Air Force SBIR/STTR

Innovation

Air Force SBIR/STTR Success Story

Topic Number:
AF103-226

Topic Title:
Continuous Indoor Vapor Intrusion Monitoring System for Volatile Organic Compounds

Contract Number:
FA9302-13-C-0002

SBIR Company Name & location:
Kestrel Corp., Albuquerque, NM

Technical Project Office:
Air Force Test Center, Edwards AFB, CA

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An example of a U.S. Air Force supported Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) developed technology that met topic requirements and has outstanding potential for the Air Force, other DoD agency, or commercial industry.

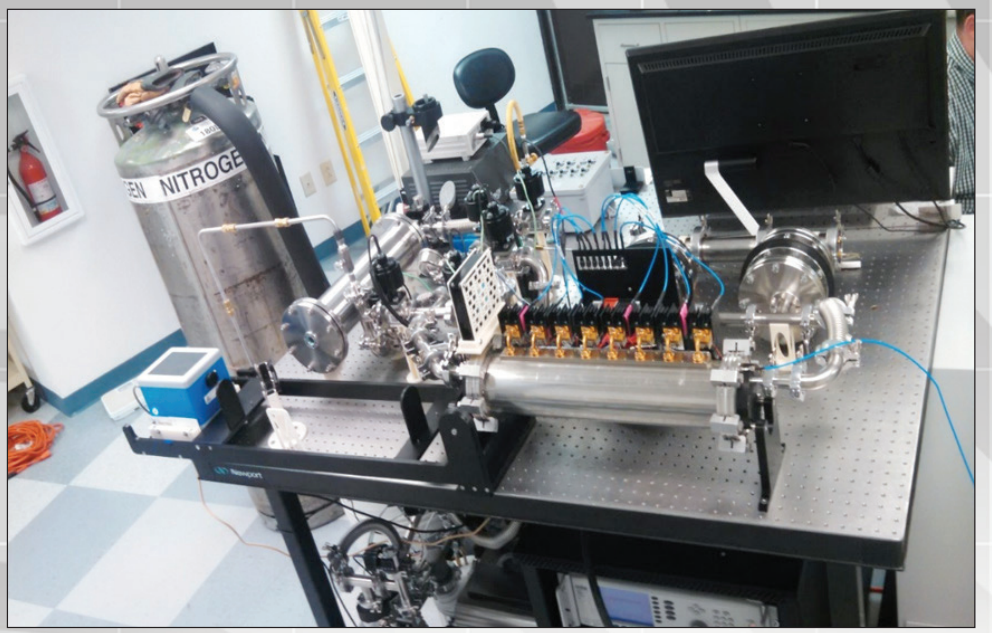

Figure1: The DMIRS gas-phase testbed. An air sample is drawn into a test cell where it is probed with various combinations of infrared and microwave radiation. (Courtesy photo)

Innovative Spectroscopic Technique Sees Through Clutter to Spot Hazards

Maintenance facilities across the country may pose tremendous health risks to personnel. Yet, the typical evaluation of a worker's exposure to an air contaminant requires a pump to draw air through a filter, sampling tube, or other contaminant collection device for a measured period of time. These samples provide an indication of the extent of a worker's exposure, but depending on the worker's tasks, do not identify the specific contributing factor.

It is a prohibitive task to find out what chemical a worker is exposed to due to the amount of data that needs to be collected in a very short period of time, the cost of sampling and analysis and the time needed for the results to be analyzed and reported.

Consider this. It's Thursday morning, you're sitting at your desk reading a technical proposal or better yet, this story. Like most people you probably give little thought to the health risks posed by the doughnut you had with your coffee or the water used to make that coffee not to mention the air that you're breathing. Maybe you should.

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Air Force Requirement

The U.S. government realized that some of the solvents previously used in maintenance facilities are carcinogens. These solvents, once considered harmless, have contaminated the groundwater, spreading the contamination to other facilities. The Environmental Protection Agency (EPA) and the California Department of Toxic Substances Control defines vapor intrusion as the migration of volatile chemicals from the subsurface into structures. Volatile chemicals may include gases and volatile organic compounds (VOC). VOC soil and groundwater contaminate plumes can migrate under buildings posing a potential health risk to workers. A simple, quick, non-contact, reliable method is needed to ensure the work environment is safe.

SBIR Technology

Kestrel Corp., a small business located in Albuquerque, New Mexico develops innovative solutions in the area of optical engineering and imaging sensor technologies. One such solution is Differential Microwave Infrared Spectroscopy (DMIRS).

To illustrate, think of a molecule as a Tinkertoy held together with springs and bearings. Various portions of the structure can vibrate and rotate at certain discrete frequencies. In nature, the distribution of frequencies normally found at a certain temperature is considered the "ground," or unexcited state. An infrared (IR) signal measures the vibrational frequencies of a molecule. DMIRS expands on the IR spectroscopy concept by selectively changing rotational frequencies of the molecule (i.e., exciting the molecule). These changes affect the energy levels of the vibrational modes, as well, thus changing the IR spectrum of the material.

The DMIRS detection device (Figure 1) draws an air sample into a test cell. The sample is then probed with various combinations of IR and microwave radiation. The difference between the excited and unexcited states yields a unique signature. The concept was initially developed under an SBIR award with the U.S. Army to consider explosives and chemical warfare agents as solids and liquids. Next, the company partnered with the Air Force under another SBIR contract and a Rapid Innovation Fund (RIF) award to apply the same theoretical concept to the detection of gases and vapors. This effort led to the first application of pulsed IR quantum cascade lasers to this technology and the discovery of the critical importance of pulse duration to maximize the signal.

A key element of this technique is the uniqueness of the excitation parameters. They are sufficiently unique that only the material being searched for can be detected, as if the clutter or interferents simply disappear.

"The beauty of this technique is that it is a multidimensional probe of a molecule. Each dimension used is like another tooth on a key, making it very difficult to spoof the technique. Thus DMIRS has exceptional reliability," said Boyd Hunter, Kestrel's chief technical officer.

Potential Appication

Applying DMIRS to gas monitoring provides a reliable means to assess and monitor the environmental risks that personnel may be exposed to due to environmental contaminants or materials being transported onto a military facility. This innovative solution improves the lives of service members by allowing monitoring of the environment in order to mitigate health risks and by allowing the detection of toxic industrial chemicals, explosives, or other hazardous chemicals.

DMIRS can be used by the Air Force, other agencies, industry and owners of residential structures for environmental monitoring in order to verify that the atmosphere in a facility does not pose an unacceptable health risk to its occupants. With this information, particularly via long-term monitoring, the effectiveness of or need for additional remediation steps can be quantified.

"This technology will generate significant changes over the next twenty years in how we do industrial hygiene, chemical detection, security, and medical diagnostics," said James Zott, physical scientist on the project.

Company Impact

Working with the Air Force SBIR program provided Kestrel with the needed momentum to move from small-scale laboratory investigations to full-scale development. They can now take a technique from a scientific curiosity to a viable solution, unleashing its full capabilities. The company received a $3 million RIF award to mature the technology as well as expand the scope to include toxic industrial chemicals.

"The ability of this technique to identify target chemicals in the presence of all kinds of confusing interferents, both chemical and otherwise, is truly impressive," said Kestrel Chief Executive Officer Eugene Butler.

To learn more about this company visit its website at http://www.kestrelcorp.com

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