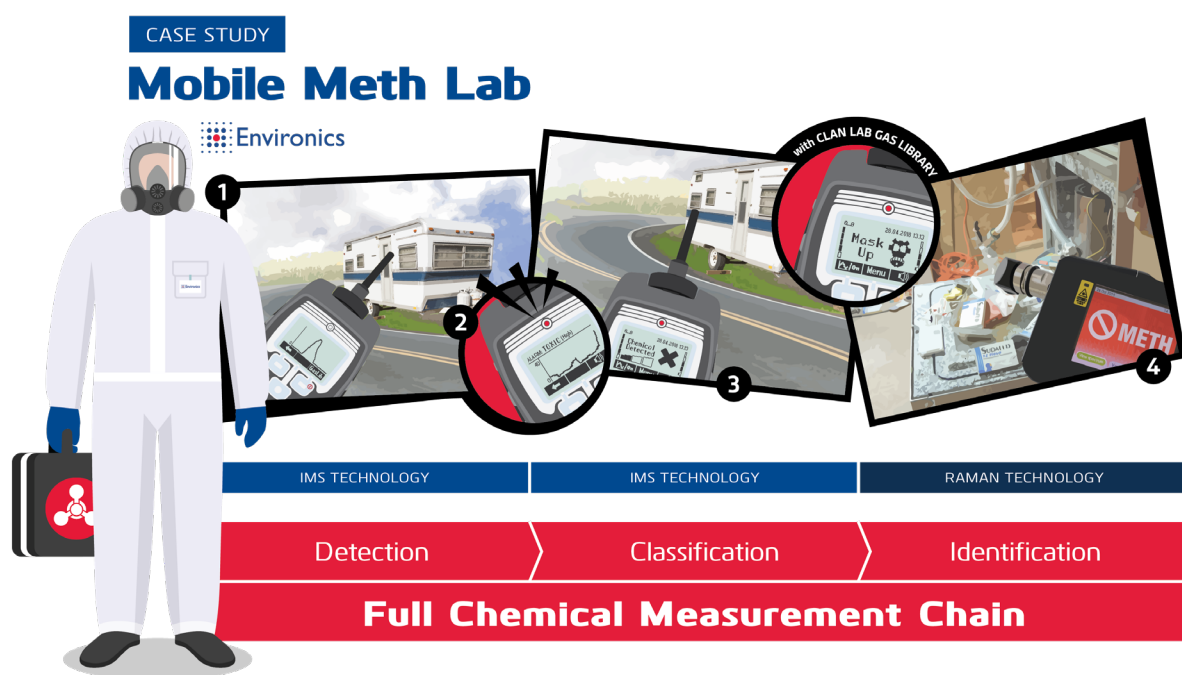


Dual Use of ChemPro100i and 100 ID: Methamphetamine Lab Case Study

This paper describes the analysis of unknown samples using clues obtained from two separate technologies – ChemPro100i Ion Mobility Spectrometer and 100 ID Raman Spectrometer. The benefits from dual use technology will be presented using a case study of challenges encountered in an illegal Methamphetamine lab.

The goal of this testing was to see if there would be any practical benefits for the Envionics Oy ChemPro100i handheld chemical detector and 100 ID being combined to detect and identify chemical components usually associated with clandestine laboratories. Results of the test indicate that almost all of the chemicals encountered and tested can be detected with Envionics Oy ChemPro100i and identified by the 100 ID. The measured levels of gases were concentrated, but also small in total. In an actual situation, the vapors would be in the open and thus likely more diluted. However, the volume of vapors encountered would be much higher.

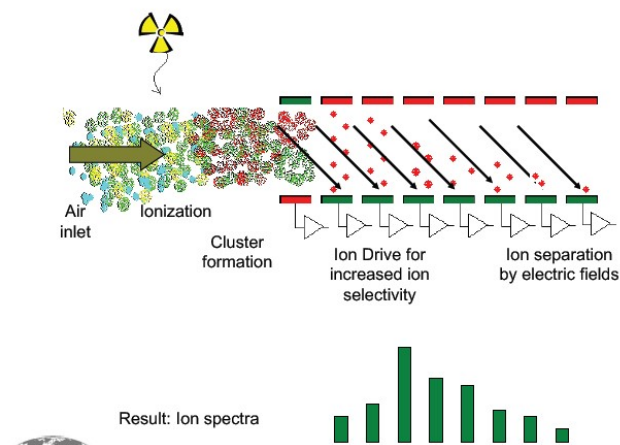
The first step would be to have the ChemPro100i locate the source of the chemical vapors, for example a specific room in a house or a vehicle. After identifying the target location and source, the 100 ID would be used to identify the liquids or solids found. This helps to determine and validate the kinds of operations being done at the site. Preliminary testing with these two detectors has shown the process to be viable. Methylamine vapor would likely be the easiest to detect by ChemPro100i from a long distance of the common chemicals usually found in a clandestine lab. This is due to high vapor pressure combined with chemical properties that trigger many of the sensors inside a ChemPro100i unit.



Introduction to Ion Mobility Spectrometry and the ChemPro100i

The ChemPro100i is a handheld gas and vapor detector for detection and classification of Toxic Industrial Chemicals (TICs) and Chemical Warfare Agents (CWAs). It is used daily in "routine" HazMat, and for the, less common, CWA incident. The unique trend display shows the chemical concentration with a rolling line graph

and audible “Geiger counter” style beep in real time. It allows a fast and easy way to read and hear contamination and a way to quickly localize the chemical. When significant concentrations of chemicals are found and classified, this information is shown on the “trend” display.



The ChemPro100i is based on open-loop Ion Mobility Spectrometry (IMS). In IMS, the sample is always a vapor. The device has a built-in pump for sample air, which is ionized and the resulting ion clusters are introduced into a series of electric fields. The ions travel different distances depending on their ion mobility and molecular size and are eventually captured by a set of electrodes and electric fields. An electrical current is produced into each field and each gas creates a signal pattern that is unique. The ChemPro100i has 11 different selectable gas libraries preloaded into the memory that are

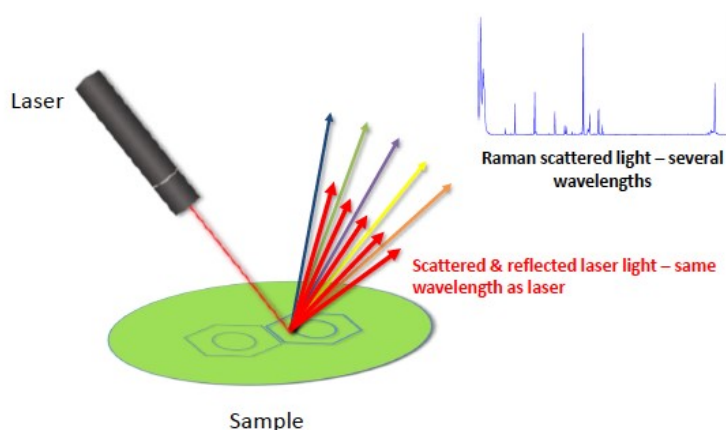
compared to the signal pattern obtained. The user can manually scroll between libraries. The measurement is performed in real time – typically, results come in seconds. The detector classifies different gases into groups. With some chemicals, more specific identification is possible.



The ChemPro100i is a “PID on Steroids”. With its 60,000-eV ionization energy it allows detection of hundreds of dangerous chemicals and then sorts the ions, instead of counting them like a PID. Therefore, the ChemPro100i 100i is ideally suitable to warn the presence of dangerous gases. The detection technology is based on orthogonal sensors with a 16 channel IMS and multiple other sensors.

Introduction to Raman Spectroscopy and the 100 ID

100 ID is an easy-to-use, handheld, Raman spectrometer that enables on-the-spot chemical identification and data sharing. In Raman spectroscopy, sample molecules start to vibrate due to laser illumination. The vibration generates a specific light pattern (spectrum) that can be seen as the chemical fingerprint of the sample. The fingerprint is analyzed by the 100 ID and then compared to spectra of known chemicals in the embedded database. When a spectrum match is found, it is displayed with a confidence level indication.



Raman spectroscopy is suitable for measuring inorganic and organic compounds in liquid or solid form. It does not detect gases or vapors. The sample can be analyzed directly through the wall of the sample container provided the container is clear.

The 100 ID is capable of analyzing for example

- Drugs
- Explosives
- Narcotics



Case Study – Illegal Methamphetamine laboratory

A typical illegal methamphetamine laboratory may contain various chemical vapor and liquid substances in different purities and phases of the manufacturing process. Analyzing these on site quickly and reliably is a challenge.

A clandestine drug lab is a health and safety nightmare for the first responder. The various chemicals are almost never labelled. The initial on-site team is normally followed by several hazardous materials technicians. These experts need to make sure the crime scene is safe and that dangerous items are properly handled before evidence technicians can fully process the scene.

The most common chemicals found in an amphetamine lab, in addition to controlled substances are:

- Formamide
- Formic acid
- Sulfuric acid
- Hydrochloric acid
- Sodium hydroxide
- Methylamine
- Various solvents.

A set of substances was tested with both ChemPro100i and 100 ID. ChemPro100i tests were headspace tests (sniff tests) straight from the bottle whereas 100 ID was used to measure either directly through the container or using the sample vials. The samples tested were: BMK (butyl methyl ketone), which is used as a raw material in both amphetamine and methamphetamine, and amphetamine bases of three different purity levels (54% base / 74% sulfide salt, 61% base / 84% sulfide salt and 70% base / 96% sulfide salt).

Dual use principles and system benefits

Adding Raman Spectroscopy to IMS in the field immediately delivers the advantage of analyzing also Narcotics and Explosives in addition to the current capability of IMS for Chemical vapors. Furthermore – the sample matrix now consists of volatile gases to liquids, powders and solids.

In a Methamphetamine laboratory, the ChemPro100i can be used to quickly screen the several containers and vials on site. The Responder may then select specific ones for further analysis by the 100 ID.

Both technologies have their advantages and disadvantages in detection and identification. IMS is suitable for gas detection and Raman for solids and liquids. Bringing the information from these two together helps a responder to reach an educated conclusion regarding sample content.

Each technology has its limitations:

Raman technology might have challenges in:

- Mixtures with very low concentration of target samples
- Layered samples
- Dark colored samples – possibility to an explosion in case of high solvent content on a dark sample
- Samples containing polar compounds (such as water, Hydrogen Fluoride, Ammonia, Hydrogen Chloride)

On the other hand – IMS can have problems with:

- Mixtures
- Very low volatility compounds (many narcotics for example – detection requires sample collection and heating; headspace analysis is rarely enough)
- High water content
- Extremely high concentrations – typically on a headspace analysis (can be solved by clever sampling technique)
- Substances that give only small amount of vapor signal such as Benzene.

A scenario where these limitations may happen: Dark colored substance with a high concentration of solvent (Methanol)

Raman might have difficulties in identifying the sample.

Therefore, it is always recommended to first perform a sniff test with the ChemPro100i- in case of a solvent the ChemPro100i will alarm "TIC Organic" with the TIC Classifier library. Trend display will give indication of the volatility. In this scenario, careful proceeding with the Raman is recommended perhaps by reducing the sample volume to a minimum.

Results

The 100 ID can measure and identify a wide range of chemicals and chemical mixtures. Of the measured substances, hydrochloride acid and water solution of sodium hydroxide were unable to be measured with Raman spectroscopy due to little or no signal. Additionally, methylamine gave a clear indication of methanol. Sodium hydroxide granules gave a low indication of sodium nitrate. On the other hand, of the 10 chemicals measured, 7 were identified correctly - even in mixtures.

The ability of ChemPro100i to detect vapors in air requires the compound in question to be such that it evaporates readily in ambient conditions, i.e. is volatile. Alcohols and solvents are easy to detect with the ChemPro100i 100i due to high vapor pressure. In addition to the chemical being in a vaporized form, the chemical properties of the compound determine which, if any, of the additional ChemPro100i sensors react to the compound.

About Us & ChemPro100i

ChemPro100i is a product of Environics Finland, fielded in more than 50 countries and widely used among Hazmat teams and First Responders in the US and Canada. Environics has been present in the US since 1988.

Michael Phillips
Environics USA President, CEO
+1 386 383 0386
[michael.phillips\(at\)environicsusa.com](mailto:michael.phillips(at)environicsusa.com)

1107 Wonder St. Ste. 103
Round Rock, TX 78681