

# GAS AND PARTICLE SENSORS 2018

Market & Technology report - November 2018

*Air quality is breathing life into the sensor market!*

## WHAT'S NEW

- New chapters on particle sensors: segmentation, market forecasts, player mapping and technology benchmarks
- Updated gas sensor segmentation to take into account new applications
- Brand new market forecast up to 2023 in value and units by application
- Updated market shares and technology breakdown
- New part about gas and particle sensors in Asia, covering China, Taiwan and Japan
- New part on gas and particle sensor intellectual property
- Updated analysis on combo sensors and electronic noses

## AIR QUALITY MONITORING IN CARS, HOMES AND OTHER BUILDINGS IS DRIVING THE GAS AND PARTICLE SENSOR MARKET

Outdoor air pollution is one of the major challenges of the 21<sup>st</sup> century, and about 4 million deaths globally are attributed to it, according to a World Health Organization (WHO) estimate in 2014. Another estimate, from 2016, is that more than 90% of the world's population lives in regions where air pollutant levels are higher than the WHO specified limits. Thus, there is a global drive to tackle this problem, specifically by developing and installing gas and particle sensors.

For a long time, the main gas and particle sensor market has been restricted to industrial applications. But nowadays, degradation of the air quality is impacting many different places, homes, offices, hotels, cars and urban areas. Air quality control is therefore becoming a selling argument to promote hotels or restaurants.

Historically, gas sensors were used to control air conditioning in buildings to save energy. Today, Yole Développement (Yole) analysts are observing a shift from comfort to safety as inhabitants want safe indoor air. This trend also extends to other environments, such as personal vehicles, public transportation, and homes.

As an example, the market for air purifier systems, which often embed gas and particle sensors, are expected to expand from \$16B in 2017 to \$33B in 2023 with a 12.5% Compound Annual Growth Rate (CAGR).

Commercial vehicles have increasingly adopted gas and particle sensors onboard to ensure high quality of air for their customers. Previously sensors were embedded in-cabin to activate the air conditioning system when CO<sub>2</sub> and volatile organic compound (VOC) concentrations become critical. Today,

additional sensors can be found out of the cabin to sense the outside environment and close the ventilation system if pollution is detected. Metal Oxide Semiconductor (MOS) is the preferred technology because of its low cost, small size and improved sensitivity compared to previous generation. To support this increasing market demand, historical players involved in gas sensors, such as Paragon, and Amphenol, which has acquired SGX, are developing particle sensors. The big sensor leaders like Bosch and ams have identified the air quality market as a very promising one. They are therefore using their know-how to develop new technical solutions for both gas and particle sensing.

Although it had big promise, the consumer segment is taking more time than expected to be a real significant share of the gas sensors market. Therefore some players are currently de-emphasized their efforts to enter this segment (in the short term (example: ams)).

In this report, Yole analyzes the impact of the global air quality in every market segment. The main impacted segments are Heating, Ventilation and Air Conditioning (HVAC), consumer products and air comfort for transportation. Technical requirements, gases to be measured, market forecasts, technologies, main suppliers and regulations are fully described for each segment. Yole forecasts that the gas sensor market will top \$1B in 2022! A chapter is dedicated to environmental combos and electronic noses technology developments as they are considered as the next steps to improve air quality sensing in several applications (but there are still challenges ahead, such as having the right use-case and structuring an industrial food chain for e-noses).

### LINKED REPORT

#### Miniaturized Gas Sensor Comparison 2018

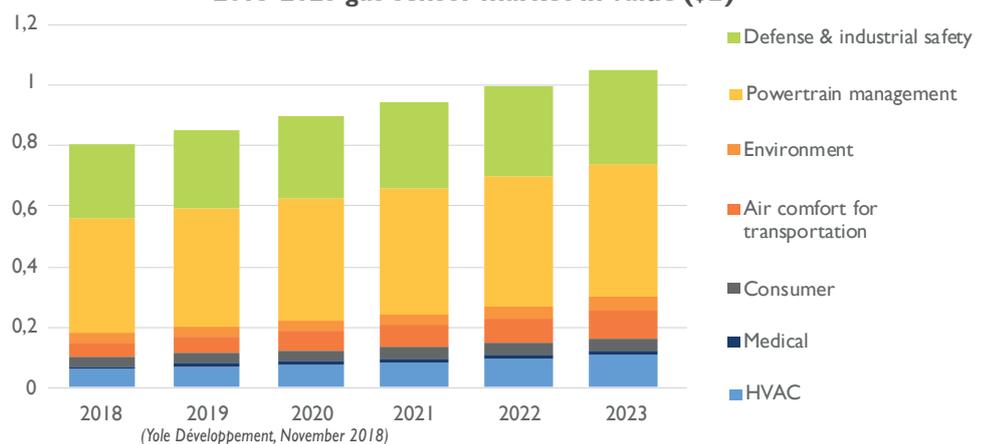
Structural, Process & Costing Report by System Plus Consulting – October 2018



Comparison of four gas sensors for consumer applications made by Bosch, ams and Sensirion.

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2018-2023 gas sensor market in value (\$B)



## MOS HAS FINALLY FOUND ITS MARKET, BUT INFRA-RED (IR) TECHNOLOGY IS THE REFERENCE FOR PARTICLE SENSING

MOS has been around for many years but its lack of sensitivity has prevented widespread adoption of this technology. Today, the use of MOS technology has been boosted thanks to two applications: indoor/outdoor automotive and air purifiers. MOS is the

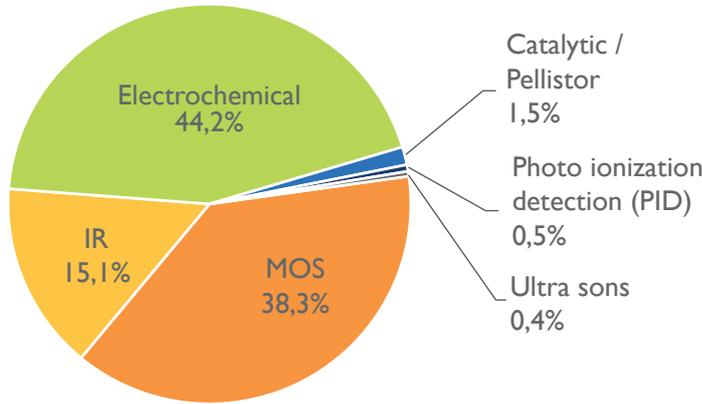
best trade-off technology in cost and size for VOC measurement.

MOS is the reference technology in automotive air quality sensing, but only for gases. In consumer applications, miniaturized Non-Dispersive Infra-Red (NDIR) sensors compete with MOS. NDIR is more expensive, but its form factor is today close to MOS and its sensitivity is better. The final choice will be application-dependent.

On the other hand, optical is the reference technology for particle sensing. Particle monitoring is becoming even more important than gas sensing. Ultra-fine particles, below 1µm in diameter (PM1) are increasingly being watched as they are the most dangerous species for health. So most players are investigating particle sensors for PM1 and below.

Yole estimates the particle sensor market to be worth about \$150M in 2017, growing to more than \$200M in 2023. The market is less fragmented than the market for gas sensors as four players today share more than 90% of the market. So there is room for newcomers!

2017 gas sensing technologies market share in value



(Yole Développement, November 2018)

## THE ASIAN PLAYER ECOSYSTEM IS DEVELOPING FAST

Gas & particles sensors: Asian players positioning in 2018

		Gas			PM2.5	
		MOS/MEMS	IR	Electrochemical	Optical	QCM
China	PLANTOWER 攀藤科技	√	√	√	√	
	诺方电子 Nova Fitness				√	
	SKYWALKER 深圳市诺方电子有限公司	√		√	√	
	蓝月测控 Bluemoon	√	√		√	
	MultiIR	√	√		√	
	海威尔 Haiwei	√	√		√	
	Winsen 炜盛科技	√	√	√	√	
	四方光电	√	√	√	√	
	益杉科技 YISHAN TECHNOLOGY				√	
如皋六维科技	√	√		√		
Japan	FIGARO	√	√	√		
	TDK	√				
	KYOCERA	√				
	FUJITSU	√				
	TAIYO YUDEN	√				
	aroma bit	√	√			
	HAMAMATSU		√			
	DAHCHI SEIKO	√				
	SHARP				√	
Panasonic				√		
Korea	ORISSTECH	√	√			
	bioinspira		√			
	TCNT	√		√		
	LITEON	√				
	EPISTAR	√				
	KINGPAK	√				
	福華				√	
	TXC					√

(Yole Développement, November 2018)

Because Asia is very concerned by air quality, our report includes a special chapter on the ecosystem of Asian players. The air purifier market is expected to ship about 20 million units annually by 2020. The Chinese market currently accounts for more than 95% of the global air purifier market, with these products using both dust and VOC sensors.

As a consequence, Asian players are developing their own technological portfolio for the local market. They cover all sensing technologies, but with geographical differences. For example, Japan and Taiwan are focusing on MOS and NDIR only, but China has all gas and particle technologies available.

The strong interest in gas and particle sensors in Asia and the large diversity in technology and R&D work are reflected by the Intellectual Property (IP) activity. Our report includes a chapter on IP activity in Asia. Patenting activity in China has strongly increased since 2010. On the contrary, patenting activity in other countries is almost stable. 85% of patents in China have been filed as priority patents and only 15% have been filed via an extension of their priority patent. In fact, there is an increasing number of Chinese companies and R&D labs among newcomers in the patent landscape since 2014.

## OBJECTIVES OF THE REPORT

Identification and analysis of the applications:

- Determination of the range of applications
- Market segmentation
- Technical and economic requirements by segment
- Chemical species to be measured
- Key players at application and system levels
- Sensor market size and market forecast 2017-2023 in \$M and Munits

Analyze and describe the technologies involved:

- Existing and future gas and particle sensing technologies
- Major actors and R&D organizations on a worldwide basis
- Technology roadmap for the different products and process
- Who is developing what?
- Competing technologies and organizations for each application
- Sensor die market size and market forecast 2017-2023 in \$M, Munits
- Main challenges, including sensitivity, selectivity and packaging

## COMPANIES CITED IN THE REPORT (non exhaustive list)

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



### Dr. Benjamin Roussel

is Director, Life Sciences and Healthcare at Yole Développement (Yole), part of Yole Group of Companies. By supporting industrial companies and R&D institutes in their development, Benjamin and his team are creating the bridge between innovative microtechnologies and numerous diagnostic, pharmaceutical, life science and medical device applications. Benjamin Roussel is the author of a large collection of market & technology reports focusing on bioMEMS, microfluidics and solid state medical imaging, and performs multiple custom consulting projects. Thanks to his deep knowledge of these industries and related technologies, he has spoken in more than 20 industry conferences worldwide over the last five years. Before joining Yole, Benjamin worked in an International Pharmaceutical company in the pharmacovigilance department. He holds a Pharmacy diploma from the University Claude Bernard Lyon, France, in addition to a master's degree in Technology and Innovation Management from EM Lyon Business School, France.

Find more details about this report here:





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- 6.6 In the case of a multisite, multi license, only the employee of the buyer can access the report or the employee of the companies in which the buyer have 100% shares. As a matter of fact the investor of a company, the joint venture done with a third party etc...cannot access the report and should pay a full license price.

## 7. TERMINATION

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