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LASER SPECTROMETERS AID IN THE DETECTION OF HAZARDOUS CHEMICALS

Sarin in Japan and Syria, Novichok in the UK, VX in Malaysia. The varieties of nerve gases and chemicals used in warfare and terrorism around the world are increasingly potent and often imperceptible to human senses. Even trace amounts can result in a racing heartbeat, nausea, diarrhea, blurred vision, pain, and weakness. Fatal doses can cause convulsions, loss of consciousness, paralysis, and death from respiratory failure.

The American military also faces threats from explosives that can be difficult to detect in a war zone. While the U.S. Army has long been invested in developing ways to identify explosive materials on the surface, the focus changed once troops were deployed to Afghanistan. In the case of a buried IED, the issue became one of not only rapidly identifying the explosive but also of accurately detecting surface disturbances.

Outside the military, toxic chemicals used in the oil and gas industry and agriculture may not be fatal but

still pose significant health risks to workers. The same goes for law enforcement personnel and first responders exposed to illegal street drugs.

Many of these toxins and dangerous chemicals come in various liquid, gas, and solid forms. Whether for military, law enforcement, or civilian use, there is a clear need for accurate and rapid chemical detection at a safe distance. In 2008, Block Engineering (aka, Block MEMS) received a Small Business Innovation Research (SBIR) contract from the Army to develop a Micro-Electro-Mechanical System (MEMS)-Enhanced Laser Spectrometer for Ultra-Sensitive Toxic Chemical Detection. The underlying concept uses a laser to detect trace amounts of chemicals at a distance, in the air, or on surfaces. Block's three main products—LaserTune™, LaserSense™, and LaserWarn™—are specialized applications intended for research institutions, original equipment manufacturers (OEMs), the oil and gas industry, and military and

commercial security efforts, respectively.

Block's SBIR contract allowed the company to build the foundation of its Quantum Cascade Laser (QCL) technology, eventually resulting in the current product line of QCL-based chemical detection for military and commercial applications. Daniel Cavicchio, Block's executive chairman, explained that "Block wouldn't have developed this technology if it hadn't been for the SBIR program. Block was a small company with exceptionally deep knowledge of infrared spectroscopy but without the resources to perform this novel research. Myron Block, the company's late founder, once was asked 'What would be the ultimate spectrometer?' which led the company to apply for the SBIR and eventually resulted in this revolutionary technology."

Block's LaserTune is a tunable semiconductor laser source—meaning its wavelength can be altered in a controlled manner. Covering the mid-infrared spectrum, LaserTune offers fast sweep capability, fast tuning, excellent beam pointing stability, and a compact design. Block's Mini-QCL can be integrated into a wide variety of microscopes and spectrometers.

LaserSense is used during oil/gas drilling operations where geoscientists analyze gas in drilling muds to understand geological strata and to more accurately locate pockets and reserves of gas or oil. Traditional instruments have a long list of challenges, including fewer measurements, higher operating costs, a need for hazardous consumables, and on-site labor. LaserSense provides the same speed and accuracy as traditional instruments while identifying the precise composition of detected gas and increasing worker safety by omitting the use of hazardous consumables.



Block's LaserWarn is an open-path gas detection system that was developed to protect from chemical attacks. LaserWarn can be permanently installed for security monitoring of transportation facilities, embassies, military bases, government buildings, malls, and other vulnerable critical infrastructure—or it can be used for perimeter or fence-line monitoring. In permanent installations, the system is set up with a series of low-cost mirrors and retro-reflectors. The system continually scans for gases across the laser beam path. When concentration thresholds of target chemicals are detected, alarms are triggered within seconds. Eye-safe lasers in the LaserWarn system allow for mounting in areas where workers or other people will be present. Chemical warfare agents, toxic industrial chemicals/materials, and other hazardous chemicals can be detected from hundreds of meters away.

Traditional gas point sensors are still used extensively but are hard to maintain, create false alarms, and cover only a small local area. LaserWarn provides faster detection of target gases and covers a large area with a single LaserWarn system.

Depending on which algorithm is used, LaserWarn can determine either surface contamination or the air contamination between the laser and the surface. Currently, Block can identify hundreds of separate dangerous chemicals and toxins, such as fentanyl, explosives, and nerve gases.

Block initially developed a rapidly tuned QCL laser for detecting chemicals, such as toxic gasses and surface chemicals, which was primarily used in security and anti-terrorism applications. Since then, multiple additional military and government organizations have supported Block's work to address

Initially used for security purposes, Block is expanding their laser applications into the oil and gas industry.



Daniel Cavicchio



Block MEMS' products include the LaserWarn, left, LaserTune, center, and the Mini-QCL, which can be integrated into a wide variety of microscopes and spectrometers.

increasingly complex challenges for the warfighter. Block has worked with the Department of Homeland Security (DHS), Defense Threat Reduction Agency and Edgewood Chemical and Biological Center, as well as the Intelligence Advanced Research Projects Agency (IARPA), the Defense Advanced Research Projects Agency (DARPA) and the Joint Improvised Explosive Device Defeat Organization. The technology is currently in use by the DHS and The Joint Program Executive Office for Chemical and Biological Defense.

DHS successfully tested LaserWarn at Grand Central Terminal in New York, and the Department of Defense (DoD) performed additional successful testing at Dugway Proving Ground. The system is currently operating in multiple transportation and sports facilities throughout the world.

Kristy DeWitt, Program Manager at IARPA who has worked directly with Block, considers the company a “very strong performer” and said IARPA has been exceptionally pleased with Block’s technical performance: “Block had a history of building quantum cascade laser systems for research and OEM commercial products and some DoD applications, but had less experience with the combination of trace surface detection and active spectroscopy. IARPA provided the



funding for this high risk, high payoff research, allowing them to expand into an area they were unfamiliar with. Block rose to the challenge and produced high-power QCL sources and accompanying algorithms to detect trace surface chemicals with sensitivity levels better than what anyone had been able to do before with optical techniques.”

Initially used for security purposes, Block is expanding their laser applications into the oil and gas industry, where they’re being used to detect chemicals, including toxic gasses. Aside from use in research and development settings, Block is working closely with IARPA and DARPA to fine tune the LaserWarn system for law enforcement personnel tasked with finding suspicious labs making drugs or chemical agents. The LaserWarn system would be mounted on vehicles to scan metro areas and point at targets while in motion, with lasers bouncing off retro-reflectors and buildings. The system can also detect trace amounts of fentanyl to alert law enforcement and first responders in situations where they might come in contact with dangerous amounts of the drug.

What started with one man’s search for the ultimate laser spectrometer has turned into a lifesaving technology that spans both the military and civilian worlds. ✨

Block MEMS, LLC