

End of the Spectrum

Knowing Is Half the Battle

LIBS helps to detect explosives, chemical agents, and bioweapons

Parmesan cheese, talcum powder, flour used to mark a running path — all have been mistaken for anthrax spores in the past two years. Thanks to the ongoing threat of terrorist attacks, every unidentified powder, liquid, and package is cause for concern. To quickly identify genuine hazards, researchers are refining a spectroscopic technique already proven capable of differentiating between three species of *Bacillus* bacteria closely related to anthrax.

Laser-induced breakdown spectroscopy (LIBS) relies on a nanoseconds-long laser pulse to heat a minute portion of the material in question to temperatures as high as 43,000 °F. The laser energy breaks sample molecules into a highly energized plasma for approximately 1 μ s. As the plasma cools, its atomic components radiate light of characteristic wavelengths. The emitted light is collected, dispersed by a spectrograph, and measured by a charge-coupled device detector. The resulting spectra are then compared with a computer database to identify the sample.

Any known substance — that is, any element or compound in the database — can be identified in real time by this process. In addition, LIBS is noninvasive, uses nano- to milligrams of sample, and is applicable to in situ analysis of solids, liquids, and gases.

All these features, however, are useless for in-field applications unless the systems can be made fully portable. According to David Cremers of the LIBS User Facility, Los Alamos National Laboratory (LANL, Los Alamos, NM), the lab has already built “person-portable versions . . . they can be commercialized at any time.” Currently, LANL scientists are testing a prototype system that comprises a backpack-mounted analysis unit and forearm-mounted computer.

Patrick French, instruments program manager for ADA Technologies (Littleton, CO), which is also developing a human-portable instrument, expects to complete field tests of the ~50-lb unit this October.

Such advances in portability, in conjunction with the speed and versatility of the technique, have inspired plans for untended systems in high-traffic areas to continuously monitor the air for chemical and biological agents; robotic vehicle-mounted units to ascertain the safety of an area before human occupation; and stand-off detection of explosives, with the LIBS laser located hundreds of feet from the suspect material.

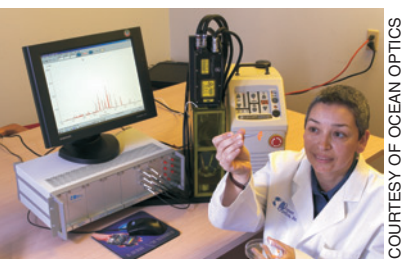
Before these visions can be realized, however, “we need to develop . . . libraries of broadband LIBS spectra of actual hazardous compounds. This is now in the works,” said Andrzej Miziolek of the Weapons and

Materials Research Directorate, U.S. Army Research Laboratory (ARL, Aberdeen Proving Ground, MD).

To improve collection of such spectra, ARL researchers, in cooperation with Ocean Optics (Dunedin, FL), have developed a broadband spectrometer. According to Miziolek, “The very large spectral coverage of the LIBS2000+ unit (200–980 nm) [is] sensitive to all chemical elements in the periodic table. Thus, the simultaneous capture of light emission from all major and principal minor elements of a given target material (e.g. bacterial spore) offers an unprecedented amount of information about such material.”

The antiterrorism applications of the technique were explored in the LIBS and Homeland Defense panel discussion held during LIBS 2002, a topical meeting sponsored by the Optical Society of America (Washington, DC). LIBS, however, is by no means limited to military uses; last September’s meeting also featured papers about identification of kidney stones, analysis of pollutant levels in lichens, and determination of geological samples in a simulated Mars atmosphere. In Miziolek’s words, “LIBS really has tremendous potential for a wide range of field applications.” ■

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The LIBS2000+ broadband laser-induced breakdown spectrometer (Ocean Optics, Dunedin, FL).