Smoking out terrorism

Argonne scientists build high-tech tools to track illicit substances in the air

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Argonne National Laboratory scientist Nachappa "Sami" Gopalsami explains how this passive millimeter-wave device can identify chemicals that might be used as weapons.

Inside a room with sea-foam green walls, unreliable air conditioning and a collection of what looks like reject droids from the "Star Wars" set, a new front on the war against terror is opening.

Argonne National Laboratory scientists are fine-tuning a device with the capability of secretly detecting illicit substances that could be used in a chemical or nuclear attack.

Researchers started work on the project in 1991 during the Gulf War, when talk of chemical warfare was rife.

Now in the wake of the Sept. 11, 2001, terrorist attacks and subsequent wars in Afghanistan and Iraq, using science as a defensive weapon is critical.

The technology Argonne experts are pioneering is called passive millimeter wave spectroscopy.

The intent is to pinpoint chemicals dispersed by factories from a safe distance.

"They may be making milk powder, they may be making chemical warfare agents, they may be making nuclear materials," senior scientist and electrical engineer Nachappa "Sami" Gopalsami said. "But whatever they're making, they will have some chemicals involved, and those chemicals will come out of the stack. If you monitor those chemicals, it can say something about what's going on."

The innovation is one of several tools Argonne researchers are developing aimed at a growing terrorism safety net, including a "supergel" that cleans radioactive surfaces on buildings.

Chemical footprint

The building in the Argonne lab near Darien that Gopalsami and his colleagues use is strictly government-issue, with outdated décor and a temperamental air-conditioning system.

But appearances are deceiving.

The passive millimeter-wave technology has the ability to identify chemical plumes from a distance of several kilometers and at concentrations as low as 100 parts per million.

One of its important features is collecting data covertly unlike more traditional methods that require transmitting signals.

"The No. 1 advantage is that the system is passive; we do not emit any energy," said Sasan Bakhtiari, a section manager in Argonne's Nuclear Engineering Division.

"It could be operated for applications when you don't want the enemy to know what you're doing."

Future applications could include flying over suspect facilities and recording emissions.

The device also can identify the fingerprint of a chemical within minutes, Argonne researcher Thomas Elmer said.

"You can't be looking for something after it's made," he said. "You have to catch it in the act."

In explaining how the device works, Gopalsami said all matter gives off electromagnetic radiation, called self-emitted radiation or blackbody radiation. For example, human bodies emit heat in the form of infrared waves.

In this case, researchers are aiming at capturing the electromagnetic radiation spewed by chemical gasses as they're ventilated out of factory stacks.

For this device, scientists are using millimeter waves, high-frequency waves that are relatively new.

As the gas-emitted waves pass through the atmosphere, they are captured by the device, which uses large lenses and a semi-conducting device to produce an electrical signal. This identifies the unique chemical signature of whatever is coming out of the stacks.

The instrument has already tested successfully at a government facility in Nevada

Right now, Argonne is in discussions with the U.S. Department of Defense and other potential sponsors.

"We will be excited to have this product in the hands of a government user and in international arms control," Gopalsami said. "That's the ultimate goal; we're very close."

A laboratory model now costs $75,000 to make, but when production moves from the lab to a manufacturing plant, expenses will be reduced.

Ultimately, researchers anticipate battery-operated versions will be available.

There are other applications for the technology, including detecting pollution when plumes of chemicals have been leaked, or as a diagnostic tool, sensing the degree of damage in burn victims, for example.

Toxic cleanups

Another focus of researchers' efforts at Argonne has been the impact of a "dirty bomb."

Such a weapon would contain radioactive material that intermingles with porous molecules in cement buildings, resulting in costly cleanup or demolition.

Argonne scientist Michael Kaminski is leading a team that is crafting a "supergel" that can be sprayed on to affected structures.

The gel contains benign chemicals that occupy the space held by the radioactivity. That contamination is soaked up by powerful absorbent fibers. Next, tiny nano-particles of dirt grab onto the radioactivity. The waste is removed by a wet-dry vacuum and taken to a specialized disposal site.

Depending on the age of a structure and whether it's painted or not -- the product is 80 percent to 100 percent effective.

"It's a success story within the lab," Kaminski said, " and for building up an arsenal of techniques to combat terror."