Super-sensitive explosives detector can detect explosives at distances exceeding 20 yards

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Using a laser and a device that converts reflected light into sound, researchers at the Department of Energy's Oak Ridge National Laboratory can detect explosives at distances exceeding 20 yards.

The method is a variation of photoacoustic spectroscopy but overcomes a number of problems associated with this technique originally demonstrated by Alexander Graham Bell in the late 1880s. Most notably, ORNL researchers are able to probe and identify materials in open air instead of having to introduce a pressurized chamber, which renders photoacoustic spectroscopy virtually useless for security and military applications.

ORNL's technique, detailed in Applied Physics Letters 92, involves illuminating the target sample with an eye-safe pulsed light source and allowing the scattered light to be detected by a quartz crystal tuning fork.

"We match the pulse frequency of the illuminating light with the mechanical resonant frequency of the quartz crystal tuning fork, generating acoustic waves at the tuning fork's air-surface interface," said Charles Van Neste of ORNL's Biosciences Division. "This produces pressures that drive the tuning fork into resonance."

The amplitude of this vibration is proportional to the intensity of the scattered light beam falling on the tuning fork, which because of the nature of quartz creates a piezoelectric voltage.

Van Neste and co-authors Larry Senesac and Thomas Thundat note that other advantages of quartz tuning fork resonators include compact size, low cost, commercial availability and the ability to operate in field conditions environments.

For their experiments, researchers used tributyl phosphate and three explosives – cyclotrimethylenetrinitromine, trinitrotoluene, commonly known as TNT, and pentaerythritol tetranitrate. They were able to detect trace residues with lasers 100 times less powerful than those of competing technologies.

While the researchers have been able to detect explosives at 20 meters, using larger collection mirrors and stronger illumination sources, they believe they can achieve detection at distances approaching 100 meters.

Source: DOE/Oak Ridge National Laboratory

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