InP Wafer and Epiwafer Market: Photonics and RF Applications 2019
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Biography & contact

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*Non-exhaustive list of companies
ABBREVIATIONS (1/3)

• LDMOS: Laterally Depleted Metal Oxide Semiconductor
• AAU: Active Antenna Unit
• ADC: Analog to Digital Converters
• AGR: Annual Growth Rate
• ALS: Ambient Light Sensor
• AOC: Active Optical Cable
• AON: Active Optical Network
• APD: Avalanche Photo Diode
• AR: Augmented Reality
• ASP: Average Selling Price
• ASPIC: Application Specific Photonic Integrated Circuit
• ATE: Automatic Test Equipment
• BAW: Bulk Acoustic Wave
• BBU: Baseband Unit
• BH: Buried Heterostructure
• Bi-CMOS: Bipolar and CMOS process technology
• BiCMOS: Bipolar-CMOS
• BIFET: Bi Field Effect Transistor
• BOM: Bill Of Materials
• BP: Baseband Processor
• BT: Bandwidth-Time product
• BTS: Base Transceiver Station

• CA: Carrier Aggregation
• CC: Component Carrier
• CDMA: Code Division Multiple Access
• CdTe: Cadmium Tellurium
• CIGS: Copper-Indium-Gallium-Selenium
• CMOS: Complementary Metal-on Silicon Oxide Semiconductor
• CU: Central Unit
• CWDM: Coarse Wavelength-Division Multiplexing
• DAC: Direct Attach Cable
• DBR: Distributed Bragg Reflector
• DFB: Distributed Feedback Laser
• DHBT: Double Heterojunction Bipolar Transistor
• DU: Distributed Unit
• DWDM: Dense Wavelength-Division Multiplexing
• EAM: Electro-Absorption Modulator
• EDGE: Enhanced Data Rate for GSM Evolution
• EEL: Edge Emitting Laser
• EML: Externally Modulated Laser
• EPC: Evolved Packet Core
• EPD: Etch Pitch Density
• EPON: Ethernet-PON
• EW: Electronics Warfare
• FEM: Front-End Module
• FET: Field Effect Transistor
• FFTx: Fiber to the x
• FIR: Far Infrared
• FM: Frequency Modulation
• F-P: Fabry Pérot
• FTTH: Fiber to the Home
• GaAs: Gallium Arsenide
• GaN: Gallium Nitride
• GPON: Gigabit-Capable PON
• GPRS: General Packet Radio Service
• GSM: Global System for Mobile Communications
• HB: High Band
• HBT: Heterojunction Bipolar Transistor
• HCPV: High Concentrated PhotoVoltaics
• HD: High Definition
• HE: High End
• HEMT: High Electron Mobility Transistor
• HSPA: High-Speed Packet Access
• IC: Integrated Circuit
• IED: Improvised Explosive Device
• InP: Indium Phosphide
• IR: Infrared
• JFOM: Johnson Figure of Merit
• LB: Low Band
• LE: Low End
• LEC: Liquid Encapsulated Czochralski
• LED: Light Emitting Diode
• LIDAR: Light Detection and Ranging
• LNA: Low Noise Amplifier
• LPE: Liquid Phase Epitaxy
• LTE: Long-Term Evolution
• LTE-A: Long-Term Evolution Advanced
• LWIR: Long Wave Infrared
• MB: Mid-Band
• MBE: Molecular Beam Epitaxy
• Mbps: Megabytes per second
• MCM: Multi-Chip Module
• MEC: Mobile/Multi-access Edge Computing
• MEMS: Micro-Electro-Mechanical System
• MESFET: Metal Semiconductor Field Effect Transistor
• MIMO: Multiple Input, Multiple Output
• MMIC: Monolithic Microwave Integrated Circuit
• MMW: Millimeter Wave
• MOCell: MetalOrganic Chemical Vapor Deposition
• MODEM: Modulator/Demodulator
• MQW: Multiple Quantum Wells
ABBREVIATIONS (3/3)

- MW: MicroWave
- MZM: Mach-Zehnder modulator
- NIR: Near Infrared
- OCT: Optical Coherence Tomography
- ODM: Original Design Manufacturer
- OEM: Original Equipment Manufacturer
- PA: Power Amplifier
- PAE: Power Added Efficiency
- Passive Waveguide (PWG)
- PD: Photodiode
- PMP: Point-to-Multipoint
- PON: Passive Optical Network
- PTP: Point-to-Point Structure
- RADAR: Radio Detection And Ranging
- RAN: Radio Access Network
- RAT: Radio Access Technologies
- RFFE: RF Front-End
- RRU: Remote Radio Unit
- RWG: Ridge waveguide
- SC: Semi Conductive
- SEL: Surface Emitting Laser
- SHBT: Single Heterojunction Bipolar Transistor
- Si: Semi Insulative
- SiC: Silicon Carbide
- SiGe: Silicon Germanium
- SiPH: Silicon Photonics
- SNR: Signal-to-Noise Ratio
- SOI: Silicon-on-Insulator
- SPDT: Single Pole Double Throw
- SSC: Spot-Size Converter (SSC)
- SWI: Submillimeter Wave Instrument
- TCV: Thermal Coefficient of Velocity
- TDD: Time Division Duplex
- TDMA: Time Division Multiple Access
- TD-SCDMA: Time Division Synchronous Code Division Multiple Access
- THz: Terahertz
- TIA: Transimpedance Amplifier
- TIS: Time Interleaved Sampling
- TOF: Time of Flight
- Tx: Transmit/Transmitter/Transmission
- UHB: Ultra High Band
- UMTS: Universal Mobile Telecommunications System
- VCO: Voltage Controlled Oscillators
- VCSEL: Vertically Cavity Surface Emitting Laser
- VED: Vacuum Electronic Devices
- VGF: Vertical Gradient Freeze
- VISAR: Video Synthetic Aperture Radar
- VR: Virtual Reality
- WCDMA: Wideband Code Division Multiple Access
- WDM: Wavelength-Division Multiplexing
- WiMAX: Worldwide Interoperability for Microwave Access
- WLAN: Wireless Local Area Network
REPORT OBJECTIVES (1/2)

Provide a clear understanding of the InP wafer and epiwafer market.

Focus of this report
REPORT OBJECTIVES (2/2)

Provide a clear understanding of the InP wafer and InP epiwafer market.

Analysis and description of the applicative markets:

- RF
- Photonique
- LED
- PV

Status of InP wafer growth and epi growth technology

- Technical description

Ecosystem identification and analysis:

- Determine market dynamics
- Key players by market and analysis
- Wafer and epi wafer Market size and market forecast in $M and Munits
InP wafer market is dominated by the high-speed fiber optic communication market, as InP is capable of emission and detection in wavelengths above 1000 nm.

Indeed, the InP wafer market is largely impacted by the photonics market, particularly driven by Datacom and Telecom applications where InP is used as substrate for both laser diodes and photodiodes in optical transceivers. The arrival of 5G and the increasing growth of Datacom business is expected to drive the InP wafer and epiwafer market.

However, InP market growth will not be limited to optical communication. Some people have begun to talk about the potential opportunities in LiDAR and even handset PA applications. In fact, InP has remarkable intrinsic material properties for high speed and low noise for high frequency RF applications. With the arrival of the 5G network, there are many opportunities for InP.

In this context, we have investigated what the real market opportunities are. In this report, we invite you to discover with us what is happening in the InP industry.
InP wafer is used for two large categories: Photonics and RF.

For more details, see applications sections.
Currently the InP Telecom market dominates the InP photonics market, which is expected to grow at a steady rate.

InP Datacom market volume is expected to pass Telecom market by 2024, posting a XX CAGR in 2017-2024 period.
METHODOLOGY OF EPIWAFER MARKET ESTIMATION

Applicative markets → InP device → InP epiwafer → InP wafer

Top-down approach

Outsourcing ratio

InP epiwafer → InP wafer

Bottom-up approach
InP PIC APPLICATIONS OVERVIEW

Optical communication (transceivers)

Sensing

Medical applications

Lidar

InP PIC

Fiber-optic sensing offers a growth opportunity with drivers from the oil industry as well as structural engineering, industrial metrology and aerospace.

E.g. optical coherence tomography (OCT):
Traditionally OCT is done in the 800 nm window, which is the preferred choice for retina diagnostics. For skin or blood vessel diagnostics, 1500 nm is better, allowing three times higher penetration depth.
InP RF APPLICATIVE MARKET OVERVIEW

Military & Defense Applications

- Military radar
- Military telecommunication
- Imaging & security

Civil Applications

- Atmospheric sensing
- Medical imaging
- Radio astronomy
- Handset applications
- Automatic test equipment
- Wireless transmission
- Fiber-optic communication

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Toward Terahertz Technologies

At a glance

• The part of the electromagnetic spectrum between 0.1 and 30THz correspond to Terahertz or submillimeter range. The THz frequency range lies between the electronic based devices and photonic devices.

• For THz based solutions, THz generation and detection systems are needed.
  • THz generation is provided by sources such as thermal sources, solid-state electronics and emitters driven by lasers.
  • THz detection sensors use photoconductive antennas, Schottky diode based detectors and FETs.

Terahertz waves can be used for numerous applications from telecommunication to medical.
InP CRYSTAL GROWTH METHODS

Liquid Encapsulated Czochralski (LEC)

- The raw materials (pre-synthesized InP polycrystalline chunks) are placed in growth crucible along with a pellet of boron trioxide
- The raw material melt is maintained at a predetermined temperature by a heater surrounding the crucible
- The seed crystal is pulled up toward a low temperature area in the upper portion of a furnace to grow a single crystal

Polycrystalline InP

- Fast crystal growth (5 to 10 mm/h)
- Less expensive operating costs (not including equipment investment)
- Large diameter possible: 6 inch

Overview

Key players

LEC

Benefits

- Impact (FR)
- Wafer Technology (UK)

Drawbacks

- Large temperature gradient in the crystal growth direction (several tens of °C/cm) causing high defect density
- Difficult control environment due to heat rising while pulling the seed from the top
## InP EPIWAFER SUPPLIERS

### Classification by application

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- MOCVD
- MBE
- No Activity
RELATED REPORTS

- LiDAR for Automotive and Industrial Applications: Challenges and Market Opportunities
- GaAs Wafer and Epiwafer Market: RF, Photonics, LED, and PV
- 5G Impact on RF Front-End Modules & Connectivity for Cellphones: 2018 Report
- Silicon Photonics 2018: Yes, we're reaching Si photonics' tipping point!
- IR LEDs and Laser Diodes: Technology, Applications and Industry Scenarios: 2018 Report
As an old but still gold-standard member of the compound semiconductor family, InP possesses the key advantages of emission and detection capabilities over 1000 nm in the photonics domain, as well as high speed and low noise performance in high-frequency RF applications. Though it is often overshadowed by rivals like GaAs and SiGe for mass-volume, cost-driven RF applications, InP remains a top choice for performance-driven niche markets like military communication, radar, and radiometry, as well as automatic test equipment. Moreover, different industrial actors (i.e. Skyworks, GCS, and IntelliEPI) are monitoring InP technology for the upcoming 5G move.

Currently, the real boost for the InP wafer market is expected in photonic applications. In optical communication, InP offers high performance in many functions including emission, photo detection, modulation, and mixing, but it is often challenged by other semiconductor platforms because of its high cost. Nevertheless, InP is an indispensable building block for laser diodes in transceivers used for telecom and datacom applications. Specific to the cyclic telecom market, which has recently slowed down, massive investment plans from different operators (i.e. China Telecom) are expected with the imminent 5G network. In fact, the InP wafer market for telecom is projected to reach around $53M by 2024. Also, significant investment in the datacom market is expected from different players, led by internet giants Google, Amazon, Alibaba, and more.

With the requirement of more data transfer at higher speeds, transceiver technology is migrating to technology offering better rates (100GbE and 400GbE), for which InP is more favorable. The wafer market for datacom is expected to explode, with an impressive CAGR of 28%. Last but not least, exciting LiDAR applications could be promising for InP, i.e. enabling eye safety at higher wavelength, which is currently in an early R&D phase.

This report provides an overview of the InP wafer and epiwafer markets' size and market forecast for two large applicative markets: RF and photonics. Yole Développement (Yole) addresses the 5G network’s impact on the InP RF and photonic wafer markets. Moreover, this report outlines Yole’s understanding of current market dynamics and future evolution, with a technical description of InP wafer growth, epiwafer growth technology, and the main challenges.

The InP industry features lots of players at device level, and a high concentration at epiwafer and wafer level. The InP industry has different business models and numerous players. It is worth noting that from wafer to device manufacturing, this market's concentration level is different. At device level, Yole has identified more than 30 InP foundries and integrated fabs, most of which are currently focused on photonic chips. InP fabs are found globally, from the US to Europe and Asia. The majority of players are integrated fabs for their own products. These fabs have their own epiwafer production capacity or R&D capability, along with an outsourcing division for their epiwafers. There are also InP fabs that purchase epiwafers on
the open market. Yole does not expect the outsourcing ratio to evolve quickly in the coming years.

Contrary to the device manufacturing arena, the epiwafer open market is heavily concentrated. Landmark is the leader, focused on photonic applications. IQE also plays a key role with products covering photonics and RF applications.

When we observe wafer level, we see that it mirrors the epiwafer market in terms of concentration. More than 80% of market share is held by two firms: Sumitomo Electric Industries (SEI) and AXT Inc. JX Nippon Group occupies third place in terms of wafer sales. Other players are either in pilot-line production and only delivering small wafer volumes, or still in the R&D stages.

This report furnishes an overview of the InP industry playing field, covering wafer, epiwafer, foundry, and IDM players. Also outlined is Yole’s understanding of the market’s current dynamics and future evolution, covering technical and economic aspects.

IF CHALLENGED BY SILICON PHOTONICS, WHAT WOULD THE FUTURE LOOK LIKE FOR INP-BASED PHOTONIC IC?

Photonic IC (PIC) is not a new concept. It was first introduced in 1969, and since then different PIC platforms like InP, silicon photonics, and polymer have been studied and developed. InP-based PIC is widely studied, since it allows emission at wavelengths > 1000 nm, corresponding to several windows of optical fibers and also being necessary for some other applications. During our discussions with industry players about
market data, Yole’s analysts found that there are questions concerning the definition of monolithic InP PIC. In the extreme, EML (Electro-absorption Modulated Laser) is already monolithic. In fact, it all depends on level of integration. Although different building blocks - passive components, polarization components, phase modulator, laser, detector, and others have been demonstrated with InP - commercially-available, fully-integrated InP products are still limited.

In recent years, InP PIC has faced strong competition from silicon photonics, where industrial players like Intel have heavily invested. Indeed, when comparing Si photonics and InP PIC, it is hard to dispute Si photonics’ cost advantage for large-volume applications, due to large, higher-quality Si wafers. But though InP has faced (and will continue to face) strong competition from other materials for photonic applications, InP’s direct bandgap makes it unique for laser diode applications. Thus, we believe InP laser devices will exist for a long time, at least for active optoelectronic devices. Moreover, InP PIC makes sense for small-volume markets, addressing diverse applications such as medical, high-end LiDAR, and sensing, as well as optical communication. Players in these areas are likely to capitalize on the existing telecom/datacom supply chain for ramping up.

This report establishes Yole Développement’s understanding of InP PIC technology’s maturity, and its applicative potential.

COMPANIES CITED IN THE REPORT (non exhaustive list)

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**AUTHORS**

As a Technology & Market Analyst, Compound Semiconductors, Ezgi Dogmus, PhD is member of the Power & Wireless division at Yole Développement (Yole). She is daily contributing to the development of these activities with a dedicated collection of market & technology reports as well as custom consulting projects. Prior Yole, Ezgi was deeply involved in the development of GaN-based solutions at IEMN (Lille, France). Ezgi also participated in numerous international conferences and has authored or co-authored more than 12 papers. Upon graduating from University of Augsburg (Germany) and Grenoble Institute of Technology (France), Ezgi received her PhD in Microelectronics at IEMN (France).

Hong Lin, PhD works at Yole Développement (Yole), as a Senior Technology and Market Analyst, Compound Semiconductors within the Power & Wireless division since 2013. She is specialized in compound semiconductors and provides technical and economic analysis. Before joining Yole Développement, she worked as R&D engineer at Newstep Technologies. She was in charge of the development of cold cathodes by PECVD for visible and UV lamp applications based on nanotechnologies. She holds a PhD in Physics and Chemistry of materials.
# ORDER FORM

**InP Wafer and Epiwafer Market - Photonic and RF Applications 2019**

## BILL TO

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## PAYMENT

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- Mastercard
- Amex

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### BY BANK TRANSFER

- BANK INFO: HSBC, 1 place de la Bourse, F-69002 Lyon, France,
- Bank code: 30056, Branch code: 00170
- 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

## SHIPPING CONTACT

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## ABOUT YOLE DEVELOPPEMENT

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](http://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](http://www.i-micronews.com/reports)

## CONTACTS

For more information about:

- Consulting & Financial Services: Jean-Christophe Eloy ([eloy@yole.fr](mailto:eloy@yole.fr))
- Reports: David Jourdan ([jourdan@yole.fr](mailto:jourdan@yole.fr)) Yole Group of Companies
- Press Relations & Corporate Communication: Sandrine Leroy ([leroy@yole.fr](mailto:leroy@yole.fr))
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 Development’s Terms and Conditions”.

“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” (“IPR”) means any rights held by the Seller in its Products, including any patents, trademarks, registered models, designs, copyrights, inventions, know-how and the Buyer on the other hand.

“Monitoring” means any rights held by the Seller in its Products, including any patents, trademarks, registered models, designs, copyrights, inventions, know-how and trademarks, registered models, designs, copyrights, inventions, know-how and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they may not be registered and including any pending registration of one of the above mentioned rights.

“Products”: Depending on the purchase order, reports or monitors on MEMS, Imaging, SLS, 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*”: Reports are established in PowerPoint and delivered in PDF format with an additional Excel file. Q&A with an Analyst are included for each report. More time can be allocated on a fee basis.

“License*” for the reports 3 different licenses are proposed. The Buyer can choose one of the following:

- Single user license: one user at the company can use the report. Sharing is strictly forbidden.
- Multi-user license: the 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.
- Corporate license: the report can be used by an unlimited number of users worldwide, but only in the country of the primary user. Subsidiaries and Joint-Ventures are included, while subsidiaries and Joint-Ventures are excluded.

“Monitor*”: Monitors are established and delivered in Excel. An additional PDF format is available with an Analyst if possible with a maximum with a maximum of 100th/year. Frequency of the release varies according to the monitor or service.

“Seller*: Based in Villeurbanne (France headquarters Yole Développement is developing is providing marketing, technology and strategy consulting, media and corporate finance, reverse engineering/costing services as well as IP and patent analysis). With more than 70 market analysts, Yole Development works worldwide with the key industrial companies, R&D institutes and investors to help them understand the markets and technology trends.

1. SCOPE

1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. ANY ADDITIONAL, DIFFERENT OR CONFLICTING TERMS AND CONDITIONS IN ANY OTHER DOCUMENTS ISSUED BY THE BUYER AT ANY TIME ARE HEREBY OBJECTED TO BY THE SELLER, SHALL BE WHOLLY INAPPLICABLE AND NOT MADE HEREUNDER AND SHALL BE FREE FROM BID AND INFORMATION TO ANY WAY ON THE SELLER.

1.2 This agreement becomes valid and enforceable between the Seller and the Buyer on the date of order, to be sent either by email or to the Buyer's email/password. If the Product's electronic delivery format contains contaminating or destructive properties before the release varies according to the monitor or service. Any Product returned to the Seller without providing prior advice and acts it deduces thereof.

2. Mailing of the Products

2.1 Products are sent by email to the Buyer:

- within a reasonable period of time for products ordered prior to the date of order, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.
- within one month from the order date for products already released; or
- within a reasonable time for products ordered prior to the date of order, in which cases in a week after the order for the product is sent by email or to the Buyer's address. In the absence of any confirmation of writing, orders shall be deemed to have been accepted.

2.2 The mailing of the Product will occur only upon payment by the Buyer, in accordance with the conditions contained in article 3.

2.3 The mailing of the Product is the one applicable at the time of the order. In the event of non-conformity shall be sent in writing to the Seller within 8 days of receipt of the Products. For this purpose, the Buyer agrees to produce sufficient evidence of such defects.

2.4 No returns of Products shall be accepted without prior information to the Seller, even in case of delayed delivery. Any Product returned to the Seller without providing prior information to the Seller, in accordance with article 2.5 shall remain at the Buyer's risk.

3. PRICE, INVOICING AND PAYMENT

3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to bundled offers. They are expressed to be inclusive of all taxes. The prices may be reevaluated from time to time. The effective price is deemed to be the one applicable at the time of the order.

3.2 Payments due by the Buyer shall be sent by cheque payable to Yole Development via credit card or by electronic transfer to the following account: HSBC, 1 place de la Bourse 69002 Lyon France Bank code: 00170

Branch code: 00170
Account n°: 0170 200 1546 87
BIC or SWIFT: FRPRP
IBAN: FR76 3005 6001 7001 7020 0156 87
To ensure the payments, the Seller reserves the right to request down payments from the Buyer. In this case, the need of down payments will be specified in writing within 7 days of the order date.

3.3 Payment is due by the Buyer to the Seller within 30 days from invoice date, except in the case of a particular written agreement. 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 based on the annual rate Ref of the BCE + 7 points, in accordance with article L.411-6 of the French Commercial Code (example of calculation database...etc.) are delivered only after receipt of the payment.

4. IN the event of termination of the contract, or of misconduct, due to the Buyer's fault, the Seller will have the right to invoicing at the stage in progress, and to take legal action for damages.

4. LIABILITIES

4.1 The Buyer or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products that meet the needs of the Buyer. The Seller makes of the products documents it purchases, of the results he obtains, and of the advice and acts it deduces thereof.

4.2 The Seller shall only be liable for (a) direct and (b) foreseeable pecuniary loss, caused by the Products or arising from a material breach of this agreement.

4.3 In no event shall the Seller be liable for:

- damages arising from use without limitation, incidental or consequential damages (including, but not limited to, damages for loss of profits, business interruption and loss of programs or data contained in the Products), loss that may be borne by the Buyer, following this decision.

4.4 All the information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, reliability or completeness of the information provided on the website or in the Products; or, any information on the Products, or any information provided on the website, or in the Products; b) any claim attributable to errors, omissions or inaccuracies in the Product or interpretations thereof.

4.5 All the Products shall be used for the intended purpose only.

5. FORCE MAJEURE

5.1 The Seller shall not be liable 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, epidemics, equipment failure or any other cause beyond the Seller’s control.

6. LIABILITIES

6.1 The Seller agrees not to disclose, copy, reproduce, redistribute, reestablish, sell or give any part of it to any other party other than employees of the company. The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use the Product for purposes such as:

- Information storage and retrieval systems;
- Recordings and re-transmitters over any network (including any local area network);
- Use in any timesharing, 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.

6.2 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from its employees or any person to whom the Buyer has given access to the Product. The Seller shall have the right to claim any loss or damage caused to the Seller as a result of the breach of this agreement, or any further damages as agreed by the Seller and the Buyer.

7. TERMINATION

7.1 If the Buyer cancels the order in whole or in part or postpones the mailing, the Seller reserves the right to charge the entire costs that have been incurred as at the date of notification by the Buyer of such delay or cancellation. This may apply for any other direct or indirect consequential loss that may be borne by the Seller, following this decision.

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

8. MISCELLANEOUS

8.1 These Terms and Conditions of Sales are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to assert and enforce those provisions against the Buyer. Any notice 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. The Buyer will not be required to accept 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 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into in application of these terms and conditions by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.

9.2 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into in application of these terms and conditions by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.

9.3 Any dispute arising out of or linked to these Terms and Conditions or to any contract (orders) entered into in application of these terms and conditions by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.

9.4 Any dispute arising out of or linked to these Terms and Conditions or to any contract (orders) entered into in application of these terms and conditions by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.
YOLE DEVELOPPEMENT – FIELDS OF EXPERTISE

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
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/or Quarterly update
  - Excel database covering supply, demand, and technology
  - Price, market, demand and production forecasts
  - Supplier market shares

- **Media**
  - i-Micronews.com website
  - @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

©2019 | www.yole.fr | About Yole Développement
OUR GLOBAL ACTIVITY

40% of our business

30% of our business

30% of our business

Europe office

Greater China office

HQ in Lyon

Nice

Nantes

Paris

Tokyo

Hsinchu

Phoenix

Seoul

Texas

Yole Korea

Yole Japan
ANALYSIS SERVICES - CONTENT COMPARISON

- Technology and Market Report
- Leadership Meeting
- Q&A Service
- Meet the Analyst
- Custom 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 multiples 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 and 10 new monitors. 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. Discover our 2019 program right now, and ensure you get a true vision of the industry. Stay tuned!
OUR 2019 REPORTS COLLECTION (1/4)

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 indepth 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**
- **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
- **STRUCTURE, PROCESS & COST REPORT**
  - MEMS & Sensors Comparison 2019
  - MEMS Pressure Sensor Comparison 2018
  - Particle Sensors Comparison 2019
  - Miniaturized Gas Sensors Comparison 2018
- **PATENT REPORT**
  - MEMS Foundry Business Portfolio 2019 - New
  - Miniaturized Gas Sensors 2019 - New

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

**RF DEVICES AND TECHNOLOGIES**
- **MARKET AND TECHNOLOGY REPORT**
  - 5G’s Impact on RF Front-End Module and Connectivity for Cell Phones 2019 - Update
  - Radar and V2X Market & Technology for Automotive 2019 - Update
  - Advanced RF Antenna Market & Technology 2019 - New
- **STRUCTURE, PROCESS & COST REPORT**
  - RF Front-End Module Comparison 2019 - Update
  - Automotive Radar RF Chipset Comparison 2018
- **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: Materials, Devices and Modules 2018

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 📌
  - 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 Flat Panel Detectors for Military, Industrial and Medical 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 2018 📌 📌
  - Liquid Biopsy: from Isolation to Downstream Applications 2018 📌
  - Chinese Microfluidics Industry 2018 📌
- **STRUCTURE, PROCESS & COST REPORT**
  - Compact Camera Modules Comparison 2019 📌
  - CMOS Image Sensors Comparison 2019 📌
- **PATENT REPORT**
  - Microfluidic Manufacturing Technologies 2019 – New 📌

**INKJET AND ACCURATE DISPENSING**
- **MARKET AND TECHNOLOGY REPORT**
  - Inkjet printheads - Dispensing Technologies & Market Landscape 2019 - Update 📌 📌 📌 📌
  - Emerging Printing Technologies for Microsystem Manufacturing 2019 - New 📌 📌 📌 📌 📌 📌 📌
  - Piezoelectric Materials 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
  - Nanopore Sequencing 2019 - New

SOFTWARE AND COMPUTING
- MARKET AND TECHNOLOGY REPORT
  - Hardware and Software for Artificial Intelligence (AI) in Automotive Applications 2019 - New
  - Hardware and Software for Artificial Intelligence (AI) in Consumer Applications 2019 - Update
  - From Image Processing to Deep Learning 2019 - Update
  - xPU (Processing Units) for Cryptocurrency, Blockchain, HPC and Gaming 2019 – New

MEMORY
- MARKET AND TECHNOLOGY REPORT
  - Status of the Memory Business 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 2019 - Update
  - Status of Advanced Substrates 2019 - Update
  - Panel Level Packaging Trends 2019 - Update
  - RF System-in-Package & Materials for 5G 2019 - New
  - System in Package (SIP) Technology and Market 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
OUR 2019 REPORTS COLLECTION (4/5)

SEMICONDUCTOR MANUFACTURING
- MARKET AND TECHNOLOGY REPORT
  - Nano Imprint Lithography 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 - Technology, Industry and Market Trends 2019 - Update
  - IR LEDs and Laser Diodes – Technology, Applications, and Industry Trends 2018
  - UV LEDs - Technology, Manufacturing and Application Trends 2018
  - LiFi: Technology, Industry and Market Trends 2018
- STRUCTURE, PROCESS & COST REPORT
- PATENT REPORT
  - VCSEL Comparison 2019
  - VCSELS 2018

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

Update: 2018 version still available
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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 Compound Semiconductor 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

Update: 2018 version still available
OUR 2019 MONITORS COLLECTION (1/2)

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.
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 epiwafers, 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 epiwafers, 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 (LiNiMO2), 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.
**MICRONEWS MEDIA**

- **About Micronews Media**

  To meet the growing demand for market, technological and business information, Micronews Media integrates several tools able to reach each individual contact within its network. We will ensure you benefit from this.

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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.

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Several key events planned for 2018 on different topics to attract 120 attendees on average.

Gain new leads for your business from an average of 340 registrants per webcast.

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