Air Quality Sensing in Automotive applications

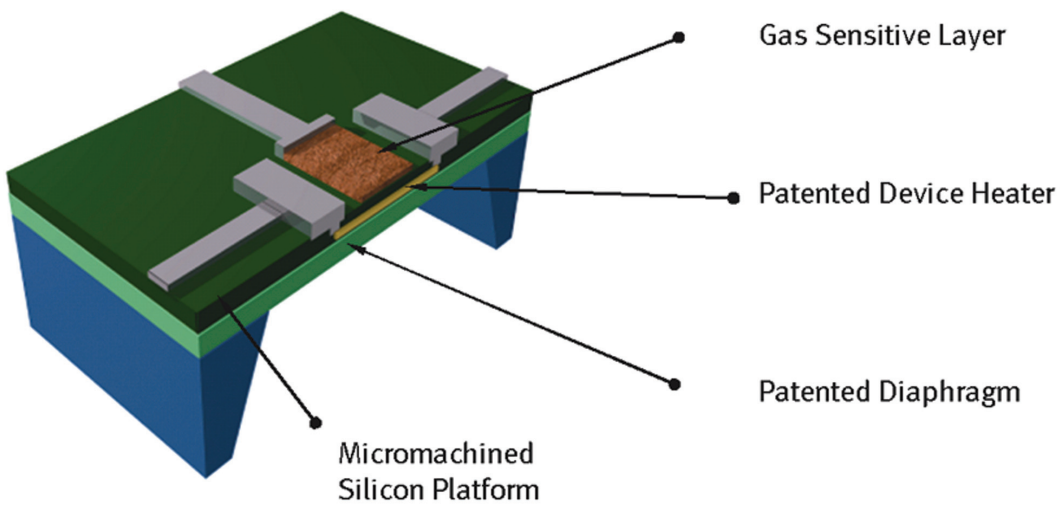
History of AQS market

The first function of a car is to transport drivers and passengers from point A to point B. This function was successfully achieved from the early days of the automotive age. Very soon, other requirements were added to this main function i.e. Speed, safety, comfort, economy & finally environmental impact.
The first developments in terms of comfort were made in the area of mechanics; these created a car that doesn't expose the occupants to excessive vibration during a long drive. Later improvements included the introduction of climate control, initially incorporating a heater but finally introducing air conditioning allowing the occupant to drive in nearly every climatic condition between -40°C and +40°C.

To maintain the air quality it is desirable that pollution and bad odours coming from the external environment should be prevented from entering the cabin Air Quality Sensors (AQS) have been placed inside automotive climate control systems since the 1980s to detect pollution from other vehicles and to then automatically close the air recirculation flap. At that time, this function was reserved for top of the range vehicles. Today, lower manufacturing costs as well as a higher awareness of the public to air quality in general has widen the use of AQS, so that these sensors can now be found in vehicles from virtually every manufacturer & brand, starting often at the C-class, i.e. VW Golf-size. Premium brands offer AQS in all their cars.

State of the art technology

Origins of AQS saw the use of bulk type semiconductor gas sensors. Today, in air quality sensing as well as in other branches of the sensors business, sensors manufactured using MEMS (Microelectromechanical systems) manufacturing techniques are increasingly used. The main advantages of these sensors are the repeatability of processes and the ability to strongly reduce the unit costs when made in high volumes. e2v technologies is one of the leading companies able to deliver MEMS based AQS to the automotive industry. MEMS technology sensors are specified by leading automotive companies as their preferred technology for its robustness, repeatability and cost effectiveness. The physical principle behind the gas detection is a change of conductance within a layer of semiconductor material when it is exposed to the gas. The material that has been most often used is tin dioxide (SnO_2). The latest state of the art AQS is an intelligent system comprising an electronic PCB containing up 3 gas sensors as well as a microcontroller for signal analysis, packaged in a rugged housing that protects the components from the harsh automotive environment.



The 3 gas sensors, mentioned above, are developed to react specifically to pollution vapours from petrol and diesel engine operation as well as from industrial and agricultural odours such as animal manure. The key target gases that are commonly specified for this sensor and application are CO, NO_2 and NH_3 respectively.

Some sensors integrate temperature and relative humidity sensors to enable the computation of the dew point of the air flowing into the HVAC (Heating, Ventilation and Air-Conditioning) unit. This enables car makers to fine tune and increase the efficiency the cooling process, even resulting in some saving of fuel.

Benefits of this technology

- Comfort and health: the AQS, by preventing polluted air entering the cabin of the car, improves the air quality inside the cabin. This has a positive effect on the health of the driver and any passengers. Children, elderly people and those with breathing difficulties will derive the most benefit. The AQS complements the function of the HVAC pollen filter, whose lifetime is also increased because more polluted air stays outside of the cabin. Moreover, a HVAC pollen filter is not able to filter out sub-micron particles. The AQS, despite being a gas sensor, acts to filter out sub-micron particles whose concentration is well correlated with the level automotive pollution on our roads.
- Safety: the AQS, being an automated system allows the driver to fully concentrate on the primary task i.e. driving. The improved air quality inside the cabin plays also a very favourable role in maintaining driver alertness.

Basic Principles

Detection of pollution

Automatic closing of air inlet flap

Future Developments

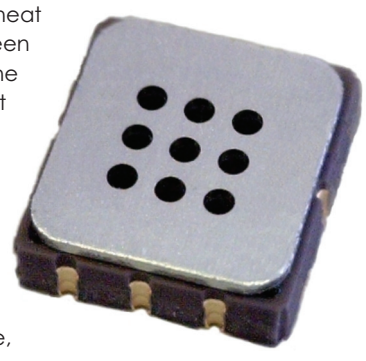
Technology:

There is a continual drive to reduce manufacturing costs in the automotive industry. Development of future technology will need to take this into account. Future developments in MEMS sensors will combine three or more gas sensors into one chip, thus reducing the price factor. We expect also integration of gas sensing chips with other sensors to further reduce overall costs.

After having successfully introduced MOS sensors in the automotive industry in the area of Air Quality Sensing, gas sensor suppliers like e2v technologies are looking to introduce other technologies such as infrared gas sensing, & thermal conductivity gas sensing to this demanding market.

In-cabin air quality:

An important trend in the automotive industry today is to improve the fuel efficiency of cars. This tends to result in an increase in the driving time with the recirculation flap being closed. This means that the air you are breathing is not coming from outside, but rather from inside the cabin. In hot weather, the HVAC unit needs to cool down the air (drawn from the cabin) from a lower temperature than that of the outside ' and in cold weather, the HVAC unit needs to heat up the air (from the cabin) that has already been heated up before and is warmer than that of the outside air . Overall this leads to significant power reduction. These strategies are commonly used in cars today, but mainly to reduce the so-called cooling down and heating up times. These values represent the elapsed time until the car has reached the comfort zone. With petrol prices going up, this strategy may be used for more time than the current 3 initial minutes of driving time, possibly even throughout the drive.



The drawback of this strategy is that the air quality inside the cabin may be affected in time by the CO_2 and VOCs (volatile organic compounds) produced by the driver and passengers and by outside pollution entering through leaks of the car (HVAC unit, doors etc.). This means that the air has to be freshened from time to time with outside air. e2v expects that there will be a need for sensing the air quality inside the cabin, to indicate the right time to open the flap again, or activating an in-cabin filter system such as an ioniser.

The need for conventional AQS sensing of the air outside remains, because the need of opening the flap from time to time remains. Opening right behind a truck or in the middle of a tunnel would not be desirable! The air quality management in future cars will certainly need two AQS: one inside, and one outside the cabin. This is particularly true for battery-powered electrical cars, for which power consumption is more than ever crucial.

Hydrogen sensing:

There are strong signals from the market that hydrogen sensors may play an important role within certain future car designs. Fuel cell vehicles are likely to be introduced over the next decades and these may well incorporate hydrogen gas sensors, mainly for safety reasons. These sensors would provide detection of possible gas leaks bearing mind that Hydrogen would need to be contained within the car. e2v technologies is well positioned to address this growing market.

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