Enhanced Methods for the In-field Identification of Low Dose Fentanyl-Based Street Drugs

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Summary

- New patent pending technique, Narc ChasIR™, designed to identify illicit narcotics at <0.5% concentration.
- Combines proprietary new mixture algorithms with innovative pre-concentration method.
- Specifically designed for in-field use.
- Can analyze tablets as well as powders, only 20ng of material needed for analysis.
- Minimal sample prep, minimal training
- Complete analysis in less than one minute.
- 99% accurate at concentrations of 0.5% or more
- Generally applicable - identify Fentanyl, Carfentanil, Heroin, Cocaine, Methamphetamine plus many more.

Introduction

Fentanyl and its analogs are very toxic synthetic opioids that present one of the largest forensic, public health and potential homeland security challenges. According to the Centers for Disease Control and Prevention (CDC), the potency of fentanyl is 50-100 times that of morphine.[1] 2 milligrams (mg) of fentanyl is considered a lethal dose for most humans, see Fig. 1. Carfentanil, a fentanyl analog, is 100 times more toxic than fentanyl, 10,000 times more toxic than morphine.[2] Due to their potency and relative low cost, fentanyl analogs have become significant contributors to drug abuse, addiction, and overdoses. They have also been found in counterfeit prescription

Figure 1. Lethal dose of fentanyl. Source : DEA

formulations, with potentially deadly implications. On a third front, the high toxicity leads to fears that fentanyl and its analogs might be considered as weapons of mass destruction (WMD).[3] Positive identification, at the location where these drugs are found, is a critical need for emergency responders in forensics and homeland security.

Fourier transform infrared (FT-IR) spectroscopy is a commonly employed chemical analysis method for materials characterization, used in both laboratory and field analyses. FT-IR with an Attenuated Total Reflectance (ATR) sample interface provides an easy to use identification tool for solids and liquids requiring only microgram (µg) quantities of sample. FT-IR spectroscopy has been categorized as among "Category A" techniques, having "maximum potential discriminating power" by the Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG).[4] The IR absorption spectrum of a material is unique, arising from the unique molecular structure of that material, making FT-IR spectroscopy highly effective at identifying unknown threats.

A traditional limitation of FT-IR spectroscopy is that it is considered a "bulk" technique. Samples are typically measured in whole, without any separation or preconcentration. Consequently, the limit of identification (LOI) for a minor component of a mixture is approximately 10% by weight. Although this relative concentration may seem high, when using ATR sample interfaces, the weight of material sampled is quite low. The maximum amount of sample measured on the ThreatID™ portable FT-IR spectrometer is 2.3 µg. The amount of sample required for identification is on the order of 20 nanograms (ng). The challenge is to deliver the small quantity of material to the diamond ATR internal reflection element (IRE).

RedWave has developed a patent-pending in-field method, Narc ChasIR™, to identify fentanyl and other street drug mixtures at lower concentrations than typically achievable by infrared spectroscopy. The method is general and can also be used with other street drugs including heroin, cocaine, methamphetamine, or MDMA (ecstasy) as well as fentanyl and fentanyl analogs. The active narcotic drug can be present in pills and powders at low levels and mixed with cutting agents. Cutting agents can vary but common cutting agents include carbohydrates such as starch, lactose, glucose (dextrose), mannitol, inositol and other materials; they are generally present relatively large concentrations and can mask the signal of drug substances using conventional FTIR techniques.

Advanced Mixture Analysis

Advanced software methods have been developed by RedWave to unravel components in mixtures automatically, with no user input required. The ThreatID contains an IR spectral library of known narcotics and cutting agents; the automated mixture analysis software calculates a

suitable combination of library components that accurately represent the sample spectrum. As an example, the analysis of an opioid mixture containing 65% mannitol cutting agent, 10% fentanyl HCl and 25% heroin HCl, as measured on the ThreatID, is shown in Fig. 2. The results screen shows the collected sample spectrum in green and the best library fit in orange. This library fit was generated as the sum of the three components found by the mixture analysis algorithm, in their relative proportions, as shown in the list on the right. For this bulk analysis, the software accurately determined the identity of all three components, identifying both opioids even in the presence of the large amount of cutting agent.

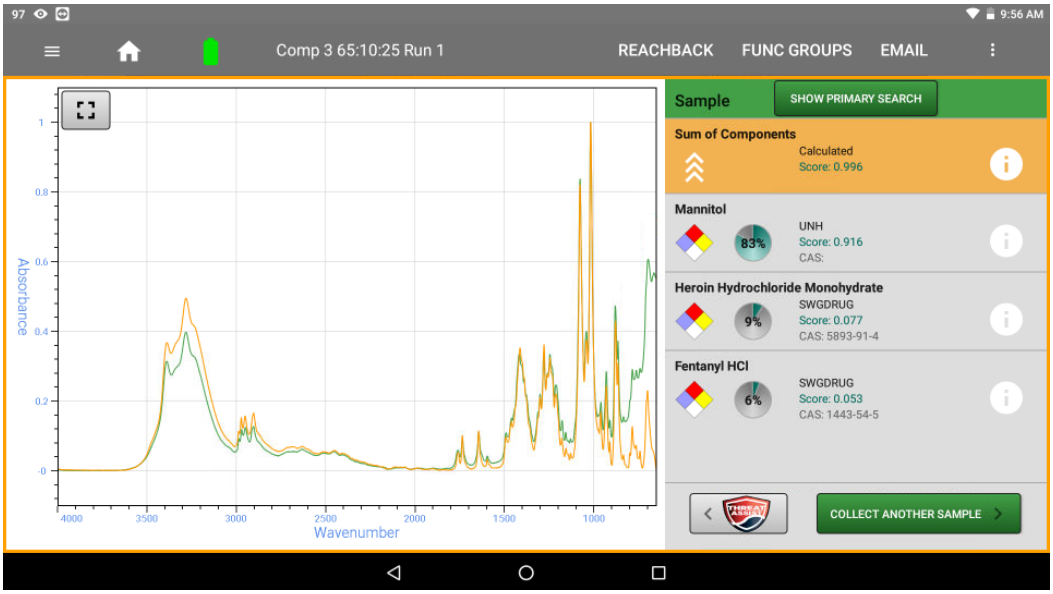
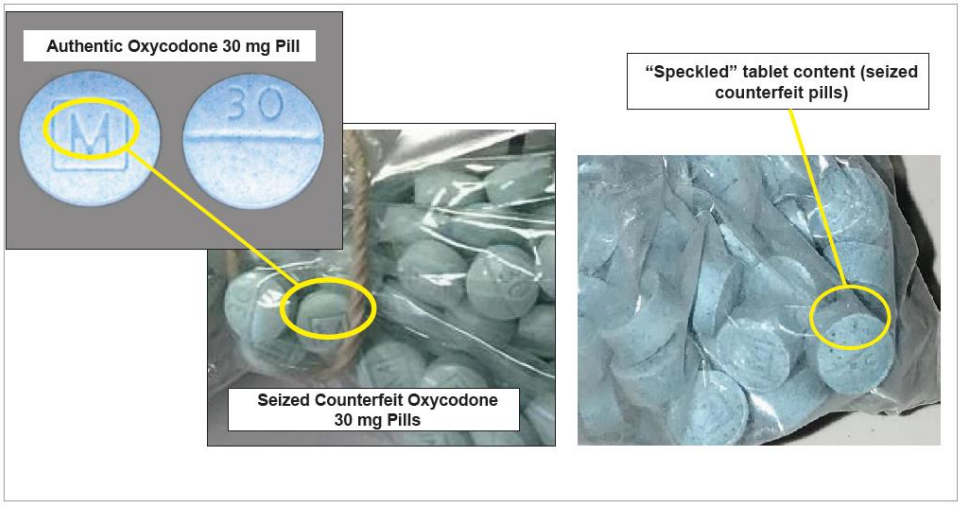


Figure 2. Automated mixture search results for a three (3) component mixture consisting of mannitol cutting agent, heroin hydrochloride, and fentanyl hydrochloride.

Counterfeit pharmaceuticals

A significant contemporary problem are counterfeit oxycodone tablets where fentanyl HCl is used instead of the pharmaceutical active ingredient. These tablets are often made to appear like 30 mg tablets; Fig. 3 below, shows images of authentic oxycodone tablets and seized counterfeit tablets. Both the authentic and counterfeit tablets are comprised primarily of acetaminophen with a small concentration of oxycodone (authentic) or fentanyl HCl (counterfeit). As mentioned above, the lethal dose of fentanyl is ca. 2 mg; therefore, the quantity of fentanyl in the tablets should be quite low, although tablets with lethal doses of fentanyl are found. The common concentration of fentanyl in the counterfeit tablets can be 1% by weight, which can present problems for in-field methods such as FT-IR or Raman spectroscopy and wet chemical analyses such as Nark kits.



Source: DEA Philadelphia Field Division

Figure 3. Authentic oxycodone tablets compared with seized counterfeit tablets.

We have developed the Narc ChasIR™ method for analyzing concentrations of fentanyl lower than the 1% concentration range. The method separates the fentanyl from the bulk acetaminophen and concentrates the fentanyl in a free-base form, which is then deposited directly onto the diamond IRE sample interface. Since the ThreatID only requires approximately 20 ng of pure material, a very small amount of sample is required. The automated mixture analysis in the ThreatID software can be used to identify the low-level narcotic even if there is some carry-over of other materials. In addition to fentanyl, this general method can be applied to powders and tablets of other narcotics such as heroin HCl, cocaine HCl, or methamphetamine HCl. Small quantities of drugs swabbed from surfaces can also be concentrated and identified using this method. Fig. 4, below illustrates an FT-IR spectroscopic analysis of 0.5% fentanyl HCl mixed with 95.5% of acetaminophen. Automated mixture search correctly identifies a single component, the free base form of fentanyl. The measured spectrum in green is overlaid with the orange library spectrum for comparison.

Conclusion

These examples demonstrate the extension of a powerful unknown identification technique, FT-IR spectroscopy, to analyze relevant concentrations of a toxic narcotic, fentanyl. The Narc ChasIR™ methods comprise advanced software for automated, unsupervised mixture resolution and a preconcentration technique to eliminate the bulk contribution of cutting agents or other components in a tablet or powdered street drug. These methods will be very useful in providing

immediate situational awareness to responders or investigators in the field in their mission to collect evidence, secure a clandestine laboratory, or provide safety to themselves or the public.

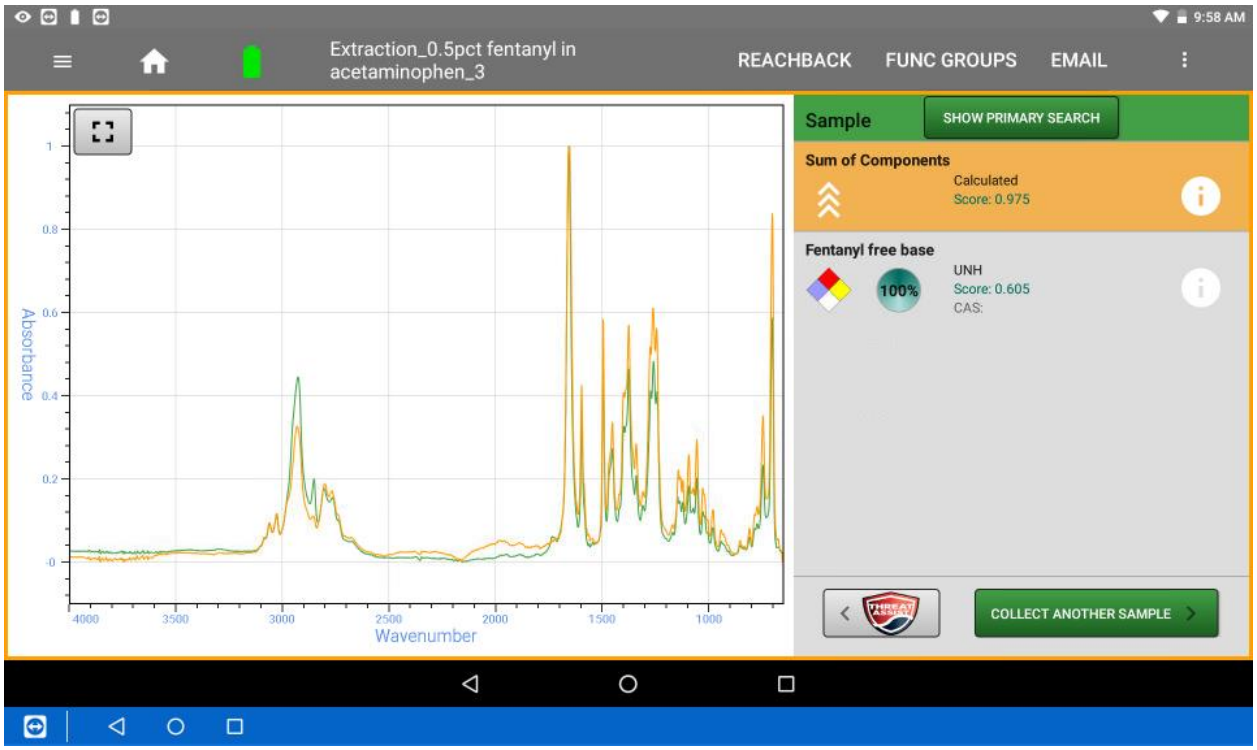


Figure 4. Screen capture of an FT-IR spectroscopic analysis of 0.5% fentanyl HCl mixed with 95.5% of acetaminophen. Identified as the free base form. Green – measured spectrum, Orange – library spectrum of fentanyl base form.

References

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