Photonics21 Press Release

Photonics: New ‘lamp post’ gas detector to prevent millions of air pollution deaths

A new gas-sensing network that analyses multiple gasses in real-time in towns and cities is being developed to prevent deaths caused by ambient air pollution.

This new air quality monitoring system uses cutting-edge laser technology to detect even the smallest amount of toxic gasses in large, densely populated regions.

With multiple sensors connected to form a gas analysing network, the units can spot trace amounts of numerous gasses – including nitrogen dioxide (NO2), sulphur dioxide (SO2), carbon monoxide (CO), ozone (O3), and particulate matter –in real-time in dynamic environments like schools, towns, and cities.

The World Health Organisation estimates that 4.2 million people die prematurely from the high levels of toxic gas molecules and particulate matter they breathe in the air outdoors or ambient air pollution.

Currently, methods for assessing air quality in urban environments rely on huge units the size of refrigerators, which can cost up to €100K. Low-cost sensors rely on chemical reactions, which are inaccurate and can give false readings.

However, the € 6.9 million EU-funded project called PASSEPARTOUT aims to provide a compact detector with a complete understanding of the types and concentrations of toxic gases at a much more reasonable price. PASSEPARTOUT project coordinator Dr William Whelan-Curtin said:

“The miniature PASSEPARTOUT hyperspectral optical-based sensors will provide a comprehensive approach to understanding urban air quality. To have a widespread network and to take meaningful steps towards a smart city, current, expensive methods are not feasible.

“At present, accurate assessments of urban air are difficult. Air quality varies significantly over time, over short distances and across different areas within a city. Traditional monitoring methods struggle to capture these nuanced variations adequately. We are working to provide a system with high precision and excellent spatial resolution to detect NOx, SO2, NH3, CH4, CO, CO2, and black carbon.”

Detectors on Every Lamppost

The project has aspirations to make its real-time metropolitan networks commonplace in our towns and cities.

“We would like to make the technology as common as video surveillance by installing a detector on every lamppost. As part of the project, we are developing a smartphone app to check air quality in real-time. In the future, we hope this can be integrated into Google

Maps so that your journey to and from work or school can show you not just traffic hotspots but also the route with the cleanest air.

“Ultimately, we want to help save lives and help citizens everywhere enjoy clean air. At the sub-one thousand Euro price tag, our technology will enable municipalities, environmental agencies, and researchers the ability to make targeted interventions and policy decisions for a fraction of the price.”

Quartz Crystal Technology

The system works by using the photothermal and photo-acoustic effects. The laser creates pulses or small blasts of laser light. When the laser light hits a toxic gas, the molecule absorbs light energy, giving off a heat ‘signature’ that is then reported back to the system. The system then unmistakably identifies what the harmful gas is, as well as how much of it is present.

The PASSEPARTOUT system goes a step further by using quartz tuning fork technology – or Quartz Enhanced Photo-Acoustic Spectroscopy. Dr Whelan-Curtin explains:

“QEPAS is particularly useful for the detection and quantification of trace gases in challenging environments. We use a quartz tuning fork with a sharp mechanical resonance to detect the signals generated by the gas sample while suppressing the background noise. This tuning fork detects the acoustic waves generated by the gas as it heats and cools. The signal is then analysed to determine the concentration of the target gas. The exact wavelengths of the laser, or lasers, can be tuned to match the characteristic absorption spectrum of the target gas, meaning our system categorically detects specific gases, like carbon monoxide or sulphur dioxide.”

This robust sensing allows the PASSEPARTOUT detector to monitor environments, providing dynamic and to-the-minute air quality representations continuously. “Even the most tiny fluctuations in toxic gas concentrations can be captured promptly, enabling more effective and timely interventions.”

The PASSEPARTOUT team is trialling their technology in landfill sites, seaports, at the University of Bari, and in a selection of schools in Cork.

The PASSEPARTOUT project is coordinated by Munster Technological University and will conclude in 2024. It includes 19 other partners: University College Cork - National University Of Ireland, Cork (Ireland); Universita Degli Studi Di Bari Aldo Moro, Politecnico Di Bari, Etg Risorse E Tecnologia Srl, Ecospray Technologies Srl, Techno Sky Srl Technologies For Air Traffic Management, Comune Di Bari (Italy); Nanoplus Nanosystems And Technologies, Technische Universitaet Muenchen (Germany); Centre National De La Recherche Scientifique Cnrs, Universite Cote D’azur, Le Verre Fluore (France); Green Lab Magyarorszag Mernoki Iroda Korlatolt Felelossegu Tarsasag (Hungary); Argotech As (Czechia); Technische Universitaet Wien (Austria); Vario-Optics Ag, Fachhochschule Nordwestschweiz Fhnw (Switzerland); Haze Instruments, Razvoj In Proizvodnja Merilnih Instrumentov Doo (Slovenia); AUG Signals Hellas Technology Developments And Applications Hellas Single Member Private Company (Greece).