally care of any related proceedings, and the Seller shall bear related financial consequences in their entirety.

6.5 The Seller shall deliver a Product to the Buyer in the form of a protected link or, in case of non-usage of the Seller’s Software or if the Buyer’s internal systems, the Seller shall be entitled to receive the protected link that will allow the Buyer to access the Products.

6.6 Please note that whether in Bundles or Annual Subscription, all unspected reports will be cancelled and lost after the 12 month period of license validation.

6.7 As a matter of fact the investor of a company, external consultants, the joint venture done with third party, and so on cannot access the report and should publish 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 loss that may be borne by the Seller, following this cancellation.

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 or letter sent with a receipt 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.

7.3 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 loss that may be borne by the Seller, following this cancellation.
Life Sciences & Healthcare
- Microfluidics
- BioMEMS & Medical Microsystems
- Inkjet and accurate dispensing
- Solid-State Medical Imaging & BioPhotonics
- BioTechnologies

Power & Wireless
- RF Devices & Technologies
- Compound Semiconductors & Emerging Materials
- Power Electronics
- Batteries & Energy Management

Semiconductor & Software
- Package, Assembly & Substrates
- Semiconductor Manufacturing
- Memory
- Software & Computing

Photonics, Sensing & Display
- Solid-State Lighting
- Display
- MEMS, Sensors & Actuators
- Imaging
- Photonics & Optoelectronics

About Yole Développement | www.yole.fr | ©2019
4 BUSINESS MODELS

- **Consulting and Analysis**
  - Market data & research, marketing analysis
  - Technology analysis
  - Strategy consulting
  - Reverse engineering & costing
  - Patent analysis
  - Design and characterization of innovative optical systems
  - Financial services (due diligence, M&A with our partner)

- **Syndicated reports**
  - Market & technology reports
  - Patent investigation and patent infringement risk analysis
  - Teardowns & reverse costing analysis
  - Cost simulation tool
    - [www.i-Micronews.com/reports](http://www.i-Micronews.com/reports)

- **Monitors**
  - Monthly and quarterly update
  - Excel database covering supply, demand, and technology
  - Price, market, demand and production forecasts
  - Supplier market shares

- **Media**
  - i-Micronews.com website
  - i-Micronews e-newsletter
  - Communication & webcast services
  - Events: TechDays, forums, …

[www.i-Micronews.com](http://www.i-Micronews.com)
6 COMPANIES TO SERVE YOUR BUSINESS

Yole Group of Companies

- **Yole Développement**
  - Market, technology and strategy consulting
  - www.yole.fr

- **SystemPlus Consulting**
  - Manufacturing costs analysis
  - Teardown and reverse engineering
  - Cost simulation tools
  - www.systemplus.fr

- **KnowMade**
  - IP analysis
  - Patent assessment
  - www.knowmade.fr

- **Piseo**
  - Design and characterization of innovative optical systems
  - www.piseo.fr

- **Blumorpho**
  - Innovation and business maker
  - www.blumorpho.com

- **Yole Finance**
  - Due diligence
  - www.yole.fr
OUR GLOBAL ACTIVITY

40% of our business

30% of our business

30% of our business

Yole Deutschland
Frankfurt

Yole Korea
Seoul

Yole Japan
Tokyo

Greater China office
Hsinchu

Yole Inc.
Cornelius

BLUMORPHO
Paris

SYSTEMPLUS
Nantes

PLESC
Vénissieux

KnowMade
Nice

HQ in Lyon

Paris

Nantes

Vénissieux

Nice

Yole Deutschland

Yole Korea

Yole Japan

Yole Inc.
ANALYSIS SERVICES - CONTENT COMPARISON

- Technology and Market Report
- Leadership Meeting
- Q&A Service
- Meet the Analyst
- Custom Analysis

Breadth of the analysis vs. Depth of the analysis
SERVING THE ENTIRE SUPPLY CHAIN

Integrators, end-users and software developers

Device manufacturers

Suppliers: material, equipment, OSAT, foundries...

Financial investors, R&D centers

Our analysts provide market analysis, technology evaluation, and business plans along the entire supply chain.
We work across multiple industries to understand the impact of More-than-Moore technologies from device to system.
Over the course of more than 20 years, Yole Développement has grown to become a group of companies. Together with System Plus Consulting and KnowMade, we now provide marketing, technology and strategy consulting, media and corporate finance services, reverse costing, structure, process and cost analysis services and well as intellectual property (IP) and patent analysis. Together, our group of companies is collaborating ever closer and therefore will offer, in 2019, a collection of over 125 reports, 10 new monitors and 120 teardowns. Combining respective expertise and methodologies from the three companies, they cover:

- MEMS & Sensors
- RF devices & technologies
- Medical technologies
- Semiconductor Manufacturing
- Advanced packaging
- Memory
- Batteries and energy management
- Power electronics
- Compound semiconductors
- Solid state lighting
- Displays
- Software
- Imaging
- Photonics

If you are looking for:

- An analysis of your product market and technology
- A review of how your competitors are evolving
- An understanding of your manufacturing and production costs
- An understanding of your industry’s technology roadmap and related IPs
- A clear view supply chain evolution

Our reports and monitors are for you!

Our team of over 70 analysts, including PhD and MBA qualified industry veterans from Yole Développement, System Plus Consulting and KnowMade, collect information, identify trends, challenges, emerging markets, and competitive environments. They turn that information into results and give you a complete picture of your industry’s landscape. In the past 20 years, we have worked on more than 2,000 projects, interacting with technology professionals and high-level opinion makers from the main players of their industries and realized more than 5,000 interviews per year.

WHAT TO EXPECT IN 2019?

In 2019 we will extend our offering with a new ‘monitor’ product which provides more updates on your industry during the year. The Yole Group of Companies is also building on and expanding its investigations of the memory industry. Moreover, in parallel, the Yole Group reaffirms its commitment to a new collection of reports mixing software and hardware and is increasing its involvement in displays, radio-frequency (RF) technology, advanced substrates, batteries and compound semiconductors. Last but not least, System Plus Consulting is developing its teardowns service providing 120+ offers related to phones, smart home, wearables and connected devices. Discover our 2019 program right now, and ensure you get a true vision of the industry. Stay tuned!
18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

**Market – Technology – Strategy – by Yole Développement**
Yole Développement (Yole) offers market reports including quantitative market forecasts, technology trends, company strategy evaluation and in-depth application analyses. Yole will publish more than 55 reports in 2019, with our partner PISEO contributing to some of the lighting reports.

The Reverse Costing® report developed by System Plus Consulting provides full teardowns, including detailed photos, precise measurements, material analyses, manufacturing process flows, supply chain evaluations, manufacturing cost analyses and selling price estimations. The reports listed below are comparisons of several analyzed components from System Plus Consulting. More reports are however available, and over 60 reports will be released in 2019. The complete list is available at www.systemplus.fr.

**Patent Reports – by KnowMade**
More than describing the status of the IP situation, these analyses provide a missing link between patented technologies and market, technological and business trends. They offer an understanding of the competitive landscape and technology developments from a patent perspective. They include key insights into key IP players, key patents and future technology trends. For 2019 KnowMade will release over 15 reports.

**The markets targeted are:**
- Mobile & Consumer
- Automotive & Transportation
- Medical
- Industrial
- Telecom & Infrastructure
- Defense & Aerospace

Linked reports are dealing with the same topic to provide a more detailed analysis.
OUR 2019 REPORTS COLLECTION (1/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

MEMS & SENSORS
  o MARKET AND TECHNOLOGY REPORT
    Status of the MEMS Industry 2019 - Update
    Status of the Audio Industry 2019 - New
    Uncooled Infrared Imagers and Detectors 2019 – Update
    Consumer Biometrics: Technologies and Market Trends 2018
    MEMS Pressure Sensor Market and Technologies 2018
    Gas & Particle Sensors 2018
  o STRUCTURE, PROCESS & COST REPORT
    MEMS & Sensors Comparison 2019
    MEMS Pressure Sensor Comparison 2018
    Particle Sensors Comparison 2019
    Miniaturized Gas Sensors Comparison 2018
  o PATENT REPORT
    MEMS Foundry Business Portfolio 2019 - New
    Miniaturized Gas Sensors 2019 - New

PHOTONIC AND OPTOELECTRONICS
  o MARKET AND TECHNOLOGY REPORT
    Silicon Photonics and Photonic Integrated Circuits 2019
    LiDARs for Automotive and Industrial Applications 2019 - Update
  o PATENT REPORT
    Silicon Photonics for Data Centers: Optical Transceiver 2019 - New
    LiDAR for Automotive 2018

RF DEVICES AND TECHNOLOGIES
  o MARKET AND TECHNOLOGY REPORT
    5G’s Impact on RF Front-End Module and Connectivity for Cell Phones 2019 – Update
    5G Impact on Telecom Infrastructure 2019 - New
    Radar and Wireless for Automotive: Market and Technology Trends 2019 - Update
    Advanced RF Antenna Market & Technology 2019 - New
    RF Standards and Technologies for Connected Objects 2018
  o STRUCTURE, PROCESS & COST REPORT
    RF Front-End Module Comparison 2019 - Update
    Automotive Radar RF Chipset Comparison 2018
  o PATENT REPORT
    Antenna for 5G Wireless Communications 2019 - New
    RF Front End Modules for Cellphones 2018
    RF Filter for 5G Wireless Communications: Materials and Technologies 2019
    RF GaN 2019 – Patent Landscape Analysis

Update : 2018 version still available
OUR 2019 REPORTS COLLECTION (2/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

**IMAGING**
- **MARKET AND TECHNOLOGY REPORT**
  - Status of the CIS Industry 2019: Technology and Foundry Business - Update
  - Imaging for Automotive 2019 - Update
  - Neuromorphic Technologies for Sensing 2019 - Update
  - Status of the CCM and WLO Industry 2019 - Update
  - 3D Imaging & Sensing 2018
  - Machine Vision for Industry and Automation 2018
  - Sensors for Robotic Vehicles 2018
  - **STRUCTURE, PROCESS & COST REPORT**
    - Compact Camera Modules Comparison 2019
    - CMOS Image Sensors Comparison 2019
  - **PATENT REPORT**
    - Facial & Gesture Recognition Technologies in Mobile Devices 2019 - New
    - Apple iPhone X Proximity Sensor & Flood Illuminator 2018

**MEDICAL IMAGING AND BIOPHOTONICS**
- **MARKET AND TECHNOLOGY REPORT**
  - X-Ray Detectors for Medical, Industrial and Security Applications 2019 - New
  - Microscopy Life Science Cameras: Market and Technology Analysis 2019
  - Ultrasound technologies for Medical, Industrial and Consumer Applications 2018
  - **PATENT REPORT**
    - Optical Coherence Tomography Medical Imaging 2018

**MICROFLUIDICS**
- **MARKET AND TECHNOLOGY REPORT**
  - Status of the Microfluidics Industry 2019 - Update
  - Organ-on-a-Chip Market & Technology Landscape 2019 - Update
  - Point-of-Need Testing Application of Microfluidic Technologies 2019
  - Liquid Biopsy: from Isolation to Downstream Applications 2018
  - Chinese Microfluidics Industry 2018
  - **PATENT REPORT**
    - Microfluidic Manufacturing Technologies 2019 - New
    - Nanopore Sequencing 2019 - New

**INKJET AND ACCURATE DISPENSING**
- **MARKET AND TECHNOLOGY REPORT**
  - Inkjet Printheads - Dispensing Technologies & Market Landscape 2019 - Update
  - Emerging Printing Technologies for Microsystems Manufacturing 2019 - New
  - Piezoelectric Devices from Bulk to Thin Film 2019 - New
  - Inkjet Functional and Additive Manufacturing for Electronics 2018
  - **STRUCTURE, PROCESS & COST REPORT**
    - Piezoelectric Materials from Bulk to Thin Film Comparison 2019
OUR 2019 REPORTS COLLECTION (3/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

BIOTECHNOLOGIES
- MARKET AND TECHNOLOGY REPORT
  - CRISPR-Cas9 Technology: From Lab to Industries 2018
- PATENT REPORT
  - Personalized Medicine 2019 – New

BIOMEMS & MEDICAL Microsystems
- MARKET AND TECHNOLOGY REPORT
  - Medical Wearables: Market & Technology Analysis 2019 - New
  - Neurotechnologies and Brain Computer Interface 2018
  - BioMEMS & Non-Invasive Sensors: Microsystems for Life Sciences & Healthcare 2018
- PATENT REPORT
  - 3D Cell Printing 2019 - New
  - Circulating Tumor Cells Isolation 2019 - New

SOFTWARE AND COMPUTING
- MARKET AND TECHNOLOGY REPORT
  - Artificial Intelligence Computing For Automotive 2019 - New
  - Hardware and Software for Artificial Intelligence (AI) in Consumer Applications 2019 - Update
  - Image Signal Processor and Vision Processor Market and Technology Trends 2019
  - xPU (Processing Units) for Cryptocurrency, Blockchain, HPC and Gaming 2019 – New
- PATENT REPORT
  - Artificial Intelligence for Medical Diagnostics - New

MEMORY
- MARKET AND TECHNOLOGY REPORT
  - Status of the Memory Industry 2019 - New
  - MRAM Technology and Business 2019 - New
  - Emerging Non-Volatile Memory 2018
- STRUCTURE, PROCESS & COST REPORT
  - Memory Comparison 2019
- PATENT REPORT
  - Magnetoresistive Random-Access Memory (MRAM) 2019 - New
  - 3D Non-Volatile Memory 2018

ADVANCED PACKAGING
- MARKET AND TECHNOLOGY REPORT
  - Fan Out Packaging Technologies and Market Trends 2019 - Update
  - 3D TSV Integration and Monolithic Business Update 2019 - Update
  - Advanced RF SiP for Cellphones 2019 - Update
  - Status of Advanced Packaging Industry 2019 - Update
  - Status of Advanced Substrates 2019 - Update
  - Panel Level Packaging Trends 2019 - Update
  - Automotive Packaging Market & Technology Trends 2019 - New
  - Trends in Automotive Packaging 2018
  - Thin-Film Integrated Passive Devices 2018
- STRUCTURE, PROCESS & COST REPORT
  - Advanced RF SiP for Cellphones Comparison 2019

Update: 2018 version still available
OUR 2019 REPORTS COLLECTION (4/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

**SEMICONDUCTOR MANUFACTURING**
- **MARKET AND TECHNOLOGY REPORT**
  - Nano-Imprint Technology Trends for Semiconductor Applications 2019 - New
  - Equipment and Materials for Fan Out Packaging 2019 - Update
  - Equipment for More than Moore: Thin Film Deposition & Etching 2019 - New
  - Wafer Starts for More Than Moore Applications 2018
  - Polymeric Materials at Wafer-Level for Advanced Packaging 2018
  - Bonding and Lithography Equipment Market for More than Moore Devices 2018
- **STRUCTURE, PROCESS & COST REPORT**
  - Wafer Bonding Comparison 2018
- **PATENT REPORT**
  - Hybrid Bonding for 3D Stack 2019 – New

**SOLID STATE LIGHTING**
- **MARKET AND TECHNOLOGY REPORT**
  - Status of the Solid State Light Source Industry 2019 - New
  - Edge Emitting Lasers (EELS) 2019 - New
  - Light Shaping Technologies 2019 - New
  - Automotive Advanced Front Lighting Systems 2019 - New
  - VCSELs – Market and Technology Trends 2019 - Update
- **STRUCTURE, PROCESS & COST REPORT**
  - VCSEL Comparison 2019
- **PATENT REPORT**
  - VCSELs 2018

**DISPLAY**
- **MARKET AND TECHNOLOGY REPORT**
  - Next Generation 3D Displays 2019 - New
  - Next Generation Human Machine Interaction (HMI) in Displays 2019 - New
  - Micro-and Mini-LED Displays 2019 - Update
  - Displays & Optical Vision Systems for VR, AR & MR 2018
- **PATENT REPORT**
  - MicroLED Displays: Intellectual Property Landscape 2018

Update: 2018 version still available
OUR 2019 REPORTS COLLECTION (5/5)
18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

POWER ELECTRONICS
- MARKET AND TECHNOLOGY REPORT
  - Power SiC: Materials, Devices and Applications 2019 - Update
  - Power Electronics for EV/HEV and e-mobility: Market, Innovations and Trends 2019 - Update
  - Status of the Power Electronics Industry 2019 - Update
  - Discrete Power Packaging: Material Market and Technology Trends 2019 - New
  - Status of the Power ICs Industry 2019 - Update
  - Status of the Passive Components for the Power Electronics Industry 2019 - Update
  - Status of the Inverter Industry 2019 - Update
  - Status of the Power Module Packaging Industry 2019 - Update
  - Wireless Charging Market Expectations and Technology Trends 2018
  - Power GaN 2018: Epitaxy, Devices, Applications and Technology Trends
- STRUCTURE, PROCESS & COST REPORT
  - Automotive Power Module Packaging Comparison 2018
  - GaN-on-Silicon Transistor Comparison 2019
  - SiC Transistor Comparison 2019
- PATENT REPORT
  - Power SiC: Materials, Devices and Modules 2019 - New
  - Power GaN: Materials, Devices and Modules 2019 – Update

BATTERY & ENERGY MANAGEMENT
- MARKET AND TECHNOLOGY REPORT
  - Status of the Rechargeable Li-ion Battery Industry 2019 - New
  - Li-ion Battery Packs for Automotive and Stationary Storage Applications 2019 - Update
- PATENT REPORT
  - Battery Energy Density Increase: Materials and Emerging Technologies 2019 - New
  - Solid-State Batteries 2019 - New
  - Status of the Battery Patents 2018

COMPOUND SEMI.
- MARKET AND TECHNOLOGY REPORT
  - Emerging Semiconductor Substrates: Market & Technology Trends 2019 - New
  - Status of the Compound Semiconductor Industry 2019 - New
  - InP Materials, Devices and Applications 2019 - New
  - GaAs Wafer and Epiwafer Market: RF, Photonics, LED and PV Applications 2018
- PATENT REPORT
  - GaN-on-Silicon Substrate: Materials, Devices and Applications 2019 - Update
Get the most updated overview of your market to monitor your strategy

Yole Développement, System Plus Consulting and KnowMade, all part of the Yole Group of Companies, are launching a collection of 10 monitors in 2019. The monitors aim to provide updated market, technology and patent data as well dedicated quarterly analyses of the evolution in your industry over the previous 12 months. Furthermore, you can benefit from direct access to the analyst for an on-demand Q&A and discussion session regarding trend analyses, forecasts and breaking news.

Topics covered will be compact camera modules (CCMs), advanced packaging, compound semiconductors, microfluidics, batteries, RF and memory.

MARKET MONITOR by Yole Développement

A FULL PACKAGE:
The monitors will provide the evolution of the market in units, wafer area and revenues. They will also offer insights into what is driving the business and a close look at what is happening will also be covered in it.

The following deliverables will be included in the monitors:
- An Excel database with all historical and forecast data
- A PDF slide deck with graphs and comments/analyses covering the expected evolutions

ADVANCED PACKAGING – NEW
This monitor will provide the evolution of the advanced packaging platforms. It will cover Fan-Out Wafer Level Packaging (WLP), Fan-Out Panel Level Packaging (PLP), Wafer-Level Chip Scale Packaging (WLCSP), Flip Chip packaging platforms, and 2.5D and 3D Through Silicon Via (TSV) integration. Frequency: Quarterly, starting from Q3 2019

COMPOUND SEMI. – NEW
This monitor will describe how the compound semiconductor industry is evolving. It will offer a close look at GaAs, InP, SiC, GaN and other compounds of interest providing wafer volumes, revenues, application breakdowns and momentum. Frequency: Quarterly, starting from Q3 2019

CAMERA MODULE – NEW
This monitor will provide the evolution of the imaging industry, with a close look at image sensor, camera module, lens and VCM. Volumes, revenues and momentum of companies like Sony, Samsung, Omnivision and OnSemi will thus be analysed. Frequency: Quarterly, starting from Q3 2019

MEMORY – UPDATE
For the memory industry you can have access to a quarterly monitor, as well as an additional service, a monthly pricing. Both services can be bought separately:
- DRAM Service: Including a quarterly monitor and monthly pricing.
- NAND Service: Including a quarterly monitor and monthly pricing.

REVERSE TECHNOLOGY MONITOR by System Plus Consulting

SMARTPHONES – NEW
To stay updated on the latest components, packaging and silicon chip choices of the smartphone makers, System Plus Consulting has created its first Smartphone Reverse Technology monitor. This year, get access to the packaging and silicon content database of at least 20 different flagship smartphones – more than five per quarter. Starting at the beginning of 2019, the monitor will include an Excel database report for each phone and a quarterly comparison.
OUR 2019 MONITORS COLLECTION (2/2)

Get the most updated overview of your market to monitor your strategy

**PATENT MONITOR** by KnowMade

**A FULL PACKAGE:**
Starting at the beginning of the year, the KnowMade monitors include the following deliverables:

- An Excel file including the monthly IP database of:
  - New patent applications
  - Newly granted patents
  - Expired or abandoned patents
  - Transfer of IP rights through re-assignment and licensing
  - Patent litigation and opposition

- Quarterly report including a PDF slide deck with the key facts & figures of the quarter: IP trends over the three last months, with a close look to key IP players and key patented technologies.

- **GaN for Power & RF Electronics**
  Wafers and epifaspers, GaN-on-SiC, silicon, sapphire or diamond, semiconductor devices such as transistors, and diodes, devices and applications including converters, rectifiers, switches, amplifiers, filters, and Monolithic Microwave Integrated Circuits (MMICs), packaging, modules and systems.

- **GaN for Optoelectronics & Photonics**
  Wafers and epifarsers, GaN-on-sapphire, SiC or silicon; semiconductor devices such as LEDs and lasers; and applications including lighting, display, visible communication, photonics, packaging, modules and systems.

- **Li-ion Batteries**
  Anodes made of lithium metal, silicon, and lithium titanate (LTO); cathodes made of Lithium Iron Phosphate (LFP), Nickel-Manganese-Cobalt (NMC), Lithium Nickel Cobalt Aluminium Oxide (NCA), Lithium Nickel Metal Dioxide (LiNiM02), Lithium Metal Phosphate (LiMPO4), and Lithium Metal Tetroxide (LiMO4); electrolytes including liquid, polymer/gel, and solid inorganics; ceramic and other separators; battery cells including thin film/microbattery, flexible, cylindrical and prismatic; and battery packs and systems.

- **Post Li-ion Batteries**
  Battery technologies including redox-flow batteries, sodium-ion, lithiumsulfur, lithium-air, and magnesium-ion, and their supply chains, including electrodes, electrolytes, battery cells and battery packs/systems.

- **Solid-State Batteries**
  Supply chain including electrodes, battery cells, battery packs/systems and electrolytes, including polymer, inorganic and inorganic/polymer, inorganic materials, including argyrodites, Lithium Super Ionic CONductor, (LISICONs), Thio-LISICONs, sulfide glasses, oxide glasses, perovskites, anti-perovskites and garnets.

- **RF Acoustic Wave Filters**
  Including Surface Acoustic Wave (SAW), Temperature Compensated (TC)- SAW, Bulk Acoustic Wave- Free-standing Bulk Acoustic Resonator (BAWFBAR), BAW-Solidly-Mounted Resonator (BAW-SMR), and Packaging.

- **RF Power Amplifiers**
  Including Low Noise Amplifiers, Doherty Amplifiers, Packaging, and Millimeter-Wave technology.

- **RF Front-End Modules**

- **Microfluidics**
  From components to chips and systems, including all applications.
To meet the growing demand for market, technological and business information, i-Micronews Media integrates several tools able to reach each individual contact within its network.

We will ensure your company benefits from this

**ONLINE**

- i-Micronews e-newsletter
- i-Micronews.com
- FreeFullPDF.com

**ONSITE**

- Events

**INPERSON**

- Webcasts

**Unique, cost-effective ways to reach global audiences.**

Online display advertising campaigns are great strategies for improving your product/brand visibility. They are also an efficient way to adapt with the demands of the times and to evolve an effective marketing plan and strategy.

- Brand visibility, networking opportunities

Today’s technology makes it easy for us to communicate regularly, quickly, and inexpensively – but when understanding each other is critical, there is no substitute for meeting in-person. Events are the best way to exchange ideas with your customers, partners, prospects while increasing your brand/product visibility.

- Targeted audience involvement equals clear, concise perception of your company’s message.

Webcasts are a smart, innovative way of communicating to a wider targeted audience. Webcasts create very useful, dynamic reference material for attendees and also for absentees, thanks to the recording technology.

- #15,800+ monthly unique visitors on i-Micronews.com
- #10,900+ weekly readers of i-Micronews e-newsletter
- #110 attendees on average
- #7+ key events planned for 2019 on different topics
- #380 registrants per webcast on average to gain new leads for your business

**Contact:** Camille Veyrier (veyrier@yole.fr), Marketing & Communication Director
CONTACT INFORMATION

○ CONSULTING AND SPECIFIC ANALYSIS, REPORT BUSINESS
  • North America:
    • Steve LaFerriere, Senior Sales Director for Western US & Canada
      Email: laferriere@yole.fr – +1 310 600-8267
    • Chris Youman, Senior Sales Director for Eastern US & Canada
      Email: chris.youman@yole.fr – +1 919 607 9839
  • Japan & Rest of Asia:
    • Takashi Onozawa, General Manager, Asia Business Development
      (India & ROA)
      Email: onozawa@yole.fr - +81 34405-9204
    • Miho Ohtake, Account Manager (Japan)
      Email: ohtake@yole.fr - +81 3 4405 9204
    • Itsuyo Oshiba, Account Manager (Japan & Singapore)
      Email: oshiba@yole.fr - +81-80-3577-3042
  • Korea: Peter Ok, Business Development Director
    Email: peter.ok@yole.fr - +82 10 4089 0233
  • Greater China: Mavis Wang, Director of Greater China Business Development
    Email: wang@yole.fr - +886 979 336 809
  • Europe: Lizzie Levenez, EMEA Business Development Manager
    Email: levenez@yole.fr - +49 15 123 544 182
  • RoW: Jean-Christophe Eloy, CEO & President, Yole Développement
    Email: eloy@yole.fr - +33 4 72 83 01 80

○ FINANCIAL SERVICES (in partnership with Woodside Capital Partners)
  • Jean-Christophe Eloy, CEO & President
    Email: eloy@yole.fr - +33 4 72 83 01 80
  • Ivan Donaldson, VP of Financial Market Development
    Email: ivan.donaldson@yole.fr - +1 208 850 3914

○ CUSTOM PROJECT SERVICES
  • Jérome Azémar, Technical Project Development Director
    Email: azemar@yole.fr - +33 6 27 68 69 33

○ GENERAL
  • Camille Veyrier, Director, Marketing & Communication
    Email: veyrier@yole.fr - +33 472 83 01 01
  • Sandrine Leroy, Director, Public Relations
    Email: leroy@yole.fr - +33 4 72 83 01 89 / +33 6 33 11 61 55
  • Email: info@yole.fr - +33 4 72 83 01 80

Follow us on

LinkedIn
Twitter
Facebook
YouTube