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The intersection of gas sensing and public health

Gas sensing technologies have been used in clinical settings for decades, where they provide critical capabilities in a range of applications. A good example of this is capnography, which measures the CO_2 exhaled by patients during anesthesia and in intensive care, settings where accurate CO_2 monitoring is vital to prevent hypoventilation and ensure patient stability. However, gas sensors – especially those operating in the mid-infrared (MIR) range – are now being used for a wider variety of applications, including the management of indoor air quality in hospitals, long-term care facilities and other public spaces. In parallel, advances in gas analysis are opening up new diagnostic pathways, with exhaled breath showing potential as a non-invasive biomarker for conditions ranging from sleep apnea to metabolic disorders and diabetes.[2,3] This blog discusses how innovations in gas sensing are transforming public health, from monitoring air quality in shared spaces to enabling new diagnostic and clinical applications.

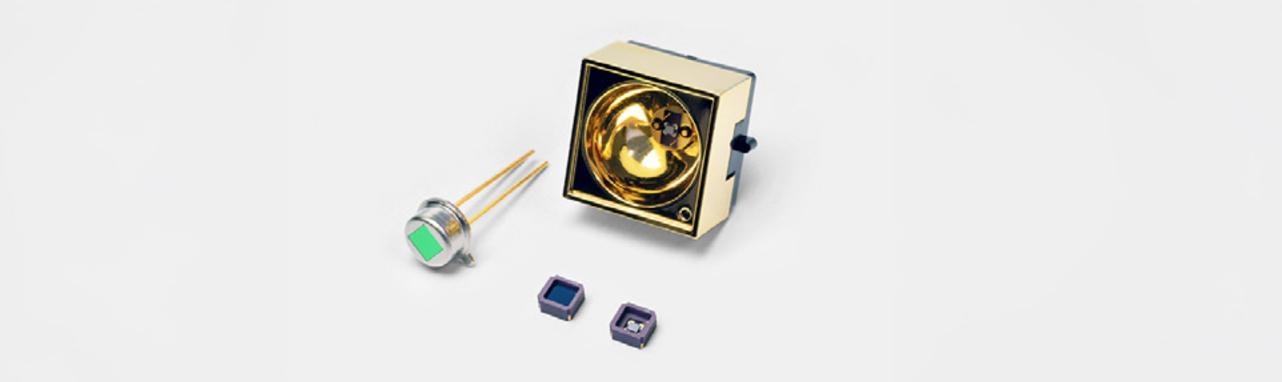
The importance of monitoring air quality in public spaces

Exposure to CO_2 and volatile organic compounds (VOCs) can lead to adverse health effects such as cognitive impairment, fatigue, and respiratory complications1, making gas sensing an essential part of real-time air quality surveillance in public and communal environments. Continuous monitoring of CO_2 and VOCs – as well as other pollutants such as nitrogen dioxide (NO_2) and fine particulates ($PM_{2.5}$) – provides essential data for managing urban health risks, particularly for vulnerable populations with asthma, chronic obstructive pulmonary disease (COPD), or cardiovascular conditions.[4] These technologies are also integral to crisis prevention, helping to detect toxic or flammable gases that can accumulate undetected in enclosed spaces such as underground transport systems, tunnels, or crowded public venues. Deploying sensitive, rapid-response gas sensors in these environments ensures that hazardous conditions are identified at the earliest possible stage, reducing the likelihood of medical emergencies or mass exposure events. This comes with its unique set of challenges as hospitals and city centers are complex environments, where multiple gases are present simultaneously, and cross-interference can make selective detection difficult. The demand for speed and reliability is particularly acute in medical facilities, with clinicians relying on near-instant readings to make patient treatment decisions. Likewise, public monitoring systems require continuous, drift-free operation to provide trustworthy data over long periods without the need for frequent recalibration.

Choosing the right gas sensing solution

Choosing the right gas sensing equipment for the right application and setting is crucial. Gas sensing systems operate in different parts of the infrared (IR) spectrum, and the chosen range directly influences their performance. Near-infrared (NIR) detectors are highly developed thanks to decades of work in the telecoms industry and are often very sensitive, but their overlapping absorption signals make it harder to distinguish between different gases in complex mixtures. In contrast, many gases have their strongest and most distinct absorption fingerprints in the MIR range, which makes it easier to separate signals and reduce cross-interference.[5] This high selectivity is particularly valuable in complex environments such as hospitals or urban centers.

Historically, mercury and lead devices were used in these applications, however indium arsenide antimonide



Hamamatsu's Mid-infrared LEDs L1589X series

(InAsSb) detectors now offer a faster, safer, and more reliable RoHS-compliant alternative, providing high performance without compromising sensitivity. These detectors can be combined with MIR LEDs to enable compact, energy-efficient systems well suited to continuous monitoring of CO_2 and NO_2 in hospitals and other public areas. Among the most advanced options, quantum cascade lasers (QCLs) serve as MIR sources that deliver extremely high sensitivity and specificity. They can resolve multiple trace gases in exhaled breath, for example, in emerging glucose monitoring applications[6], and detect complex pollutant mixtures in urban air.

Acknowledging current adoption and implementation challenges

Despite the promise of advanced gas sensing technologies, their uptake in public health has been slow, with most hospitals and municipalities continuing to use legacy systems; high-end options such as QCLs are not yet widely deployed. These organizations often continue to rely on traditional systems – such as filament lamps or lead-salt detectors – because they are familiar and supported by existing infrastructure. Regulatory limitations and exemptions have also slowed the transition to safer and more accurate alternatives.[5]

Most medical and public health devices also remain single-gas focused, even though multi-gas sensing could provide far better insights into patient health and environmental exposure. For example, during the COVID-19 pandemic, CO_2 monitors were rapidly deployed in schools and workplaces to track ventilation quality,[7] yet these devices typically measured only a single parameter, leaving other critical indoor pollutants undetected. Integration also presents barriers, as new detector technologies often require compatible electronics, robust data management systems, and staff training to be implemented effectively – a challenge for already resource-constrained healthcare providers.

Developing smarter sensors for healthier communities

The future of gas sensing in public health lies in smarter, better connected systems that can generate actionable data at scale. In urban environments, networks of distributed sensors have the potential to map pollution hotspots in real time, allowing authorities to respond quickly and protect vulnerable populations from harmful exposure. In healthcare, the development of wearable gas sensors could transform disease management by enabling continuous monitoring of chronic conditions, providing clinicians with real-time data on their patients. These innovations are also being driven by tightening policy frameworks, as both the WHO and the EU are setting increasingly stringent air quality standards, with gas sensing technologies playing an important role in meeting these requirements. The afore-mentioned growing use of CO_2 monitoring in schools and workplaces during and after the COVID-19 pandemic is a notable example, with measurements increasingly linked to infection control, cognitive performance, and student concentration.[8]

Progress depends on partnership

Delivering healthier environments will require close collaboration between technology providers, healthcare systems, and public authorities. Gas sensing is not just about components, but about integrating sources and detectors into systems that deliver reliable data where it matters most – from hospital wards to urban air monitoring networks. Hamamatsu supports this effort with a broad portfolio of NIR and MIR solutions designed for real-world performance, offering detectors and light sources that combine high sensitivity, stability, and compliance with modern safety standards. We work with partners across healthcare and environmental monitoring to develop practical tools that support public health.

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 [5] where industry experts dive into the latest advances in mid-infrared technologies and what they mean for gas sensing.

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