

Miniaturized Gas Sensors

Patent Landscape Analysis

December 2018

Picture: Micralyne MOS MEMS Sensor

THE AUTHORS



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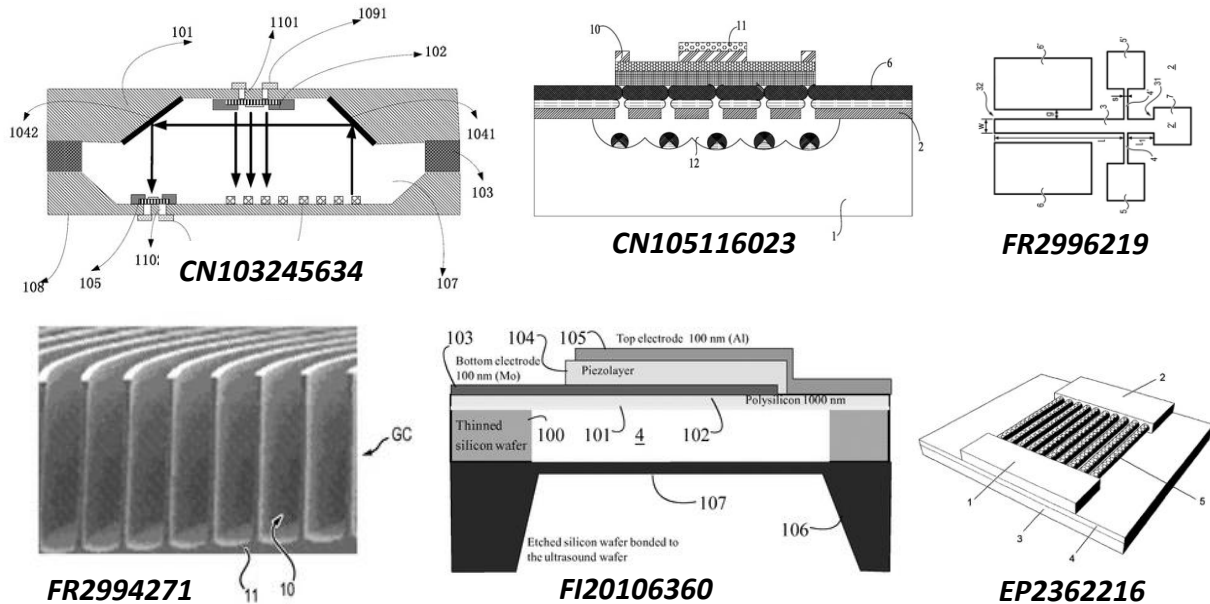
Knowmade's experts provide prior art search, patent landscape analysis, scientific literature analysis, patent valuation, IP due diligence and freedom-to-operate analysis. In parallel the company proposes litigation/licensing support, technology scouting and IP/technology watch service. **Knowmade's** analysts combine their technical and patent expertise by using powerful analytics tools and proprietary methodologies to deliver relevant patent analyses and scientific reviews.

SCOPE OF THE REPORT

- This report provides a detailed picture of the patent landscape for **miniaturized gas sensors**. It is an update of our previous report “Miniaturized Gas Sensors” published in 2016
- The report covers **patents published worldwide up to November 2018**.
- We have selected and analyzed more than **3,556 patents and patent applications** (1,710+ patent families) relevant to the scope of this report.

Included in the report

- **Gas sensing technologies with very innovative approaches, based on existing MEMS/Semiconductor/Optical integration platforms and manufactured by micro-fabricating processes.**
- **Gas sensors for consumer applications (smartphone, wearable devices, automotive, home devices)**



Not included in the report

- **Large scale gas sensors manufactured without micro-fabricating processes**
- **Gas rate or flow or pressure sensors**
- **Gas leakage sensors if the leakage is detected thanks to a gas rate or flow or pressure sensor.**
- **Devices with a miniaturized gas sensor which do not describe materials or processes used to manufacture it.**

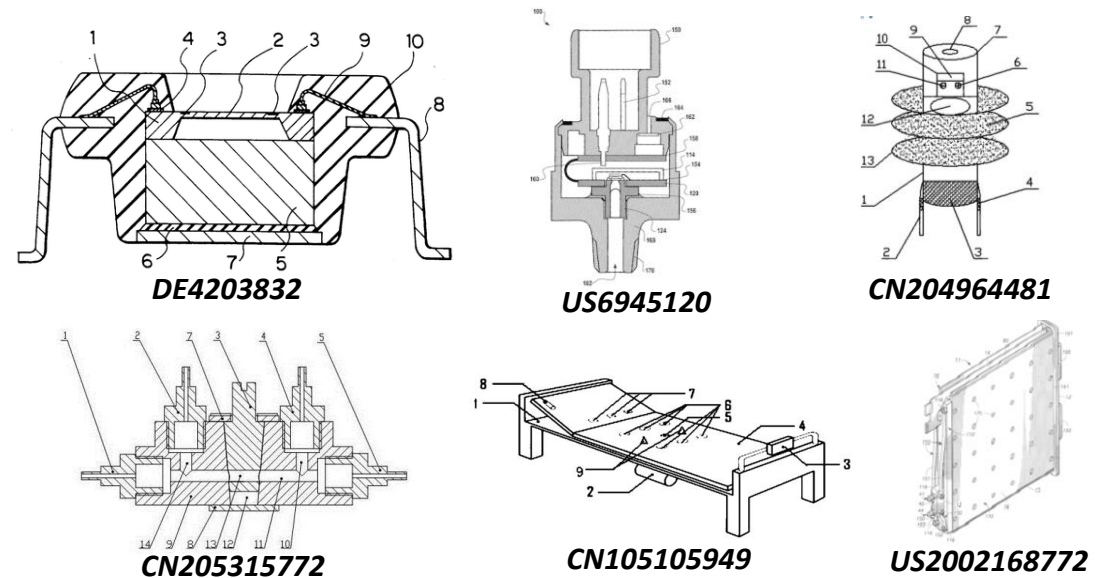


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KEY FEATURES OF THE REPORT

- The report provides **essential patent data** for **miniaturized gas sensors**.
- It provides **in-depth patent analyses** of **key technologies** and **key players** including:
 - Time evolution of patent publications and countries of patent filings.
 - Current legal status of patents.
 - Ranking of main patent applicants.
 - Key patents.
 - Granted patents near expiration.
 - Relative strength of main companies IP portfolio.
 - Matrix patent applicants/technology issues for more than 20 players.
- The “miniaturized gas sensor” **IP profiles** and portfolios comparison of **Bosch** and **AMS** companies is presented, including key patents, IP strength and latest market news.

KEY FEATURES OF THE REPORT

- The report also provides an extensive **Excel database** with all patents analyzed in the report.
- This **useful patent database** allows multi-criteria searches, including:
 - Patent publication number
 - Hyperlinks to the original documents
 - Priority date
 - Title
 - Abstract
 - Patent assignees
 - Technical segmentation
 - Legal status for each member of the patent family
- This report **does not provide** any insight **analyses or counsel regarding legal aspects** or the validity of any individual patent. Knowmade is a research firm that provides technical analysis and technical opinions. Knowmade is not a law firm. The research, technical analysis and/or work proposed or provided by Knowmade and contained herein is not a legal opinion and should not be construed as such.

BENEFITS FOR CUSTOMER

Understanding the **competitive landscape** and **technology developments** from a **patent perspective**

- Know the **key IP players**, their **key patents**, their IP/technology **strategy** and their **future intents**
- Identify **new entrants**, their **technology** and **market areas** of interest
- Follow the **technology trends** and identify **emerging technologies**
- **Benchmark** patent portfolios and know competitors' **strengths** and **weaknesses**
- Identify the **key patents** (seminal, blocking, valuable) and the **key technical solutions** that address hot technical issues
- Identify **free technologies** which can be used safely and mitigate the **risks of patent infringement**
- Identify **technologies to acquire** and potential **R&D partners**

Very complementary to market research

- Key market players
- Supply chain
- Technology Readiness Levels (TRL)
- Market product
- Emerging technologies/applications
- Forecast

Patent Landscape Overview

Patent assignees, IP dynamics, patent legal status, patent geographical coverage

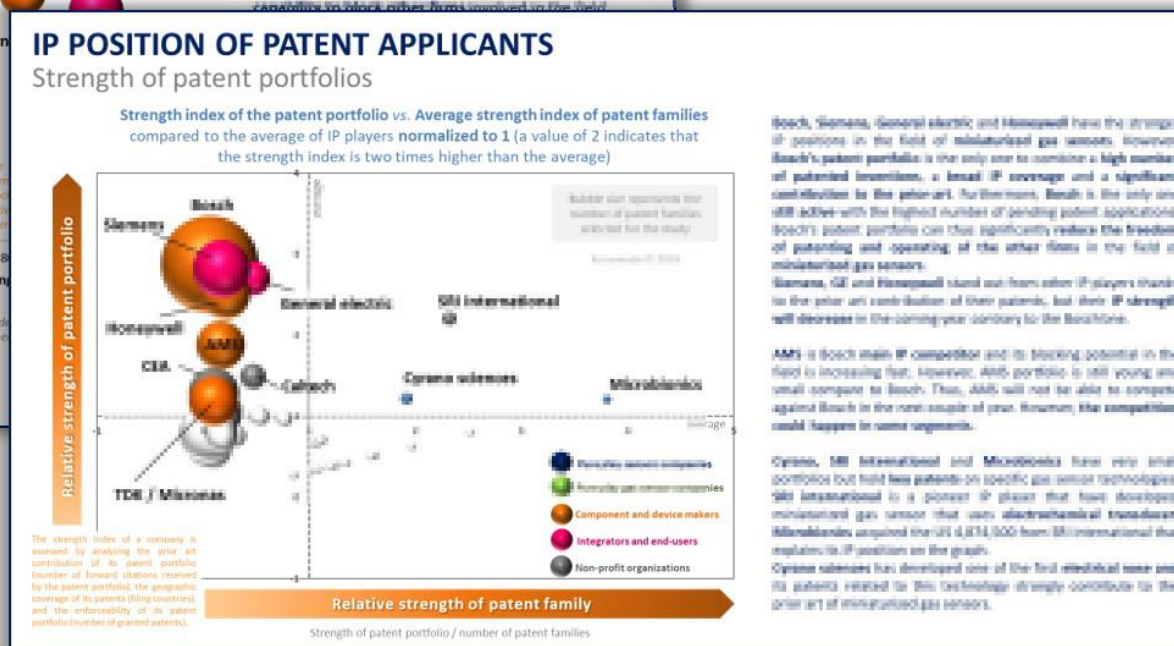
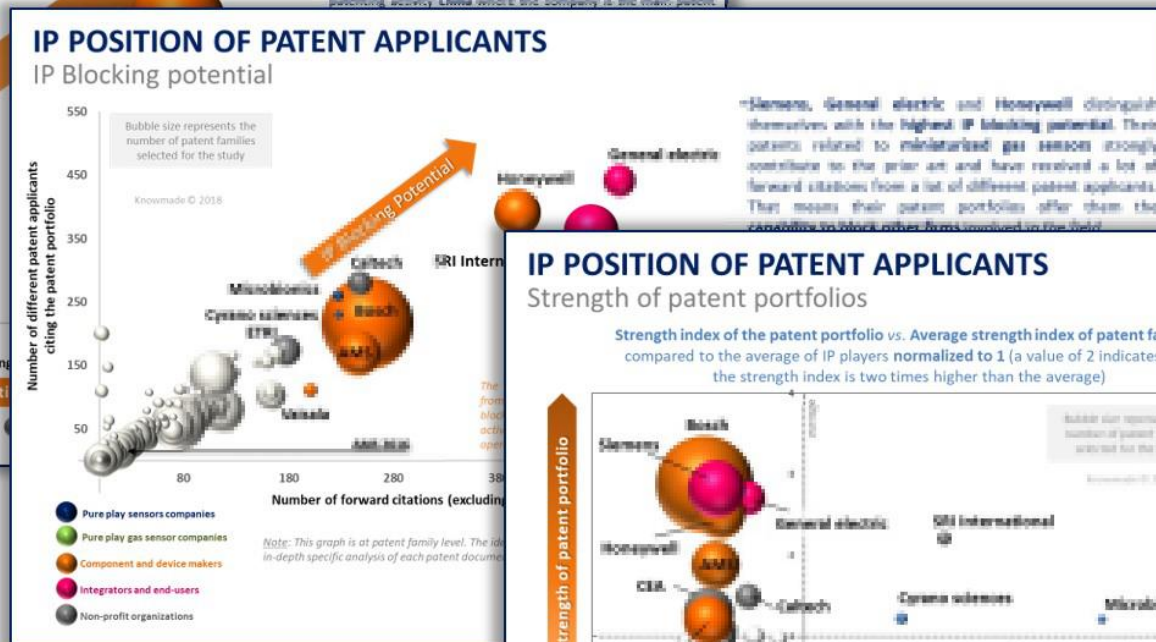
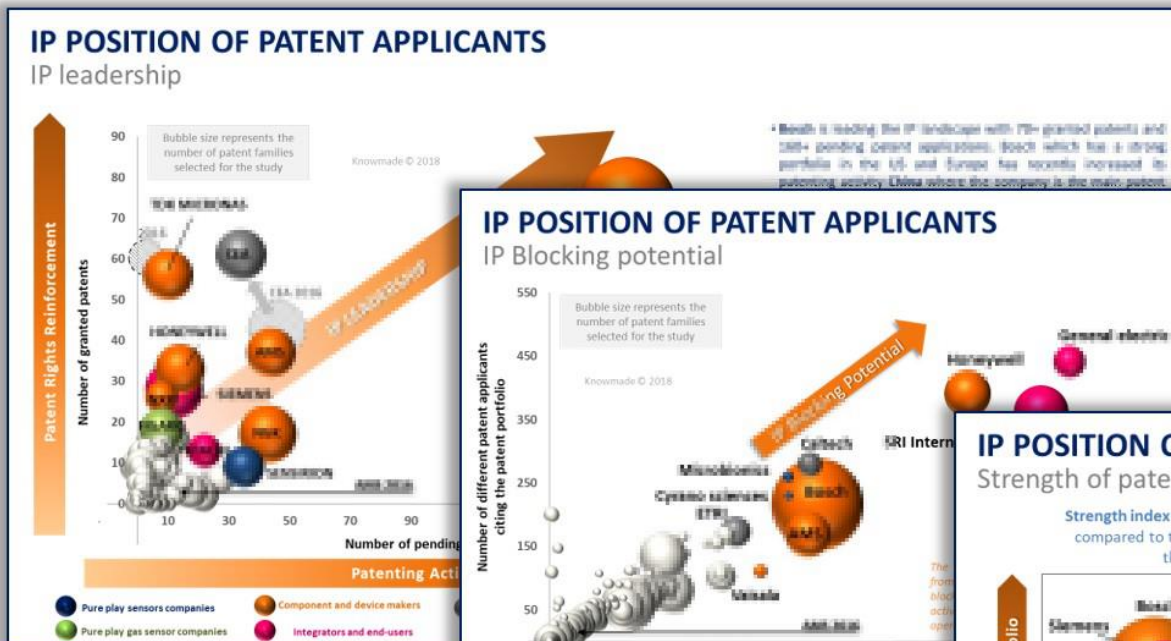
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Patent Portfolios Benchmarking: Beyond the Quantity

Who has the best patent portfolio?

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Bosch, Siemens, General electric and Honeywell have the strongest IP positions in the field of miniaturized gas sensors. However, Bosch's patent portfolio is the only one to combine a high number of patented inventions, a broad IP coverage and a significant contribution to the prior-art. Furthermore, Bosch is the only one still active with the highest number of pending patent applications. Bosch's patent portfolio can thus significantly reduce the freedom of patenting and operating of the other firms in the field of miniaturized gas sensors.

Siemens, GE and Honeywell stand out from other IP players thanks to the prior art contribution of their patents, but their IP strength will decrease in the coming year contrary to the Bosch firm.

AMI is Bosch main IP competitor and its blocking potential in the field is increasing fast. However, AMI portfolio is still young and small compared to Bosch. Thus, AMI will not be able to compete against Bosch in the next couple of years. However, the competition could happen in some regions.

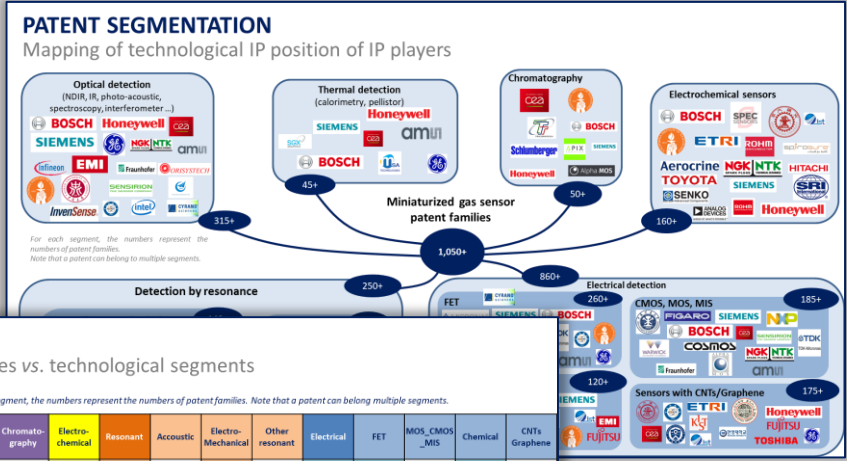
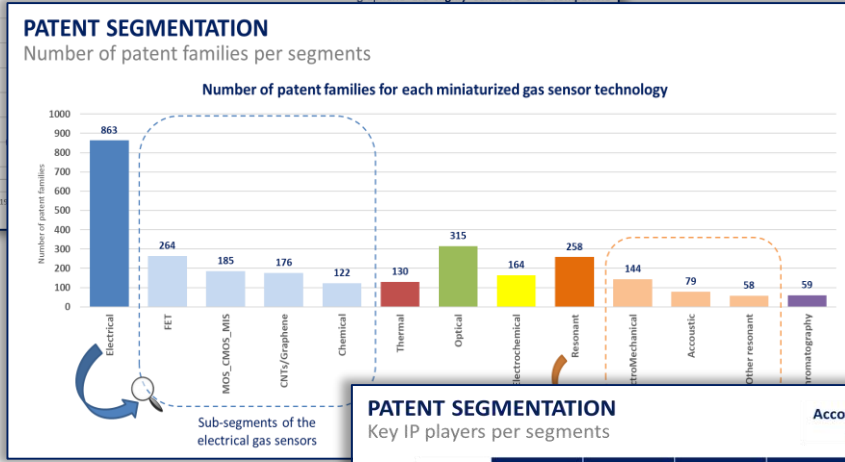
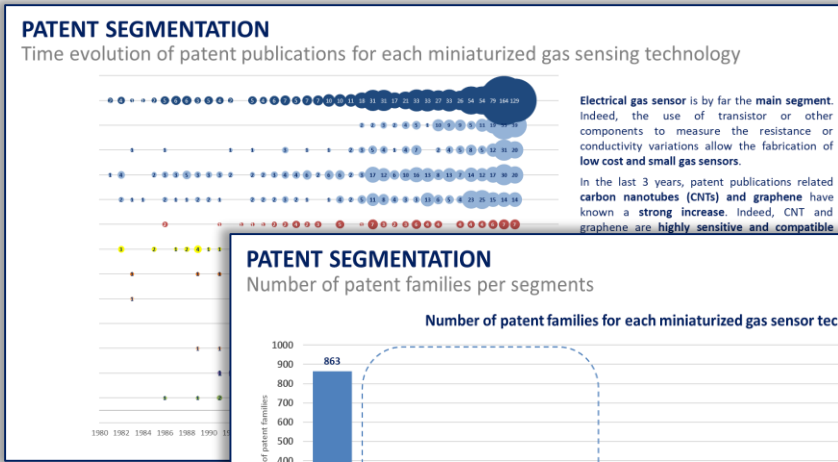
Cytiva, MI International and Microbionics have very small portfolios but hold few patents on specific gas sensor technologies. MI International is a pioneer IP player that has developed miniaturized gas sensor that uses electrochemical transducer. Microbionics acquired the US 4,814,500 from MI International that regulates its IP position on the graph.

Cytiva sensor has developed one of the first electrical ones and its patents related to this technology strongly contribute to the prior art of miniaturized gas sensors.

Patent Segmentation

What are the key IP players per gas sensing technology?

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PATENT SEGMENTATION

Matrix of main patent assignees vs. technological segments

Ranking ↓ For each segment, the numbers represent the numbers of patent families. Note that a patent can belong multiple segments.

Assignee	Number of patent families	Optical	Thermal	Chromatography	Electro-chemical	Resonant	Acoustic	Electro-Mechanical	Other resonant	Electrical	FET	MOS, CMOS, MIS	Chemical	CNTs Graphene
BOSCH	147	39	5	1	35	10		8	2	66	23	6	15	1
NGK	51	9	0		13					18		4	1	1
SIEMENS	51	8	4		1	2	8	6	2	41	36	8	3	1
				11	23	6	15	5	19	7	3	4	1	
				4	4	9	6	3		10	5		1	2
				1						32	27	5		
				1	1	5		4	1	24	9	11	4	1
				1	5			1	4	11		8		
				1	10	4	5	1	17	6	2	2	2	8
				4	4				15			8	5	
				2		2			15	1	13			
				2		11		9	7	1				
				1		1		1		14	1		2	2
				1	2	2		1	1	7	4	1		1
				2						16	12	1	1	
				1	5	1		1		12	3	1	1	7
				1	1				1	10	1	6	2	

PATENT SEGMENTATION

Key IP players per segments

According to our analysis, below are the key IP players for each miniaturized gas sensor technology

	ELECTRICAL	OPTICAL	THERMAL	ELECTRO-CHEMICAL	ELECTRO-MECHANICAL	ACOUSTIC	CHROMATOGRAPHY
Key IP players still active	BOSCH amui	BOSCH amui Infineon	amui BOSCH	BOSCH NGK SPEC SENSORS	ce2 BOSCH	Infineon VIT	ce2 Alpha MOS
Key IP players with decreasing or no longer IP activity	SIEMENS TDK	Honeywell GE	NXP Ford	SRL SPEC SENSORS	Agency for Int. Technology VIT	SIEMENS ProterixBio Honeywell	TRICONTECH
IP newcomers (non exhaustive)	sprosure Goertek InvenSense	intel NISSHA Goertek	intel SENSIRION TDK	sprosure ANALOG DEVICES	sprosure SENSIRION	MARZ ttp	iSenLab
	SUMITOMO	Sumitomo	Sumitomo	Sumitomo	Sumitomo	Sumitomo	Sumitomo

Focus on Gas Sensing Technologies

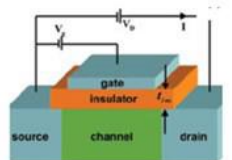
Key IP players, newcomers, key patents

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ELECTRICAL GAS SENSORS

Technology Description (1/2)

Principle

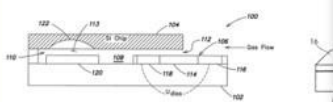


• **Field-effect transistor (FET)** is a transistor in which the shape of the semiconductor channel, i.e. its electrical conductivity is monitored by an electric field. FET conductivity is regulated by the voltage applied to the gate which is insulated from the device. The applied gate voltage imposes an electric field into the device, which attracts or repels charge carriers to or from the region between the source and the drain. The density of moving charge carriers influences the conductivity between the source and drain.

• The potential at the insulating gate surface depends on its surrounding environment. This potential changes in presence of a gas, inducing a current variation through the transistor. Gases are detected thanks to the measurement of this current variation.

• In the case of a molecule environment...

Examples of FET gas sensors for consumer electronics



FET-based gas sensor
DE102004019641

Nanosensors
US2016

OPTICAL GAS SENSORS

IP newcomers

Assignee	Publication year							IP activity	Patent List
	2010	2011	2012	2013	2014	2015	2016		
...							2	Gas sensor based on Carbene monoxide and nitrogen dioxide	...
...							1	Micro spectrometer for gas sensing applications	...
...							2	Carbon nanotubes coated with chromogenic agent	...
...							1	Patents related to gas sensor module and system (electric nose)	...
...								Infrared based gas sensor	...
...								Gas sensor using optical and electrical detection	...
...								Gas sensor for mobile phone based on photo-acoustic devices	...
...								Gas sensor based on infrared and capacitive MEMS detectors	...

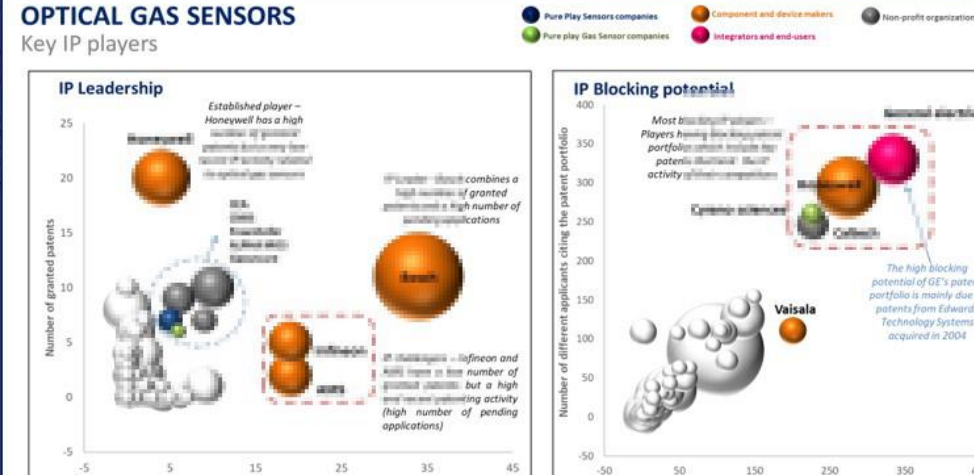
THERMAL GAS SENSORS

Key IP players and their key patents

Assignee	Portfolio analysis	Key patents
AMS	AMS is the IP leader for miniaturized thermal gas sensors. Since 2010, the company has progressively increased its patenting activity related to thermal gas sensors. In addition to filing its own patents AMS has also acquired several patents from NXP. Today with 11 pending applications and 12 granted patents AMS has the largest number of alive patents relating to thermal gas sensors. In the recent years, AMS has developed thermal conductivity sensing devices for air monitoring applications in buildings, automotive and industrial monitoring and health analysis.	<ul style="list-style-type: none"> Integrated circuit comprising a gas sensor Integrated circuit with a gas sensor and method of manufacturing an integrated circuit Gas sensor
Bosch	Bosch is the main IP challenger in the field. Indeed, Bosch strongly increased its patenting activity related to miniaturized thermal gas sensors in the last 3 years with the publication of 6 new inventions. The strengthening of its IP portfolio is due to an increasing number of granted patents, that will allow the company to compete against AMS in the near future. The main IP activity on miniaturized thermal gas sensor is based on thermoelectric and heat conductivity measurements. Furthermore, Bosch has also developed the use of thermoelectric materials.	<ul style="list-style-type: none"> Thermal conductivity sensor, method of manufacturing and method of implementation of the sensor Method for producing a semiconductor component and semiconductor component produced according to this method
NXP	In 2010 NXP filed 4 patents for thermal gas sensors, only one is still only held by NXP (the Chinese members). The last patent is still pending.	
Ford	Bosch is a pioneer IP player that developed patents US4817148 and US5451371 dedicated to thermal conductivity sensing. Thus, despite Ford being the actual IP activity due to its strong patenting activity in the field.	

OPTICAL GAS SENSORS

Key IP players



IP Leadership

- Honeywell**: Established player - Honeywell has a high number of granted patents and a high number of pending applications.
- AMS**: IP leader - combines a high number of granted patents and a high number of pending applications.
- Infineon**: IP challenger - Infineon and NXP have a high number of granted patents but a high number of pending applications (high number of pending applications).

IP Blocking potential

- GE**: Most blocking potential - Players having low IP activity but high patenting activity.
- Vaisala**: High blocking potential - The high blocking potential of GE's patent portfolio is mainly due to patents from Edwards Technology Systems acquired in 2004.

Legend: Pure Play Sensors companies (blue), Component and device makers (orange), Non-profit organizations (grey), Pure play Gas Sensor companies (green), Integrators and end-users (pink).

- Electrical
- Thermal
- Optical
- Electro-chemical
- Electro-mechanical
- Acoustic
- Chromatography

Bosch IP Portfolio vs. AMS IP Portfolio

IP profile, key patents, IP strategy

SAMPLE

BOSCH
Key patents for miniaturized gas sensors

Representative publication number	Title	Earliest publication date	Legal status (Pending, Granted, Revoked, Expired, Lapsed)	PDF
US201502056917	Component having a microphone and media sensor function	2015-09-09	DEAD (US, DE, CN)	Open
US98026900	Method for producing micromechanical fluid			
US201301909800	Micromechanical sc			
FR2963831	Gas			
US8913711				
US6072009				
US8749013	Sensor			
FR2888833	Thermal conductivity			
US7485382				
US7279682				

BOSCH
Patent portfolio summary for miniaturized gas sensors

Large Portfolio | **1998** Oldest priority date | **5 years** Patent family average age

27 USA | **11** [Country]

147 Patent families | **73** Granted patents | **161** Pending (2009-2020) | **9** Total (2020)

Strong Portfolio strength | **Strong** of manufacturing | **High** Leadership

Electrical | **Optical** | **Thermal**

Electrochemical | Electrochromatography

Chromatography | CNT/graphene

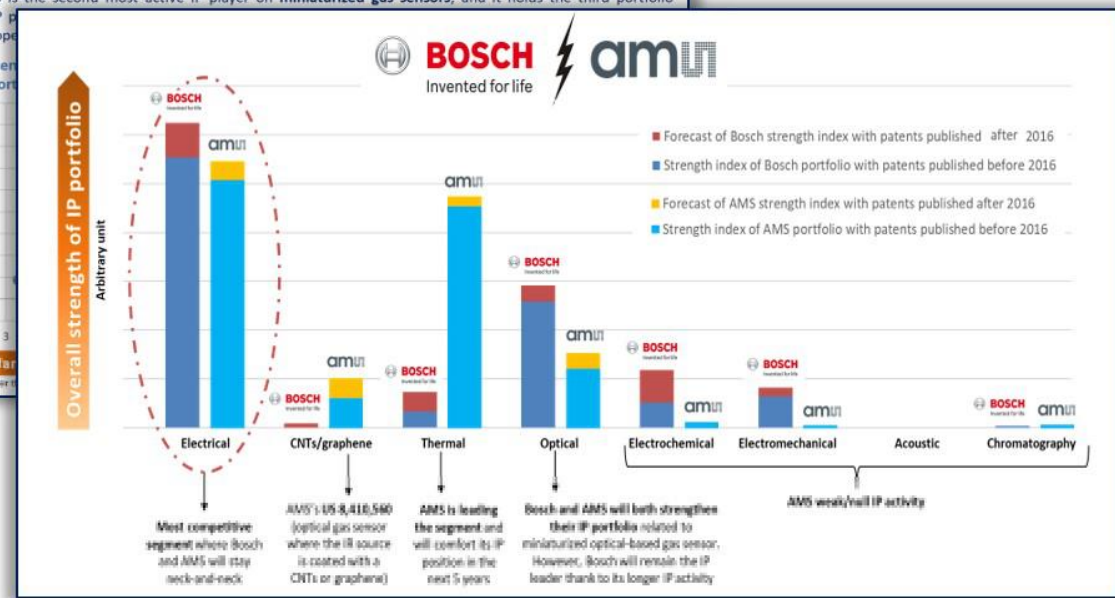
AMS INTERNATIONAL
Portfolio analysis

AMS International is a young IP player that have entered the IP landscape related to miniaturized gas sensor about 6 years ago. AMS R&D strategy is based on IP acquisition. Indeed, 24 of its 35 patent families come from other companies or Research Institutes. For instance, AMS acquired some members of two old patent families filed by Honeywell in 1997 and 2005. In addition to IP acquisitions, AMS has strengthened its IP portfolio with the acquisition of AppliedSensors in 2014 as well as Cambridge CMOS Sensors and NXP's CMOS environmental sensor business.

While at least 10 pending patents applications, AMS is the second most active IP player on miniaturized gas sensors, and it holds the third portfolio regarding alive patents. In addition to elevating its IP markets for miniaturized gas sensors (e.g. China, Europe)

Contribution of each technical segment strength index⁽¹⁾ of the AMS IP portfolio

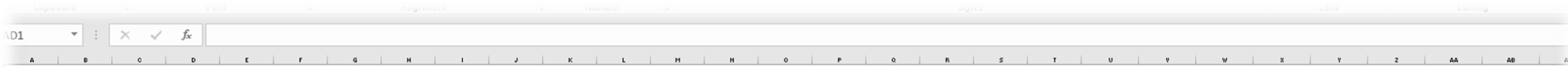
Relative strength index of patent families
(a value of 2 indicates that the strength index is two times higher)



Excel file with all patents analyzed in the report

Useful patent database allows multi-criteria searches

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Miniaturized Gas Sensors: Patent Landscape Analysis (December 2018)

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Technical Segments:

Optical	Thermal	Chromatograph	Electro-Chemical	Resonant	Acoustic	Electro-Mechanical	Electrical	CMOS
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Quant unique family ID	Publication number	Publication stage	Publication date	Original document	Application number	Application date	Priority number	Priority date	Expected expiry date	Legal status	Grant date	Current assignee	Inventors	English title	English abstract	English claim	Cited patents - Standardized publication number	Citing patents - Standardized publication number	Optical	Thermal	Chromatograph	Electro-Chemical	Resonant	Acoustic	Electro-Mechanical	Electrical	CMOS			
8173974	CN207992164U	(U)Registered utility model	2010-10-19	Dead	CN201020470052 U	2010-03-30	CN201020470052 U	2010-03-30	2020-03-30	(CN207992164U) LEGAL DETAILS	2010-10-19	MICROJET TECHNOLOGY	MOHAORAN HANYONGLI	(CN207992164U) Actuation of the	(CN207992164U) 1. An actuator zener module,															
8169600	CN106480703	(A)Published application	2010-10-19	Dead	CN201010313555 U	2010-04-10	CN201010313555 U	2010-04-10	2020-04-10	(CN106480703) LEGAL DETAILS		HANGZHOU DIANZI SUZHONGREN	DONGLIN SUZHONGREN	(CN106480703) MEMS micro qur	(CN106480703) The present utility model discloses a 1. The															
8165243	CN207964706U	(U)Registered utility model	2010-10-12	Dead	CN201020371045 U	2010-03-20	CN201020371045 U	2010-03-20	2020-03-20	(CN207964706U) LEGAL DETAILS	2010-10-12	SUZHOU DAITS OF REMOTE SENSING	MA HEPING	(CN207964706U) Unmanned aerial	(CN207964706U) The present utility model discloses a 1. The															
81656295	CN207957757U	(U)Registered utility model	2010-10-12	Dead	CN201020422729 U	2010-03-16	CN201020422729 U	2010-03-16	2020-03-16	(CN207957757U) LEGAL DETAILS	2010-10-12	SUZHOU TANTALUM	SHENFANGPING	(CN207957757U) MEMS	(CN207957757U) Gas phase chromatographic															
8160996	TW5642366	(U)Registered utility model	2010-10-11	Dead	TW2010107205984 U	2010-05-04	TW2010107205984 U	2010-05-04	2020-05-04	(TW5642366) LEGAL DETAILS		MICROJET TECHNOLOGY	MOHAORAN SUE DAWEI	(TW5642366) Gas detecting	(TW5642366) A gas detecting device comprising															
8161975	TW5642366	(U)Registered utility model	2010-10-11	Dead	TW2010107204570 U	2010-05-10	TW2010107204570 U	2010-05-10	2020-05-10	(TW5642366) LEGAL DETAILS		MICROJET TECHNOLOGY	CHENSHICHANG	(TW5642366) Gas detecting	(TW5642366) Apparation system of gas															
8161973	TW5642367	(U)Registered utility model	2010-10-11	Dead	TW2010107205987 U	2010-05-04	TW2010107205987 U	2010-05-04	2020-05-04	(TW5642367) LEGAL DETAILS		MICROJET TECHNOLOGY	MOHAORAN SUE DAWEI	(TW5642367) Separation	(TW5642367) An action device with gas															
8161961	TW5642368	(U)Registered utility model	2010-10-11	Dead	TW2010107209940 U	2010-07-20	TW2010107209940 U	2010-07-20	2020-07-20	(TW5642368) LEGAL DETAILS		MICROJET TECHNOLOGY	MOHAORAN HUANG, CHILIAO YUSUJIAN	(TW5642368) Operation device	(TW5642368) 1. An action device with gas															
8161548	TW637901	(S)Granted patent as per patent	2010-10-11	Dead	TW2010106432267	2010-09-21	TW2010106432267	2010-09-21	2027-09-21	(TW637901) LEGAL DETAILS	2010-10-11	TAIHAN CARBON	LIANG YUJIAN OAI FANGSONG	(TW637901) Method of	(TW637901) An ammonia manufacture															
8157482	CN106427544	(A)Published application	2010-10-09	Dead	CN2010710100272	2010-02-23	CN2010710100272	2010-02-23	2020-02-23	(CN106427544) LEGAL DETAILS		ZHANGJIAGANG KANGDEBIN	LI SHUA XU ZHONGYANG	(CN106427544) Flexible quartz	(CN106427544) The present application															
8157476	CN106427543	(A)Published application	2010-10-09	Dead	CN2010710100271	2010-02-23	CN2010710100271	2010-02-23	2020-02-23	(CN106427543) LEGAL DETAILS		ZHANGJIAGANG KANGDEBIN	LI SHUA XU ZHONGYANG	(CN106427543) Flexible quartz	(CN106427543) The present application															
8156124	US2010292338	(A1)Application published	2010-10-11	Dead	US157484,844	2010-02-21	US157484,844	2010-02-21	2020-02-21	(US2010292338) LEGAL DETAILS		INVESENSE (US)	HARTWELL PETER LIUFANG (US)	(US2010292338) The present invention relates	(US2010292338) to a gas sensing															
8156124	WO2010191009	(A1)Published application with publication date	2010-10-10	Dead	WO/2010/024554	2010-02-21	US157484,844	2010-02-21	2020-02-21	(WO2010191009) LEGAL DETAILS		INVESENSE (US)	HARTWELL PETER	(WO2010191009) The present invention relates	(WO2010191009) to a gas sensing															
8156485	EP3385216	(A1)Application published with publication date	2010-10-10	Dead	EP1744590	2017-04-03	EP1744590	2017-04-03	2037-04-03	(EP3385216) LEGAL DETAILS		AMS (AT)	FAES	(EP3385216) Semiconductor device (10)	(EP3385216) 1. Semiconductor device (10) relating to a mobile															
8156596	DE102017205988	(A1)Dec. laid open (First publication)	2010-10-11	Dead	DE102017205988	2017-04-07	DE102017205988	2017-04-07	2027-04-07	(DE102017205988) LEGAL DETAILS		SIEMENS (DE)	ALESSANDRO FLEISCHER	(DE102017205988) The invention relates to a mobile	(DE102017205988) device (10) relating to a mobile															
8156596	WO20101015157	(A1)Dec. laid open (First publication)	2010-10-11	Dead	WOEP2010051597	2010-04-04	DE102017205988	2017-04-07	2020-10-07	(WO20101015157) LEGAL DETAILS		SIEMENS (DE)	FLEISCHER	(WO20101015157) Mobile device	(WO20101015157) The invention relates to a mobile															
8156595	DE102017205992	(A1)Dec. laid open (First publication)	2010-10-11	Dead	DE102017205992	2017-04-07	DE102017205992	2017-04-07	2027-04-07	(DE102017205992) LEGAL DETAILS		SIEMENS (DE)	HEDLER HARRY	(DE102017205992) The invention relates to a gas	(DE102017205992) detector															
8156595	WO20101015148	(A1)Dec. laid open (First publication)	2010-10-11	Dead	WOEP2010051593	2010-04-04	DE102017205992	2017-04-07	2020-10-07	(WO20101015148) LEGAL DETAILS		SIEMENS (DE)	HEDLER HARRY	(WO20101015148) Gas sensor housing	(WO20101015148) The invention relates to a gas															
8156594	DE102017205987	(A1)Dec. laid open (First publication)	2010-10-11	Dead	DE102017205987	2017-04-07	DE102017205987	2017-04-07	2027-04-07	(DE102017205987) LEGAL DETAILS		SIEMENS (DE)	HEDLER HARRY	(DE102017205987) The invention relates to a mobile	(DE102017205987) device (10) relating to a mobile															
8156594	WO20101015155	(A1)Published application with publication date	2010-10-11	Dead	WOEP2010051592	2010-04-04	DE102017205987	2017-04-07	2020-10-07	(WO20101015155) LEGAL DETAILS		SIEMENS (DE)	HEDLER HARRY	(WO20101015155) Mobile device	(WO20101015155) The invention relates to a mobile															
8156592	DE102017205985	(A1)Dec. laid open (First publication)	2010-10-11	Dead	DE102017205985	2017-04-07	DE102017205985	2017-04-07	2027-04-07	(DE102017205985) LEGAL DETAILS		SIEMENS (DE)	HEDLER HARRY	(DE102017205985) The invention relates to a gas	(DE102017205985) sensor structure (10) for															
8156592	WO20101015159	(A1)Published application with publication date	2010-10-11	Dead	WOEP2010051601	2010-04-04	DE102017205987	2017-04-07	2020-10-07	(WO20101015159) LEGAL DETAILS		SIEMENS (DE)	HEDLER HARRY	(WO20101015159) Substrate	(WO20101015159) The invention relates to a gas															
8156595	DE102017205931	(A1)Dec. laid open (First publication)	2010-10-11	Dead	DE102017205931	2017-04-05	DE102017205931	2017-04-05	2027-04-05	(DE102017205931) LEGAL DETAILS		SIEMENS (DE)	DOERING	(DE102017205931) The invention	(DE102017205931) provides a															
8153175	TW5647842	(U)Registered utility model	2010-10-01	Dead	TW2010107204152 U	2010-06-15	TW2010107204152 U	2010-06-15	2020-06-15	(TW5647842) LEGAL DETAILS		MICROJET TECHNOLOGY	CHRISTIAN MOHAORAN HUANG, CHILIAO YUSUJIAN	(TW5647842) Gas detection	(TW5647842) One kind of gas detection															
8152654	WO20101019792	(A1)Published application with publication date	2010-10-04	Dead	WOJP2010010088	2010-03-20	JP20107063106	2010-03-20	2020-09-20	(WO20101019792) LEGAL DETAILS		FUJIFILM	KOJI Takeda	(WO20101019792) Inert gas detection	(WO20101019792) The present invention															

Patent information

Gas sensing technologies

Linked Reports

Market, technology, process, reverse costing



[Gas and Particle Sensors 2018](#), November 2018, Yole Développement



[Miniaturized Gas Sensor Comparison 2018](#), October 2018, System Plus Consulting

ORDER FORM

Miniaturized Gas Sensors

Patent Landscape Analysis – December 2018

Ref.:KM18008



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Job Title:

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Address:

City:

State:

Postcode/Zip:

Country:

VAT ID Number for EU members:

Tel:

Email:

Date:

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Check

To pay your invoice using a check, please mail your check to the following address:

KnowMade S.A.R.L.
2405 route des Dolines
06902 Valbonne Sophia Antipolis
FRANCE

Money Transfer

To pay your invoice using a bank money wire transfer please contact your bank to complete this process. Here is the information that you will need to submit the payment:

Payee: KnowMade S.A.R.L.
Bank: Banque Populaire Méditerranée, CAP 3000 Quartier du lac, 06700 St Laurent du Var, France
IBAN: FR76 1460 7003 6360 6214 5695 139
BIC/SWIFT: CCBPFRPPMAR

Paypal

In order to pay your invoice via PAYPAL, you must first register at www.paypal.com. Then you can send money to the KnowMade S.A.R.L. by entering our E-mail address contact@knowmade.fr as the recipient and entering the invoice amount.

RETURN ORDER BY

E-mail: contact@knowmade.fr

Mail: KnowMade S.A.R.L., 2405 route des Dolines, 06902 Valbonne Sophia Antipolis, FRANCE

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- €6,490 – Corporate license
 €5,990 – Single user license*

For price in dollars, please use the day's exchange rate. For French customer, add 20% for VAT.

All reports are delivered electronically in pdf format at payment reception.

**Single user license means only one person at the company can use the report. Please be aware that our publication will be watermarked on each page with the name of the recipient and of the organization (the name mentioned on the PO). This watermark will also mention that the report sharing is not allowed.*

I hereby accept Knowmade's Terms and Conditions of Sale
Signature:

Terms and Conditions of Sales

DEFINITIONS

“Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in their entirety. It is done by signing the purchase order which mentions “I hereby accept Knowmade’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 the 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, commercial secrets and know-how, technical information, company or trading names and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not and including any pending registration of one of the above mentioned rights.

“License”: For the reports and databases, 2 different licenses are proposed. The buyer has to choose one license:

1. One user license: a single individual at the company can use the report.

2. Multi user license: the report can be used by unlimited users within the company. Subsidiaries are not included.

“Products”: Reports are established in PowerPoint and delivered on a PDF format and the database may include Excel files.

“Seller”: Based in Sophia Antipolis (France headquarters), Knowmade is a technology intelligence company specialized in the research and analysis of scientific and technical information. We provide patent landscapes and scientific state of the art with high added value to businesses and research laboratories. Our intelligence digests play a key role to define your innovation and development strategy.

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 TO ANY SALE MADE HEREUNDER AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.

1.2 This agreement becomes valid and enforceable between the Contracting Parties after clear and non-equivocal consent by any duly authorized person representing the Buyer. For these purposes, the Buyer accepts these conditions of sales when signing the purchase order which mentions “I hereby accept Knowmade’s Terms and Conditions of Sale”. This results in acceptance by the Buyer.

1.3 Orders are deemed to be accepted only upon written acceptance and confirmation by the Seller, within [7 days] from the date of order, to be sent either by email or to the Buyer’s address. In the absence of any confirmation in writing, orders shall be deemed to have been accepted.

2. MAILING OF THE PRODUCTS

2.1 Products are sent by email to the Buyer:

- within [1] month from the order for Products already released; or

- within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.

2.2 Some weeks prior to the release date the Seller can propose a pre-release discount to the Buyer.

The Seller shall by no means be responsible for any delay in respect of article 2.2 above, and including in cases where a new event 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.

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

2.4 The mailing is operated through electronic means either by email via the sales department. If the Product’s electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that it is informed of the defective formatting within 90 days from the date of the original download or receipt of the Product.

2.5 The person receiving the Products on behalf of the Buyer shall immediately verify the quality of the Products and their conformity to the order. Any claim for apparent defects or for 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.

2.6 No return 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 as required under 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 annual subscriptions. 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 Knowmade, PayPal or by electronic transfer to the following account:

Banque Populaire Méditerranée, CAP 3000 Quartier du lac, 06700 St Laurent du Var, France

BIC or SWIFT code: CCBPFRPPMAR

IBAN: : FR76 1460 7003 6360 6214 5695 139

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 mentioned on the order.

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 Refi of the «BCE» + 7 points, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...) are delivered only after reception of the payment.

3.4 In the event of termination of the contract, or of misconduct, during the contract, the Seller will have the right to invoice 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 and for the use and interpretations he makes of the 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 (i) direct and (ii) 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:

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

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

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

4.5 All the Products that the Seller sells may, upon prior notice to the Buyer from time to time be modified by or substituted with similar Products meeting the needs of the Buyer. This modification shall not lead to the liability of the Seller, provided that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.6 In the case where, after inspection, it is acknowledged that the Products contain defects, the Seller undertakes to replace the defective products as far as the supplies allow and without indemnities or compensation of any kind for labor costs, delays, loss caused or any other reason. The replacement is guaranteed for a maximum of two months starting from the delivery date. Any replacement is excluded for any event as set out in article 5 below.

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

4.8 The Seller does not make any warranties, express or implied, including, without limitation, those of

saleability and fitness for a particular purpose, with respect to the Products. Although 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.

5. FORCE MAJEURE

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, labor difficulties, equipment failure, late deliveries by suppliers or other difficulties which are beyond the control, and not the fault of the Seller.

6. PROTECTION OF THE SELLER’S IPR

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

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it to any other party other than employees of its 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-transmittals 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.

6.3 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 sent the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

6.4 The Buyer shall define within its company point of contact for the needs of the contract. This person will be the recipient of each new report in PDF format. This person shall also be responsible for respect of the copyrights and will guaranty that the Products are not disseminated out of the company.

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 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

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

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 and the Buyer, 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 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 shall be settled by the French Commercial Courts of Grasse, which shall have exclusive jurisdiction upon such issues.

9.2 French law shall govern the relation between the Buyer and the Seller, in accordance with these Terms and Conditions.



KNOWMADE

Company presentation

WHAT WE DO

Knowmade helps customers to understand the **competitive landscape**, follow **technology trends**, and find out **opportunities** and **threats** in terms of **technology** and **patents**.

- Interpreting the **competitive landscape** and **technology developments** throughout **patents** and **scientific information**.
- Turning **patents** and **scientific information** into **business intelligence tools** that give you the capability to
 - Understand your **competitive environment**
 - Be ahead of **technology trends**
 - Identify patent & technology **opportunities**
 - Assess patent & technology **risks**
 - Define your **IP** and **R&D strategy**
 - Monetize your **technologies** and know-how
 - Defend your **business**
- Strong **technology expertise** with an in-depth **knowledge of patents**.
- Highly **specialized** analysts in the following sectors:
 - Electronics, Telecommunications and Photonics**
Compound semiconductors, Power electronics, Batteries, Memories, RF electronics, Wireless communications, Solid-state lighting & display, Photonics, MEMS Sensors & Actuators, Semiconductor manufacturing, Packaging & Assembly.
 - Life Sciences, Healthcare and Agri-Food**
Medical devices, Medical imaging, Microfluidics, Biotechnology, Pharmaceuticals, Food-processing

Patents
Technologies
Prior art
Scientific findings
Opportunities
Partners
Competitors
Newcomers
M&A targets



Patent landscape analysis
Scientific review
IP portfolio assessment
Patent valuation
Freedom-to-operate analysis
Litigation & licensing support
Patents linked to products
Technology scouting
Technology trends
Competitive IP landscape
Market trends
Reverse engineering

Make strategic decisions
Sustain competitive advantages
Speed R&D and enhance innovation process
Align R&D and IP with key business objectives
Strengthen IP portfolio and acquire technologies
Anticipate risks and defend core businesses
Explore new opportunities and monetize IP



WHAT WE PROPOSE



Patent Landscape Analysis
 Patent-to-Product Mapping
 Patent Portfolio Analysis
 Patent Watch



Dedicated analyses

Tailor-made analyses to meet your business needs and budgetary constraints

Off the shelf reports and analyses



Workshops and trainings

Taylor made to respond your requests
 Direct interaction between your team and our experts at your site



WHAT IS OUR ADDED VALUE

Patent Search

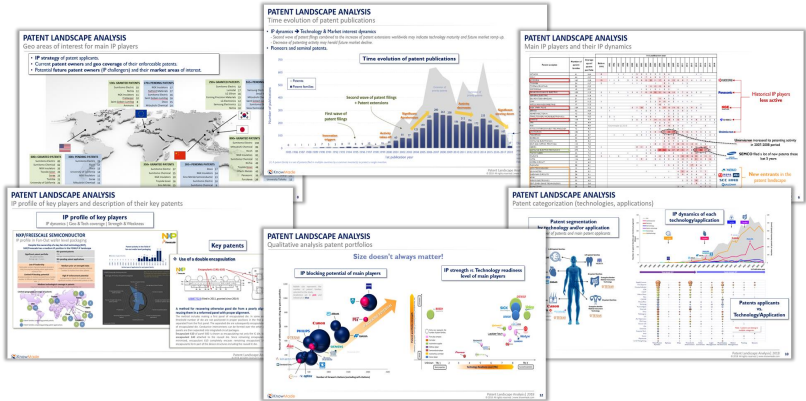
- ✓ **Strong technical expertise of our analysts with PhD degree**
 - Comprehensive search queries and keywords
 - Manual selection of relevant and related patents
 - Manual segmentation by technology & application

Analytics

- ✓ **State of the art statistical tools**
- ✓ **Innovative methodologies to deliver relevant IP analysis**
- ✓ **Business oriented data representation and graphics**

Results Analysis

- ✓ **Technical expertise**
 - Highly specialized analysts in your field
 - Benefit from knowledge capitalization
- ✓ **In-depth IP analysis combined with market data and reverse engineering ***
- ✓ **Customer support**



* Our partners



CUSTOM STUDY & CONSULTING

Tailor-made analysis to meet your needs and budgetary constraints

Prior art search

Evaluate the patentability of your invention in the course of a patent filing.

Invalidate competitor's patents in the course of patent litigation or in anticipation of one.

Make third-party observations concerning the patentability of competitor's inventions.

Patent landscape analysis

Understand the competitive environment and the technology trends from a patent perspective.

Identify key players, their IP strategy and their key patents.

Know IP collaborations, licensing agreements and litigation history.

Freedom-to-operate analysis

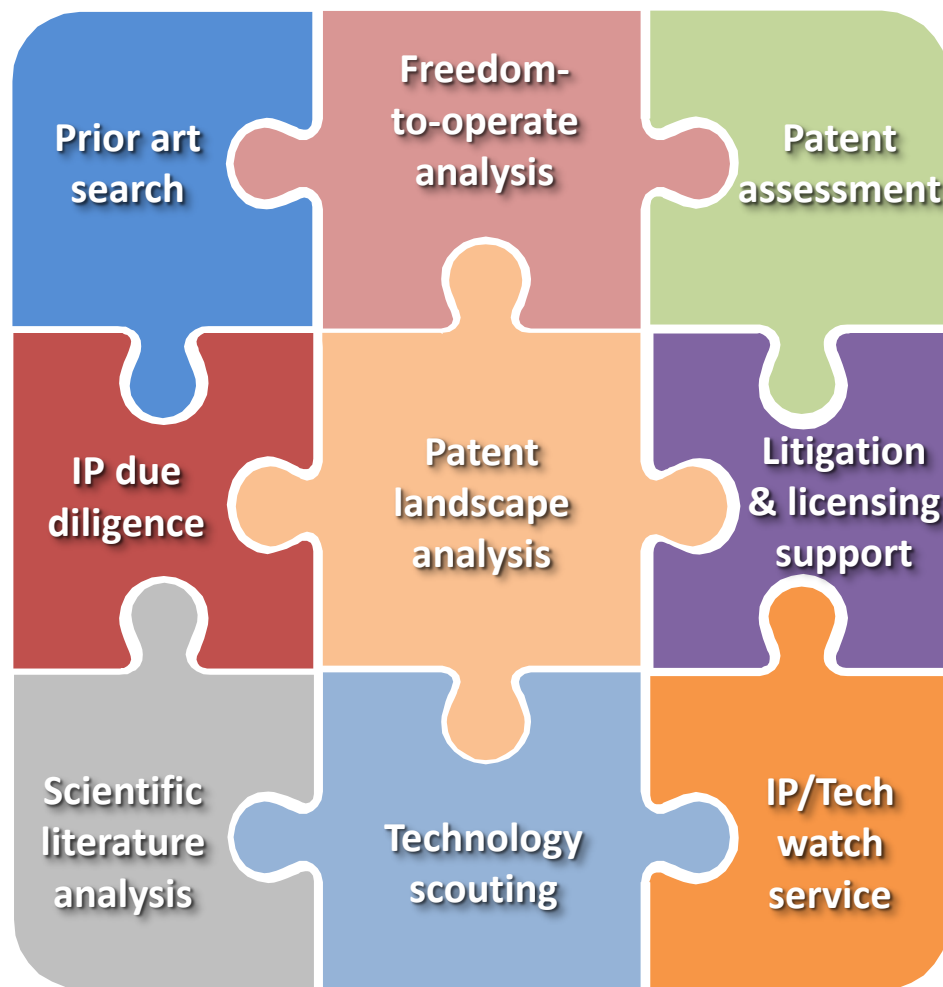
Assess the risks to infringe third-party patents.

Ensure that your products/processes can be safely manufactured, sold and used in specific countries without infringing patents held by others.

Litigation and licensing support

Evidence of infringement/non-infringement for offensive/defensive support.

Defend your position in licensing negotiation or patent litigation.



Patent assessment

Identify most valuable patents prior to patent acquisition/sales, licensing agreement, capital fundraising process, M&A or IP due diligence.

Estimate the financial value of your patent portfolio.

IP due diligence

Assess the patent portfolio of a company and reveal the SWOT matrix prior to patent acquisition/sale, licensing agreement or M&A.

Scientific literature analysis

Pinpoint key research findings and new emerging research fields, key laboratories and scientific experts, industrial/academic research collaborations, and identify prospective R&D partners.

Technology scouting

Identify, qualify and get access to external innovation.

IP & Technology watch service

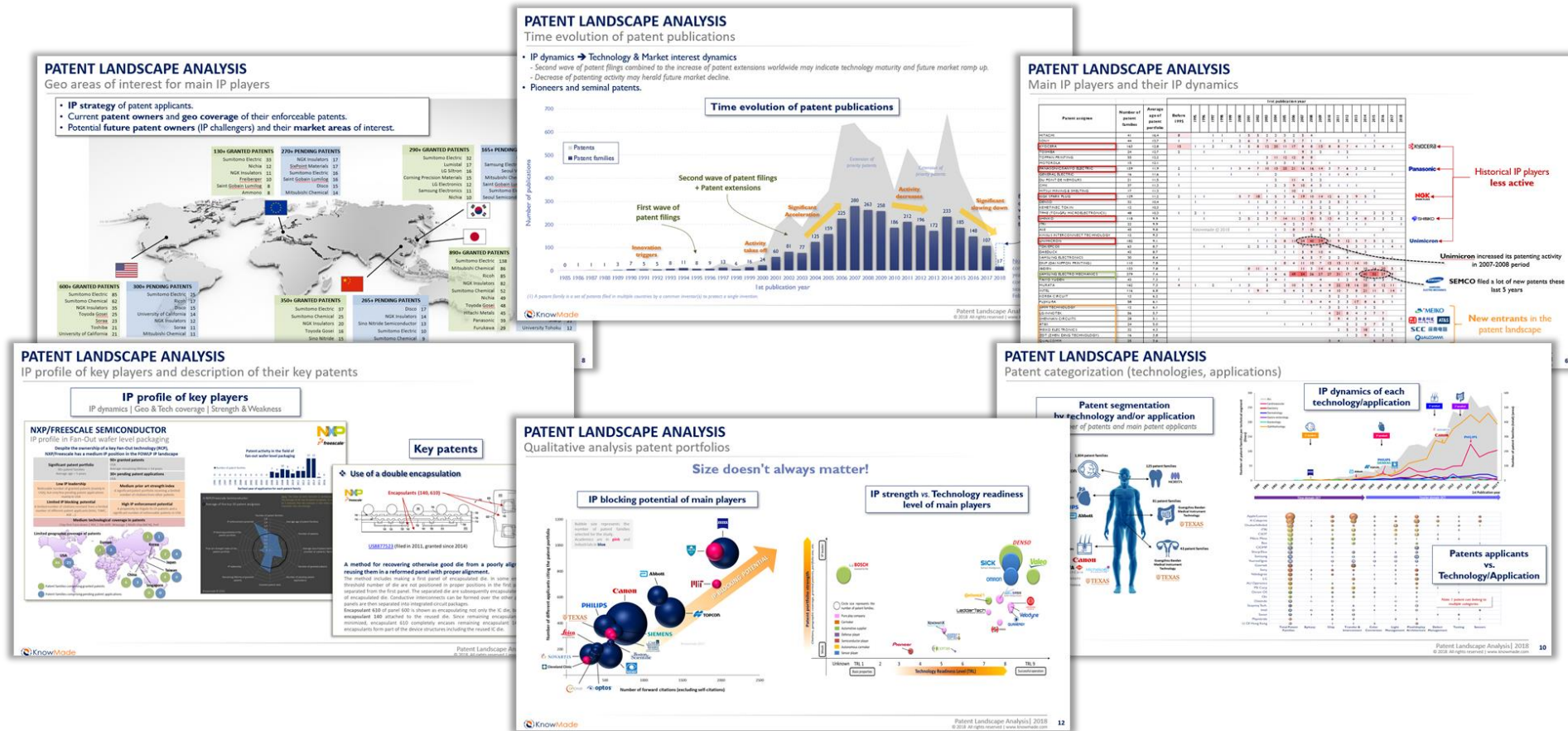
Follow IP/technology trends, keep a watch on your competitors and identify new entrants, anticipate the changes, early detect business opportunities and mitigate the risks.

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« Pre-packaged » analysis

Knowmade team of experts work all year long to collect patent and scientific information, identify and analyze the trends, the challenges, the emerging technologies, the competitive environments, and turn it into results to give you a complete picture of your industry landscape.

Every year, Knowmade publishes a comprehensive collection of reports in various technology fields. These fact-based analyses can provide you with the reliable information you need to advance your business and your competitive position.



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2019 reports collection

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- **Power SiC: MOSFETs, SBDs and Modules** – Patent Landscape 2019*
- **Power GaN: Materials, Devices and Applications** – Patent Landscape 2019*
- **Patent Trolls in the Semiconductor Market** – Litigation Risk and Potential Targets 2017

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- **Fan-Out Wafer Level Packaging** - Patent Landscape 2016

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- **Magnetoresistive Random-Access Memory (MRAM)** – Patent Landscape 2019*
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- **Microfluidic Technologies for Diagnostic Applications** - Patent Landscape 2017
- **Fluidigm** - Patent Portfolio Analysis 2017
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