

Quick ID of Opioid-Containing Drugs

Using 532 nm Handheld Raman

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INTRODUCTION

Abuse of opioid-containing medications in the United States has caused an unprecedented drug overdose epidemic [1]. Between 2001 and 2015, opioid-related overdose deaths have tripled to reach a shocking number of 33,091 [2]. Since 2009, these deaths have outnumbered the deaths from motor vehicle crashes to become a major, nationwide public health problem [3].

Many of the opioid drugs (for example, fentanyl) can be up to 50 times more potent than heroin, and up to 100 times more potent than morphine [4], and can, thus, be lethal even at low levels. Many of the opioids can easily be absorbed through the skin or inhaled, posing much risk to law enforcement officers and other first responders on duty. In some places, officers are trained to give themselves Narcan in case of exposure. In others, there are no comparable safety measures. It is important for police departments to make sure that their officers fully understand the risk. The Drug Enforcement Agency (DEA) recommends taking confiscated drugs directly to a laboratory instead of doing field testing or taking them back to the department. Agencies with drug suppression teams or narcotics units need to provide their officers with the tools able to identify opioid-based drugs on the scene without requiring them to handle samples. A handheld RamTest-CSI™ identifier based on Raman technology provides a powerful alternative to taking officers out of service to deliver drugs to a laboratory. It is able to detect miniscule levels of the opioid-containing drugs in the field without requiring an officer to handle the sample.

In addition to the field analysis benefits, RamTest-CSI™ can also significantly improve and/or accelerate the analysis in / at the laboratories serving police municipalities. Further, due to its high sensitivity, the 532 nm handheld Raman is capable of not only complementing but also replacing of several expensive lab-based analytical techniques conventionally used for analysis of controlled substances.

ADVANTAGES OF 532-nm EXCITATION FOR FORENSIC MATERIALS ID

A winner of the prestigious Analytical Scientist Innovation Award in 2016 [5], RamTest-CSI™ Handheld Raman Identifier (*Figure 1*) is specifically developed to enable best-in-class performance for detection and ID of controlled substances and explosive materials directly in the field. This is achieved through innovative optical design to minimize signal losses, non-conventional 532 nm laser excitation to generate 5 to 16 times greater Raman signal per unit laser power (comparing to conventional 785 or 1064 nm excitations, respectively), as well as a state-of-the-art analytical methodology to minimize the impact of fluorescence on Raman measurements [6].



FIGURE 1. RamTest-CSI™ Handheld Raman Identifier.

Attachments (bottom left) enable measurements of liquid / solids 'as is'; on a slide; or through containers: evidence bags, vials, bottles, jars, etc.

Summary of RamTest's unique benefits for CSI testing:

- Easy-to-use
 - *Light-weight, self-contained, battery powered, ergonomic design*
 - *No prior knowledge of spectroscopy required to operate – all measurement parameters are automatically adjusted*
 - *Automated sample ID and analysis report generation*
- Lowest-in-class unit cost
- CAN identify over 100 of most common narcotics and explosives
 - *The reference database is user-updatable*
- CAN analyze what the other handhelds cannot **[6]**:
 - *5 to 16-fold improved analysis speed and/or analysis accuracy*
 - *Lowest-in-class detection and quantitation limits*
 - *Unmatched combination of spectral resolution ($\sim 4\text{ cm}^{-1}$) and spectral range ($\sim 120\text{-}4000\text{ cm}^{-1}$)*
- CAN analyze essentially any type of substances in essentially any form:
 - *Liquids, gels, slurries or suspensions*
 - *Solids: powders, stains, crystals, tablets or pills, chips, fibers, etc.*
 - *Pure and mixed or camouflaged substances*
- Substances CAN be analyzed in multiple ways:
 - *'As is' on a surface*
 - *Directly through containers or packaging: evidence bags, blister packs, vials, jars, bottles, syringes, Petri dishes, etc.*
 - *No contact or contamination with sample occurs and no liquid is brought in contact with the sample during test, particularly important for small or trace amounts of sample.*
- Windows or Android interface available
- SERS and Drop Coated Deposition Raman (DCDR) substrates available

EXPERIMENTAL

All samples were analyzed using a RamTest-CSI™ handheld Raman Identifier (BioTools, Inc., Jupiter, FL, USA) shown in *Figure 1*. All tests were run in automated mode (requiring no prior knowledge of Raman spectroscopy), where all measurement parameters are automatically adjusted to optimize signal-to-noise ratio and minimize fluorescence, with remaining fluorescence background (if any) automatically subtracted.

RESULTS

In this paper, we demonstrate the ability of a handheld RamTest-CSI™ identifier to detect and identify opioid-containing drugs, as well as reliably distinguish them both among themselves and from other non-opioid pain-killer medications, within 5 to 30 seconds. The drug names and compositions are summarized in *Table 1*.

TABLE 1. Chemical composition of opioid containing drugs, and non-opioid medication with similar chemical composition

Sample #	Drug Name	Class	Active Ingredients
1	Oxycodone 5-325	Opioid	5 mg of Oxycodone Hydrochloride + 325 mg of Acetaminophen
2	Hydrocodone 5-325	Opioid	5 mg of Hydrocodone Bitartrate + 325 mg of Acetaminophen
3	Excedrin Extra Strength	Non-opioid	65 mg of Caffeine + 250 mg of Acetaminophen + 250 mg of Aspirin
4	Aspirin	Non-opioid	Aspirin or acetyl salicylic acid
5	Ibuprofen	Non-opioid	Ibuprofen or (±)-2-(p-Isobutylphenyl) propionic acid

Figure 2 shows raw 532 nm Raman spectra of 5 drugs listed in Table 1. The samples include 2 opioid containing drugs: Oxycodone (navy-blue) and Hydrocodone (brown), as well as 3 non-opioid pain-killer medications: Excedrin Extra Strength (black), Aspirin (dark-red) and Ibuprofen (green).

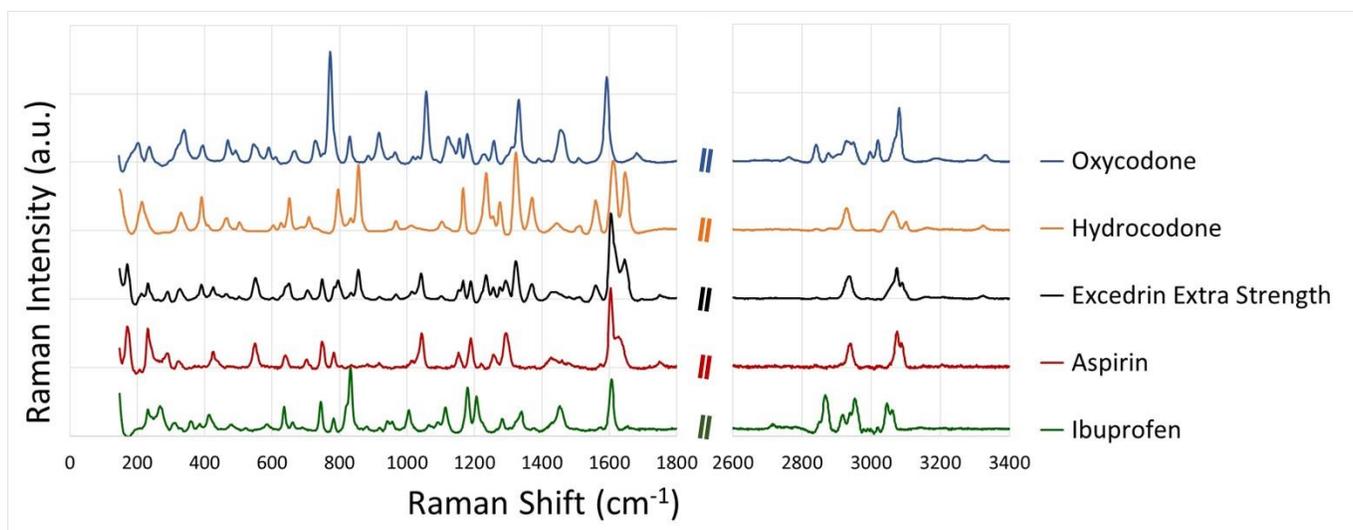


FIGURE 2. 532 nm Raman spectra of the listed drugs (please see Table 1 for detail) show remarkable differences to enable fast and reliable automated identification with RamTest-CSI™ handheld Raman identifier. NOTE: 1800 – 2600 cm⁻¹ and 3400 – 4000 cm⁻¹ spectral regions are intentionally cut for this figure, since they do not contain any characteristic Raman bands.

As can be noticed from Figure 2, the Raman spectra of the listed drugs show significant differences. Dual statistical methodology, incorporated into the instrument, capitalizes even on barely noticeable spectral differences to enable unequivocal automated identification of these and other drugs within 5 to 30 seconds (Figure 3, Oxycodone example). In addition, RamTest-CSI™ handheld Raman identifier automatically saves all the measured data, makes data log, and supports the automated report generation and/or printing, thereby not only enabling full measurement tracking but also saving time for a user.

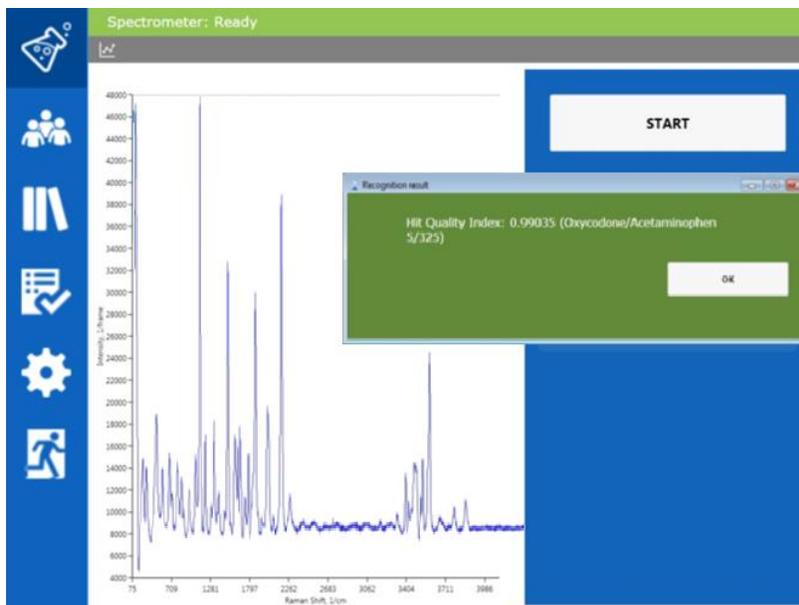


FIGURE 3. Example of Oxycodone identification by RamTest-CSI™ instrument, within 10 second measurement, as displayed by RamTest-ID software specifically developed for CSI applications. Hit Quality Index of >0.99 shows that the measured sample is identified as “Oxycodone/Acetaminophen 5/325” tablet at >99% confidence level.

CONCLUSIONS

As these trials demonstrated, the opioid-containing pain-killer drugs Oxycodone and Hydrocodone were distinguished from those not containing the opioids quickly and unambiguously. Therefore, RamTest-CSI™ handheld Raman analyzer can easily identify this class of controlled substances directly at a crime scene to provide a powerful time- and resource-saving alternative to drug analysis at a laboratory.

This conclusion can be expanded to other CSI-related substances, including over 100 most common narcotics and explosives that are currently in BioTools’ forensic database. The database is provided with every RamTest-CSI™ instrument and is continuously expanding as new compounds of forensic interest are measured. In addition, this database is USER-UPDATABLE to enable easy customization of the instrument by a user for a specific application. Further, RamTest-CSI™ analyzer combines best-in-class analytical performance and relatively low price. Thus, RamTest-CSI™ can serve as a powerful and convenient tool for every officer while on duty, including but not limited to members of drug suppression teams, narcotics units HazMat units, customs and/or TSA officers.

In addition to all the benefits of the field analysis, RamTest-CSI™ can also strongly enhance analytical capabilities of the laboratories serving police municipalities. Specifically, the implementation of 532 nm handheld Raman will significantly reduce sample turn-around times due to fast analysis; ease or eliminate sample preparation (no sample digestion requires prior to analysis, both solids or liquids are OK for analysis); provide an option to analyze substances “as is” or directly through a large variety of glass or plastic containers including evidence bags, vials, syringes, jars, bottles, Petri dishes, and others. Moreover, the 532 nm handheld Raman is capable of initially complementing or later replacing many or all of the expensive lab-based analytical techniques, conventionally used for analysis and/or ID of controlled substances, with just one fast and highly sensitive method.

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<http://www.spectroscopyonline.com/recent-developments-handheld-raman-instrumentation-industry-pharma-police-and-homeland-security-532>

ADDITIONAL INFORMATION

Resources:

RamTest Flyer: http://www.btools.com/assets/ramtest_flyer_biotoolsv2.pdf

BioTools Products: <http://www.btools.com/products.html>

If you have any questions, please contact info@btools.com or call 561-625-0133

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