Frequently Asked Questions (FAQ) about Raman spectroscopy: Applications

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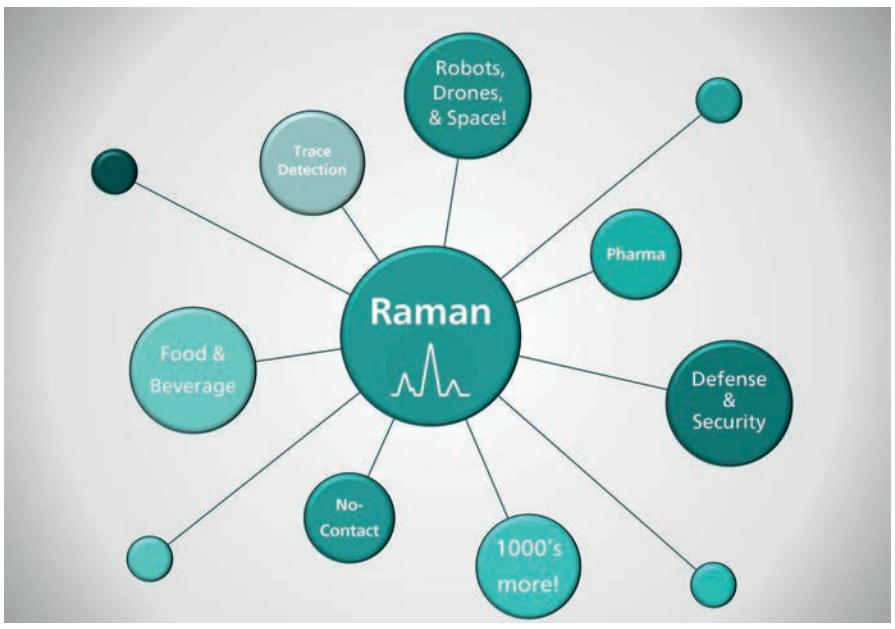
Raman spectroscopy is a ubiquitous tool that can be used for many different purposes. From robots to art, and from beer to outer space, Raman spectroscopy is applied to more and more fields to provide fast and reliable answers regarding the identity of unknowns and the verification of known substances. This overview aims to answer some frequently asked questions about the suitability of Raman spectroscopy for various applications.



1. What can Raman do that other techniques cannot?

Many analytical methods, traditionally laboratory-based, can be used for material identification. Raman is a tool that identifies substances by matching them against a library of known compounds and/or verifies materials through comparison within a model set of data.

What sets Raman apart is its unique sampling capabilities. At its most basic level, a Raman user can gather data from a sample directly in its native form, and sometimes in its original packaging, by simply pressing the sampling attachment against the material or outside of a container. The benefits of this are speed and ease, no sample contact or potential for contamination, and no sample preparation. Handheld systems permit the user to enjoy all of these advantages outside of a laboratory, anywhere sampling is required. Consider additional capabilities like remote acquisition, robot or drone or vehicle-mounting, and standoff sampling from a distance, and you realise how unique Raman applications can be. Site inspection, HazMat and CBRNE scenarios, space exploration, and illicit material detection are all possible without risking human safety.

2. How do specialised Raman techniques support unique applications?

Surface-enhanced Raman scattering (SERS) turns Raman into an excellent trace-detection technique. With SERS, it is possible to determine traces of pesticides in foods and to detect very small amounts of narcotics in complex street drug samples.

At Metrohm, SERS is even being proposed as a method for detecting narcotics in whole-blood samples. Other biomedical applications are discussed in our free on-demand webinar 'Biomedical Applications of Raman Spectroscopy'.

Metrohm specialises in a combination of Raman spectroscopy and electrochemistry (EC-Raman) that obtains information about the chemical processes including simultaneous structural and functional information in a single experiment. EC-Raman can monitor electrocatalytic reactions, energy storage devices, and corrosion processes in addition to characterisation of organic and inorganic compounds.

3. What can Raman spectroscopy offer for exciting and unusual applications?

Utilising Raman spectroscopy at a wavelength of 532 nm is ideal for the characterisation of carbon. Peak intensity, shape, and position reveal information about the internal crystallinity of the sample and can elucidate structural disorder.

Raman spectroscopy has many beneficial uses in the field of art conservation. The benefits of using Raman spectroscopy over other analytical techniques include the non-invasive, in-situ study of cultural heritage objects, fluorescence-reduction capability for identifying pigments and dyes, and standoff measurements for non-contact analysis of surfaces from up to several meters away.

4. How does Raman contribute to food and beverage analysis?

The number of ways that Raman spectroscopy can be used for food testing is surprisingly large, and there are multiple approaches available for success.

Identifying counterfeit beer	Colourful foods	Finding trace dangers in food
Raman is quite effective at discriminating between very similar samples. This is a useful trait when comparing major brands of lager or classifying different edible oils , for example. The main applications in this category are authentication of foods and raw material verification, which can be accomplished with both handheld and laboratory Raman systems.	Food and beverage applications have traditionally been a challenge for Raman spectroscopy due to fluorescence from organic substances. With XTR®, the novel fluorescence rejection technique for improved 785 nm Raman performance, this is no longer a concern. XTR supports ID of colourful compounds like beta carotene in carrots, tomatoes, and banana peels. It is also useful for the authentication of honey, a costly product that is often adulterated with cheaper sugar mixtures to gain more profit.	SERS is a powerful tool for the detection of trace dyes, additives, and a host of residues from pesticides, herbicides, and fungicides in foods and beverages. Metrohm offers a variety of easy-to-use SERS methods and materials that make it easy to protect consumer safety. • Free Application Notes for MISA can be found on the Metrohm website.

5. What's next for Raman spectroscopy at Metrohm?

To space…

While you are reading about applications for Raman spectroscopy, others are discovering the many ways that it fits into their research. With GLIMPSE (Geological Lunar In-Situ Mapper and Prospector for Surface Exploration), MIRA (Metrohm Instant Raman Analyser) could go to space.

To the skies…

Metrohm Schweiz has a new collaboration that uses a drone-mounted Raman system with a standoff accessory for automated detection of chemicals and explosives from meters away.

On land…

Remote surveillance of sensitive sites with robot-mounted Raman is possible with IBEX. IBEX is a quadrupedal robot (the Spot® robot from Boston Dynamics) equipped with a standoff Raman spectrometer (MIRA XTR DS) and a sensor pack which includes

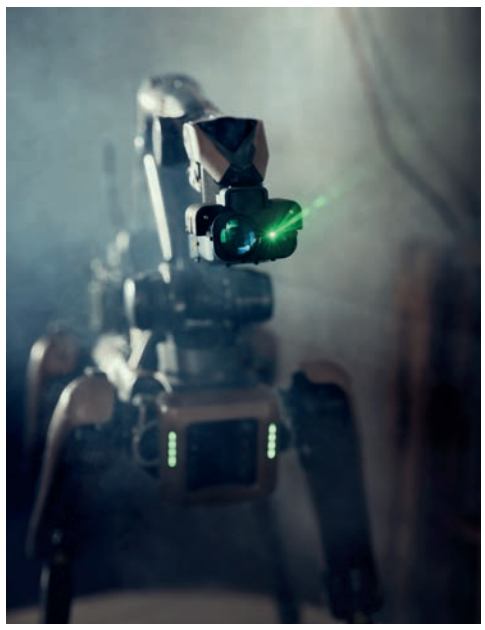
a chemical warfare agent (CWA) detector, radiological/nuclear detectors, and a combustible gas indicator. IBEX can make a full scene assessment quickly and safely to help first responders and law enforcement teams understand and mitigate threats from a distance.

6. What makes Raman so powerful for illicit and hazardous materials applications?

Raman spectroscopy is ideal for the identification of narcotics, potentially hazardous unknown chemicals, explosives, and chemical warfare agents. Operator safety is maximised with its ability to give no-contact results quickly and reliably at the scene. This is essential for applications involving illicit and hazardous materials as diverse as customs security, traffic stops, chemical spills, and surveillance of clandestine laboratories.

This is no accident - handheld Raman systems from Metrohm are designed for the rigorous specifications needed for these kinds of dangerous applications:

• Metrohm's handheld Raman instruments are rugged: resistant to



water and dust and certified to withstand shock and vibration.

- ID of hazardous materials is made safer with remote and delayed acquisition and instant hazard warnings.
- Resistive touchscreens and/or functional buttons enable use with gloves, even the ones on bulky Hazmat suits.
- The availability of multiple Raman wavelengths allows users to benefit from maximum sampling flexibility.
- Custom accessories (e.g., PowerPack for MIRA) support field-testing, even when it's an all-day job.

7. Which Raman applications and features stand out at Metrohm?

Flexibility is key for cutting-edge Raman solutions from Metrohm. Many of our Raman systems are capable of the following:

See-through Raman permits rapid material identification through opaque containers and packaging materials previously impenetrable by Raman spectroscopy, including plastic bottles and multi-layer paper.

This supports applications such as **incoming material ID**, postal service **package inspection**, and **detection of contraband** at border and customs stations.

Metrohm has revolutionised handheld Raman with patented **Orbital Raster Scanning (ORS™)** and the **Large Spot Adapter**, which are proprietary ways of overcoming low resolution, poor sensitivity, and sample degradation while still interrogating a large sample area.

These state-of-the-art technologies **improve analysis of mixtures**, like many common pharmaceutical formulations. Because the laser is dispersed over the sample, it is also ideal for the **interrogation of sensitive materials**, such as highly colored and volatile substances.

Finally, the ability to **suppress fluorescence** in the Raman spectrum is essential for both **qualitative and quantitative applications**, including fuels, polymers, and paints/dyes. Metrohm offers methods for fluorescence-suppression at the most-used Raman wavelengths.

Conclusion

Raman offerings from Metrohm are as diverse as the application possibilities. Handheld and laboratory Raman systems cover the full spectrum - trace detection, material verification, identification of unknown substances, all the way to quantitative analysis. No matter how it's used, Raman is a unique and wonderful form of spectroscopy.

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