Hyperspectral Laser Induced Fluorescence as a Method for Standoff Detection and Classification of Biological Hazardous Materials

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Abstract

The high and still increasing number of attacks by hazardous bioorganic materials makes their detection extremely difficult, since they need to be discriminated from other substances in various natural surroundings. In addition, living material may reproduce itself. Already one single bacterium may constitute a huge risk. Thus, a very high detection sensitivity and selectivity are essential, as well as a rapid identification with low false alarm rates. Laser based standoff detection can immediately provide information on propagation and compound type of a released hazardous material, while point sensors can collect and identify them. The coupling of both methods may be a promising solution to optimize the acquisition and detection of hazardous substances.

At DLR Lampoldshausen, bioorganic substances are measured applying hyperspectral laser induced fluorescence (LIF) technique in order to subsequently classify them. In this work, a procedure is presented, which utilizes time-dependent spectral data and predicts the presence of hazardous substances by statistical data analysis. For that purpose, measurements are carried out on a free transmission range at a standoff distance of 22 m, with two excitation wavelengths in alternating mode (e.g., 280 and 355 nm). A gated ICCD spectrometer system records spectral and time-dependent fluorescence data, which are processed and fed automatically into the classifier. Attention is drawn to physical states, concentrations, and to the photodecomposition of the samples assisted by absorption spectroscopy before and after each LIF measurement. This has a strong impact on the measurement procedure and, especially, on the training of the classifier.