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# The shift toward mobile gas sensing in safety-critical industries

Oil rigs, gas plants, underground mines, and firegrounds are classed as high-risk environments, as workers often face dangers such as heat, explosions, crush or fall injuries, and exposure to hazardous gases. Gases pose a significant safety risk, as poorly ventilated, confined spaces can quickly become life-threatening when flammable or toxic compounds are present. Measuring these gases is therefore key to ensuring employee well-being. Unfortunately, traditional fixed gas monitoring systems aren't always practical, especially when personnel are constantly on the move or working in remote locations. That's why there's a growing shift towards wearable and handheld gas sensors that are designed to clip onto clothing or fit in a pocket, providing real-time notifications to alert workers of potential danger.[1,2] These devices are increasingly being treated as essential personal protective equipment (PPE), especially in industries where exposure to methane ($CH_4$), carbon monoxide (CO), or volatile organic compounds (VOCs) poses a serious risk.[3] Despite their small size, these sensors also need to have a high sensitivity and long battery life, as they're often relied upon in environments where access is limited and maintenance isn't always possible. This blog discusses how optical sensing technologies – particularly non-dispersive infrared (NDIR) systems sensing in the mid-infrared (MIR) range – support the development of small, reliable gas sensors for demanding industrial environments.

## Gases to look out for

The hazardous gases typically present in high-risk environments can be categorized into three groups: asphyxiants, toxic gases, and flammable gases. Asphyxiants are gases that displace oxygen in air, leading to suffocation, and include CO, CH4, and nitrogen ($N_2$). Toxic gases – such as carbon dioxide ($CO_2$), hydrogen sulfide ($H_2S$), and chlorine ($Cl_2$) – can be detrimental to health, and even deadly, when inhaled. Propane ($C_3H_8$), gasoline ($C_8H_{18}$), and $CH_4$ may cause fires and explosions when present at sufficiently high concentrations.[2]

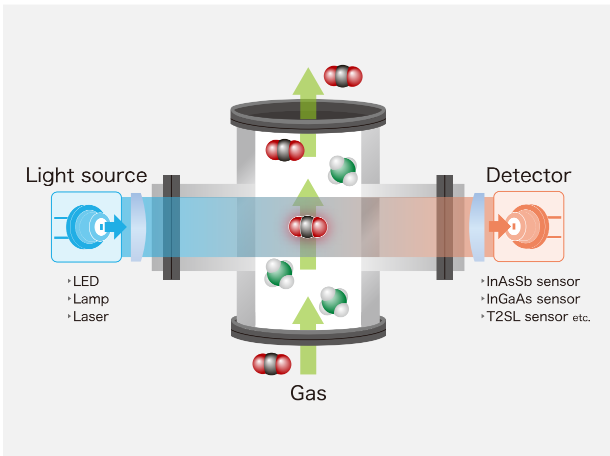


Figure 1: A schematic of a gas sensor

## An optical approach

NDIR sensing technologies using the MIR range are popular for mobile gas detection. These systems work by directing infrared light through a gas and measuring how much is absorbed at specific wavelengths. The light is typically emitted by a MIR LED, and a photodetector is placed on the other side of the gas path to measure the remaining light intensity. The difference between emitted and detected light reveals how much of the gas is present.

Many hazardous gases absorb IR light in distinct spectral bands, and this allows NDIR to detect them with high selectivity. It is especially effective for detecting gases such as $CO_2$, $CH_4$, $C_3H_8$, and other hydrocarbons, which all exhibit strong absorption in the MIR range.[4] However, it is important to note that homonuclear molecules like $N_2$ and $Cl_2$ do not have strong absorption in the IR region and therefore cannot be detected using NDIR sensing.

Hamamatsu's infrared detectors

## Small devices, big challenges

One of the key advantages of MIR NDIR sensors is that they don't rely on consumable materials. NDIR units use solid-state components – such as IR LEDs and photodiodes that are spectrally matched to the emitted light – and don't depend on chemical reactions that degrade over time. As a result, they can maintain accurate, drift-free performance for over 10 years with minimal maintenance. In contrast, electrochemical sensors suffer from limited service lives, frequent calibration needs, and sensor drift, especially in long-term, low-maintenance deployments.[4,5]

Achieving reliable gas detection in a device small enough to be worn demands smart engineering. Many commercially available sensors are now under 20 mm in length, yet still meet stringent requirements such as ATEX (ATmosphères EXplosibles) directive and the IECEx (International Electrotechnical Commission Explosive) scheme for explosive atmospheres, as well as performance standards like IEC 60079-29-1 and EN 45544 that cover the detection of flammable, toxic and asphyxiant gases in industrial environments. The sensors must also have low power consumption and high sensitivity, often relying on precisely tuned MIR sources and detectors to deliver consistent, interference-resistant measurements with minimal servicing.

To achieve this, many high-performance MIR NDIR designs use MIR LEDs paired with indium arsenide antimonide (InAsSb) photodiodes. This combination is particularly effective because the emission spectrum of the LEDs can be selected to match the absorption peaks of target gases like $CH_4$, $C_3H_8$, and $CO_2$. InAsSb photodiodes offer high sensitivity in the 3-5 μm spectral range and beyond, which matches the emission wavelengths of the molecules of interest. This strong spectral overlap ensures that even low concentrations of gas can be reliably detected, with minimal interference from environmental factors such as humidity or temperature fluctuations.[6,7] These solid-state components are compact and energy efficient, making them well-suited for long-term deployment in the field.

| Molecule | Absorption in IR (μm) |
|---|---|
| CO2 | 4.26 |
| CH4 | 3.30 |
| CO | 4.60 |
| H2S | 2.60, 7.90 |
| C3H8 | 3.37, 7.25 |
| C8H18 | 3.40, 6.80,-7.30 |

Table 1: Infrared absorption peaks of hazardous gases

However, these advantages come with trade-offs. In applications where cost or simplicity is the priority, some manufacturers opt for pyroelectric detectors, lead salt sensors, or filament-based emitters like tungsten lamps. While these components reduce production costs, they tend to respond more slowly and/or offer less precision, making them better suited to lower-end or less demanding deployments.

Most portable devices on the market today are optimized for single-gas detection, often methane, due to its flammability risk. While multi-gas sensors exist, they typically require additional optical channels, filters, or detectors, which increases complexity, size, and cost. For this reason, engineers must weigh multiple constraints to select the right design, including form factor, power budget, sensitivity requirements, and price point.

# Summary

Portable gas sensors are fast becoming a vital part of everyday safety equipment in high-risk environments. Thanks to advances in MIR LEDs and InAsSb photodiodes, modern NDIR-based sensors can deliver reliable, selective gas detection in a device small enough to fit in a pocket. These compact systems are tough, low-power and capable of running for years with minimal maintenance, making them ideal for frontline workers in the oil and gas, mining, and emergency response sectors. Hamamatsu continues to drive this progress by continuously improving sensitivity and reducing the power consumption of its detectors, while using non-hazardous materials to ensure safer, more sustainable designs. As the technology continues to improve, we can expect even smarter and more efficient sensors that keep people safe, wherever the job takes them.

For more information, or to discuss how we can help
with your gas sensing project, please visit www.hamamatsu.com
or contact us at info@hamamatsu.eu


To learn more about this topic,
you can watch an on-demand panel discussion[8]
where industry experts dive into the latest advances
in MIR technologies and what they mean
for gas sensing.

# References


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