

Battelle Number(s):

30010-E [A] and [B]

Patent(s) Issued

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Available Technologies

Improved Sensor Technology using Quantum Cascade Lasers

SUMMARY

Quantum cascade lasers (QCLs) are increasingly being used to detect, identify, and measure levels of trace gases in the air. Such systems measure the unique infrared absorption “fingerprints” of chemicals to provide high detection sensitivity and identification confidence, and are particularly useful for field-portable sensing. Applications include detecting chemical warfare agents and toxic industrial chemicals, monitoring building air quality, measuring greenhouse gases for atmospheric research, monitoring and controlling industrial processes, analyzing chemicals in exhaled breath for medical diagnostics, and many more. Compact, portable trace gas sensors enable operation in a wide range of platforms, including handheld units for use by first responders, fixed installations for monitoring air quality, and lightweight sensors for deployment in unmanned aerial vehicles (UAVs).



The suite of PNNL patent pending and patented technologies provides a new way to use QCLs for trace gas sensing and enables both size reductions and performance improvements. PNNL has demonstrated with a laboratory prototype that trace levels of absorbing chemicals inside an external cavity quantum cascade laser (ECQCL) change the electrical properties of the QCL semiconductor device. By monitoring changes to the compliance voltage of the QCL, essentially using the QCL itself as a photodetector, intracavity absorption spectra can be measured to detect and identify trace gases. The innovative technique, called EVIS (External Cavity QCL Voltage-Mediated Intracavity Sensor), allows dramatic size reductions for trace gas sensors by eliminating bulky multi-pass absorption cells and conventional photodetectors, while the intracavity sensing approach maintains high-sensitivity detection. The use of a wavelength-tunable ECQCL allows identification of many chemical species with a single, compact sensor unit.

In addition to enabling compact and sensitive trace gas sensor systems, the EVIS technique provides a new way to monitor and stabilize the optical power and output wavelength of an ECQCL. These techniques will allow construction of compact and stable ECQCL systems highly resistant to environmental disturbances, improving performance of a wide range of existing and future systems employing ECQCLs.

Patents & Intellectual Property

» 8,675,696

» 9,001,854

Technology Portfolio(s)

» Sensors

Potential Industry Applications

» Aerospace & Defense

» Chemicals

» Energy & Utilities

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