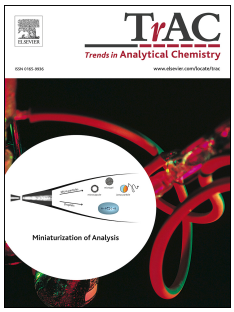
Accepted Manuscript



Key challenges and prospects for optical standoff trace detection of explosives

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PII: S0165-9936(17)30290-X

DOI: 10.1016/j.trac.2017.12.014

Reference: TRAC 15079

To appear in: *Trends in Analytical Chemistry*

Received Date: 9 August 2017

Revised Date: 30 November 2017

Accepted Date: 21 December 2017

Please cite this article as: P. Wen, M. Amin, W.D. Herzog, R.R. Kunz, Key challenges and prospects for optical standoff trace detection of explosives, *Trends in Analytical Chemistry* (2018), doi: 10.1016/j.trac.2017.12.014.

Title:
Key challenges and prospects for optical standoff trace detection of explosives

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Abstract
Sophisticated improvised explosive devices (IEDs) challenge the capabilities of current sensors, particularly in areas away from static checkpoints. This security gap could be filled by standoff chemical sensors that detect IEDs based on external trace explosive residues. Unfortunately, previous efforts have not led to widely deployed capabilities. Crucially, the physical morphology of trace explosive residues and chemical "clutter" present unique challenges to the operational performance of standoff sensors. In this review, an overview of standoff trace explosive detection systems is provided in the context of these unique challenges. Tradespace analysis is performed for two popular standoff detection methods: longwave infrared hyperspectral imaging and deep-UV Raman spectroscopy. The tradespace analysis method described in this review incorporates realistic trace explosive residues and background clutter into the technology development process. The review predicts system performance and areas where additional research is needed for these two technologies to optimize performance.

Highlights
- Optical sensing can enable standoff trace explosive detection for many applications
- The morphology of trace explosive and clutter residues present unique sensing challenges
- Sensor engineering typically includes only notional consideration of target morphologies
- Tradespace analysis can reveal system performance and risk reduction strategies
- Analysis is demonstrated for model Raman and infrared standoff sensors

Keywords: Explosives; Forensics; Fourier transform infrared spectroscopy; Hyperspectral infrared spectroscopy; Raman spectroscopy; Trace detection; Ultraviolet Raman spectroscopy