

Explosives Identification with 1064nm Dispersive Raman Spectroscopy

High signal, reduced fluorescence, better classification accuracy.

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Background

Owing to technological improvements spurred on by the telecommunications boom of the last decade, Raman spectroscopy has become much more accessible to users in all fields. The combination of improved technology and the technique's molecular sensitivity have led to a surge in Raman usage in a myriad of application areas, including forensic, defense, pharmaceutical, biomedical, and industrial, among others. However, a common problem with Raman spectroscopy has been interference from fluorescent molecules present in the 'real world' samples of interest, such as improvised explosive devices (IEDs), home-made explosives (HME), chemical agents, biological warfare agents, street narcotics, counterfeit pharmaceutical products, etc. If present, fluorescence interference is typically orders of magnitude higher than the Raman signal, and can confound automated classification systems.

For years, users have attempted the use of 785nm or 830nm dispersive Raman systems, often still facing confounding fluorescence. Or they could use FT-Raman instruments at 1064nm which avoided fluorescence but could not be made field-portable. But now, BaySpec's dispersive 1064nm Raman spectrometer family of instruments offers users a turn-key solution that combines the speed, sensitivity, and rugged design of traditional dispersive Raman instruments with the fluorescence avoidance of traditional FT-Raman instruments. In addition, this dispersive geometry permits diffraction-limited optical performance, allowing confocal and standoff Raman at 1064nm.

Study

A number of explosive materials and subsidiary compounds were analyzed using BaySpec's 785nm and 1064nm dispersive Raman systems. These samples included pentaerythritol tetranitrate (PETN), ammonium nitrate, ammonium antimony explosive, RDX, HMX, C4, composition B, TNT, and emulsion explosive.

While some of the studied samples did not evidence any fluorescence background in either the 785nm or 1064nm measurements (including ammonium nitrate,

C4, HMX, and TNT), the remaining samples emitted moderate to strong fluorescence interference at 785nm that was either reduced or eliminated using the 1064nm system. As demonstrated in Figure 1, perhaps the most apparent difference occurs with composition B, a mixture of RDX and TNT that contains wax and plasticizers that likely contribute to the high fluorescence background. "Real world" (non-purified) substances such as this sample are much more prone to unknown contaminants that may also fluoresce, providing further motivation in the case of IED or HME identification.

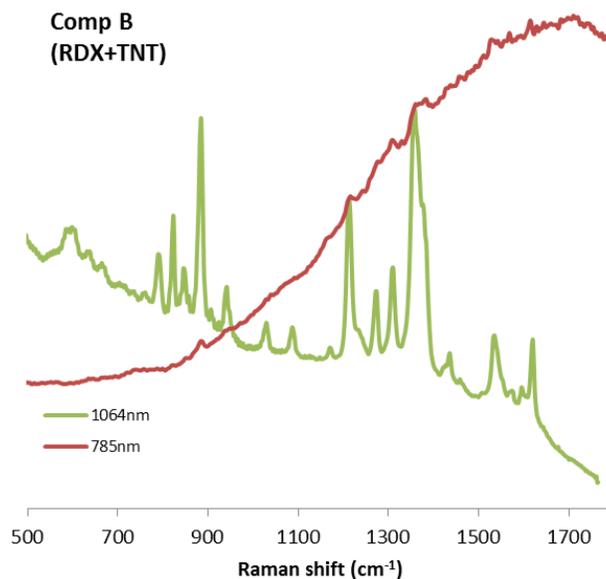


Figure 1: Composition B Raman spectrum exhibits strong fluorescence at 785nm that is completely avoided using 1064nm.

Conclusion

While traditional near-infrared Raman systems at 785nm may allow automated, non-contact identification of several explosive substances, these systems are still prone to interfering fluorescence. 1064nm dispersive Raman systems offer reduced interference and higher prediction accuracy, while preserving the rugged, field-proven architecture of conventional near-infrared Raman systems.