LIBS: A NEW VERSATILE, FIELD DEPLOYABLE, REAL-TIME DETECTOR SYSTEM FOR FORCE PROTECTION AND ANTI-TERRORISM APPLICATIONS

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Abstract

Laser Induced Breakdown Spectroscopy (LIBS) is a sensor technology undergoing rapid growth in application areas and in instrumentation. In particular, LIBS possesses great potential for use in many applications related to force protection and anti-terrorism. It is a straightforward and relatively simple technique which utilizes a pulsed laser to create a microplasma on the target material as well as an array spectrometer to capture the transient light for elemental identification and quantification. The simplicity of the technique and the technological maturity of the components that comprise a LIBS sensor attest to the fact that this technology is both rugged and robust, and therefore particularly suitable for field use. LIBS attributes include: (1) no sample preparation required, (2) it is very sensitive (nanograms), (3) has been made briefcase size for man-portable field use and could be made smaller, (4) response is real-time, and (5) can be operated as both a point sensor or in a standoff detection mode (distances of 100 meters and greater have been demonstrated). The ARL LIBS researchers have worked in this field for over 12 years (ref. 1-7).

Recently a number of potential military applications have been identified and actively pursued. Some examples include: (1) trace explosives detection (Fig. 1), (2) chem-bio detection (Fig. 2), (3) robotics applications (ground and airborne), (4) buried landmine and UXO detection (Fig. 4), and (5) RCRA/toxic metal detection and identification (ref. 7). Recent progress in instrumentation includes the development of a compact multispectrometer system which allows for very broad spectral coverage (200-950+ nm) with high resolution (0.1 nm). In particular, over the past year ARL collaborated with Ocean Optics Inc. to develop a new commercial instrument (LIBS 2000+, Fig. 3) which allows for real-time detection of all elements of any unknown target. Thus LIBS is now sensitive to molecular and biological materials. The reason for this is that all chemical elements emit light in the 200-950 nm region. Thus, molecular detection and identification is based on sensing all of the constituent elements of an unknown material as well as their relative abundances, and comparing the LIBS spectrum of an unknown with a library of reference spectra. This advance in technology has made possible the use of LIBS to discriminate between different explosive formulations and different types of plastics, which has the potential to make LIBS an important new sensor for demining. Yet another application for LIBS is the determination of chemical composition of particles of interest in advanced energetics applications. In one such study we are using LIBS to track burning metal powders (Al and Mg) in thermobaric formulations. In another study we are using LIBS to characterize the chemical composition of nanoscale energetic ingredients (nanoscale metals/alloys with passivation coatings).

We would like to acknowledge Dr. Alan Samuels, SBCCOM, who prepared the three bacilli samples for LIBS analyses.

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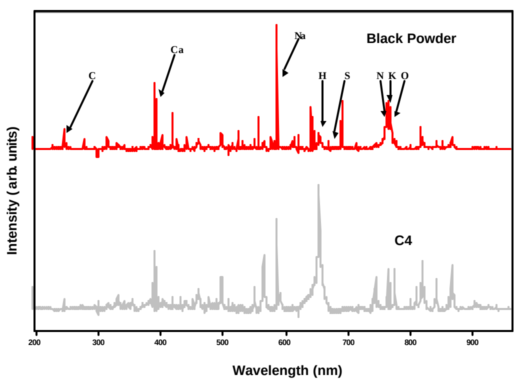

Fig. 1. Single-shot LIBS spectra of C4 and black powder

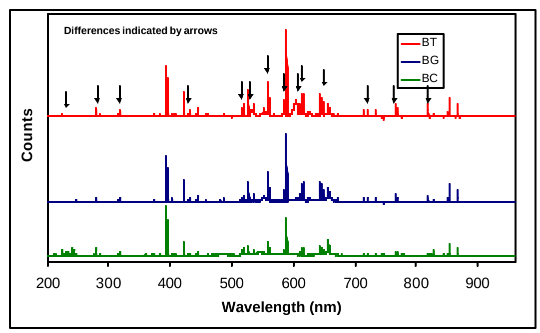

Fig. 2. LIBS spectra of anthrax surrogates BC, BG, and BT

Fig. 3. The new LIBS 2000+ broadband 7-spectrometer detector at ARL

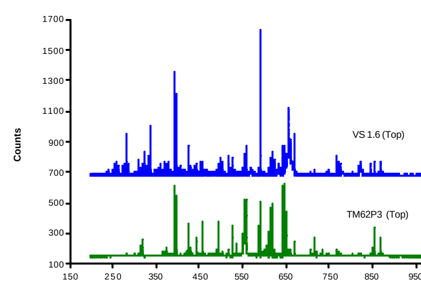

Fig. 4. Single-shot LIBS spectra of plastic casings for the VS 1.6 and TM62P3 landmines