Rapid Field Testing of Ecstasy Pills Using a 1064-nm Handheld Raman Device

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Introduction

In recent years, handheld Raman devices have become a widely used technology for safety and security personnel and law enforcement for quick identification of narcotics, pharmaceutical drugs, hazardous chemicals, explosives, and other substances. Thanks to the rugged design and portability of handheld Raman devices, police officers and public safety personnel are able to detect suspected substances in the field. However, brightly-colored street samples such as ecstasy tablets pose a serious challenge due to the fluorescence interference commonly associated with Raman devices that use a 785-nm laser. Fluorescence is photoluminescence emission upon laser excitation that potentially overwhelms the Raman signal partially or completely, resulting in a poorly defined Raman signature, and failure of identification. Fluorescence can limit the Raman detection of colorful substances and mixtures with plant-based narcotics and cutting agents, making it difficult to perform fast, presumptive tests of street samples in the field.

TacticID-1064

Laser excitation wavelength plays a critical role in fluorescence appearance. While Raman scattering can occur with any incident laser wavelength, fluorescence is wavelength-dependent. Raman spectrometers operating using visible lasers such as 532-nm and 785-nm wavelengths typically generate strong fluorescence from brightly-colored samples and street-level mixtures that overwhelms the Raman signal. A laser wavelength in the near-infrared region of light, such as 1064 nm, naturally reduces the fluorescence generated from these types of samples. For this reason, handheld Raman systems that contain 1064-nm laser excitation, as opposed to the 785-nm laser excitation traditionally used, are the newest advancement in Raman instrumentation in an effort to significantly reduce fluorescence interference.

B&W Tek's newly released TacticID®-1064 is a field-ready handheld Raman system utilizing 1064-nm wavelength laser excitation. Designed for forensic analysis by safety personnel, first responders, and law enforcement personnel, the TacticID-1064 significantly reduces fluorescence, allowing users to identify tough street samples such as ecstasy tablets in a variety of colors and mixture forms.

Case Study: Ecstasy

Popular among teenagers and young adults, ecstasy tablets are often found in many colors with various logos at club scenes and rave music events to attract young people. The main ingredient MDMA (3,4-methylenedioxymethamphetamine) is a synthetic drug, chemically similar to those of stimulants and hallucinogens that alters mood and perceptions. Listed by the US Drug Enforcement Administration (DEA) as Schedule I drug, MDMA has high potential for abuse. Deaths from MDMA are commonly associated with a fatal increase in body temperature and dehydration.

Due to the colorful and nonhomogeneous nature of ecstasy pills, when they are measured with a Raman device with a 785-nm excitation wavelength the Raman signatures tend to be overwhelmed by strong fluorescence, which limits the capability of identification. To illustrate the fluorescence interference of colorful ecstasy pills generated by a 785-nm laser, Figure 1 shows Raman spectra collected from a pink-colored MDMA tablet using a Raman device with a 785-nm laser (blue trace) and a Raman device with a 1064-nm laser (red trace). The fluorescence generated from the 785-nm laser overwhelms the Raman peaks characteristic of MDMA, while excitation with the 1064-nm laser results in clear, distinct MDMA Raman signature peaks.

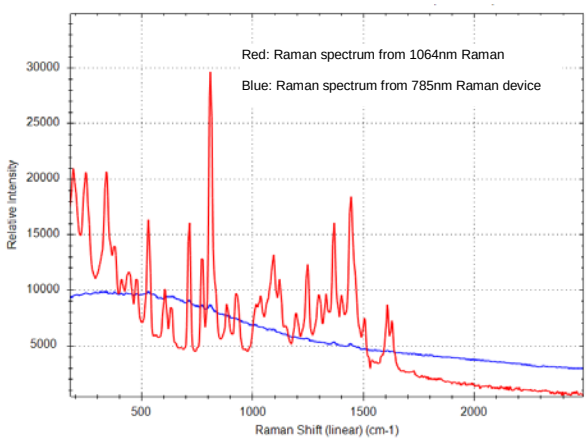

Fig. 1 MDMA pink tablet Raman spectra measured by 1064-nm laser (red trace) vs. 785-nm laser (blue trace)

TacticID-1064 Test Results

The TacticID-1064 was used to test ecstasy pills of different colors. Figure 2 displays the test result of a pink tablet. With an integration time of 2 seconds, the scan matches to MDMA HCl in the reference library with a hit quality index (HQI) at 96. An HQI score is a measure of how well the unknown sample spectrum correlates to a library spectrum. An HQI score of 100 indicates 100% correlation between the sample spectrum and the library signature. An HQI score of 96 indicates a very high correlation between the sample and the MDMA reference. In general, an HQI score higher than 85 indicate sufficient correlation to the reference signature to identify the main component in the street samples. For test results with HQI score lower than 85, the user can initiate mixture analysis to further analyze the components in the sample mix. Other ecstasy pills with different colors and logos were tested using TacticID-1064. The results are summarized in Table 1.

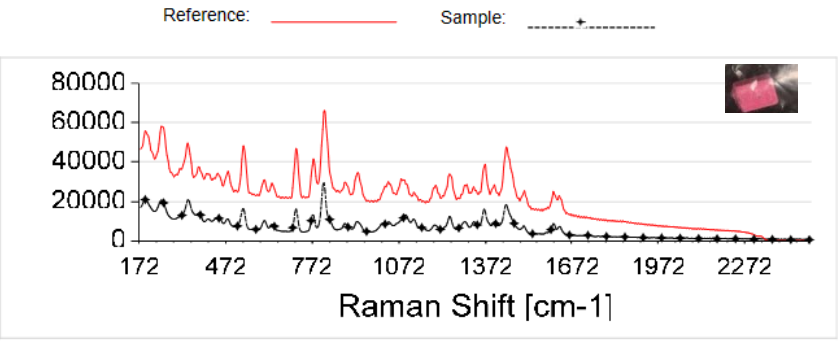

Fig. 2 TacticID-1064 test on pink ecstasy pill matching to MDMA HCl with HQI=96

Table 1. TacticID-1064 testing details for different ecstasy pills

Pill Color	Markings	Photo	Top Match	HQI	Mixture Analysis
Pink	Stamped with "Supreme"		MDMA HCl	96.1	N/A
Blue	Blue Grenade	N/A	MDA HCl	90.5	N/A
Yellow	Tiger		MDMA HCl	87.2	N/A
Pink	Red Bull logo		MDPV	86.0	N/A
Orange	Tesla symbol		MDE (MDEA)	63.1	Paper, MDEA HCl

Figure 3 overlays spectra from four ecstasy pills of different colors measured with the TacticID-1064. Unlike Raman devices with 785-nm laser wavelengths, the TacticID-1064 is able to significantly reduce the fluorescence from the dyes and other additives in the pills, providing distinctive Raman signatures for accurate and reliable identification.

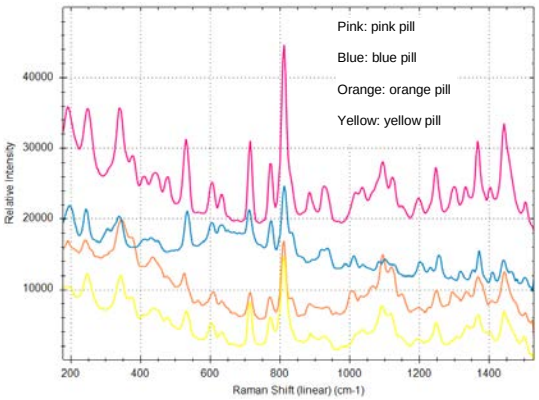

Fig. 3 TacticID-1064 spectra from ecstasy pills of pink, blue, orange, and yellow colors

Although MDMA is usually the main component of ecstasy, oftentimes tablets are a mixture of several stimulants such as MDA (3,4-methylenedioxyamphetamine), MDEA (3,4-methylenedioxy-N-ethylamphetamine), amphetamine, methamphetamine, caffeine, and other cutting agents. Using the TacticID-1064's mixture analysis algorithm, the user can further analyze spectra with HQI values less than 85. For the orange pill stamped with a Tesla logo, the top hit matches to MDE (MDEA) with an HQI of 63.1. This low HQI value indicates the sample composition is likely not dominated by just one component. The further mixture analysis (Figure 4) on the scan resulted in two components: paper and MDEA HCl. The component "paper" relates to the cellulose-type cutting agents or binding materials inside the pill. The percentage values reported from the mixture analysis indicate the probability of each individual component spectrum in forming the composite spectrum of the sample.

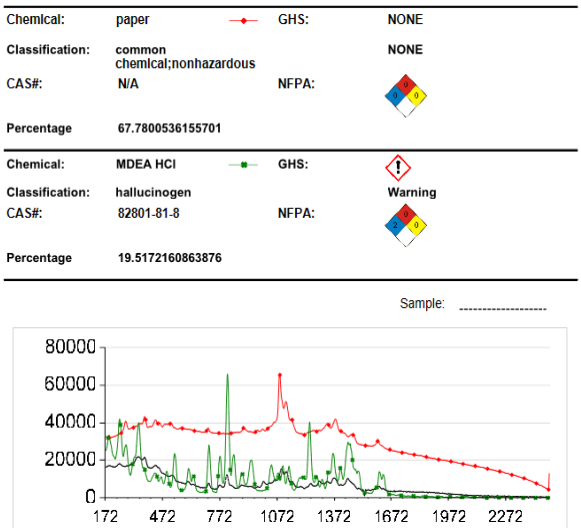

Fig. 4 TacticID-1064 mixture analysis result for orange pill with Tesla logo

Another pink pill marketed by the name “Bull99” and stamped with the Red Bull logo resulted in a match to the stimulant MDPV (methylenedioxypyrovalerone). Figure 5 shows the Raman spectrum from the pill compared to the reference spectrum of MDPV. “Bull99” matched to MDPV with an HQI score of 86.

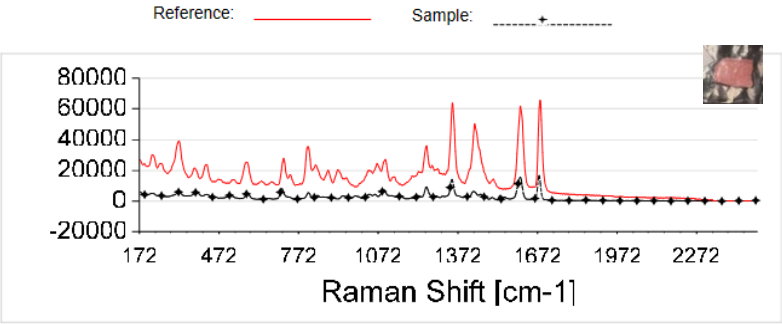

Fig. 5 TacticID-1064 test for “Bull99” pill matching to MDPV

Conclusions

Raman devices with 1064-nm laser excitation significantly reduce the fluorescence commonly observed from colorful samples upon excitation with a 785-nm laser. The TacticID-1064, B&W Tek’s new handheld Raman device, employs a 1064-nm laser that is capable of generating distinctive Raman signatures of MDMA and other synthetic components contained in colorful ecstasy pills. The TacticID-1064 successfully identified ecstasy pills in colors such as pink, red, yellow, blue, and orange based on HQI scores that provide a correlation of how well the spectrum from the unknown sample matches to a library spectrum. Mixture analysis on the TacticID-1064 was used to identify components in pills that are not comprised of a single pure component. Ultimately, the advent of Raman devices with 1064-nm laser excitation like the TacticID-1064 expands the scope of materials that law enforcement officials and hazardous materials technicians can reliably and safely identify.

