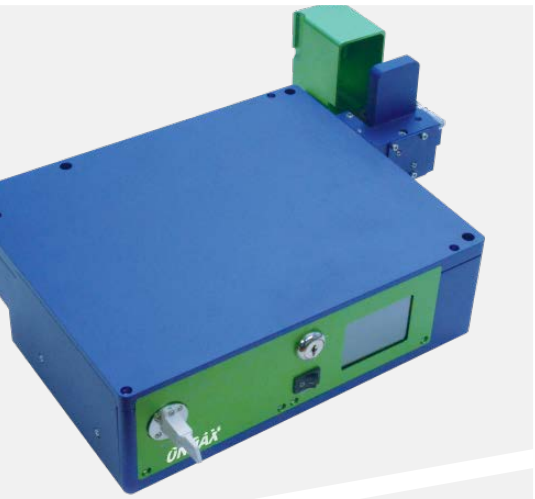
ONDAX

Advanced Solutions for Optical Measurements

THz-Raman®

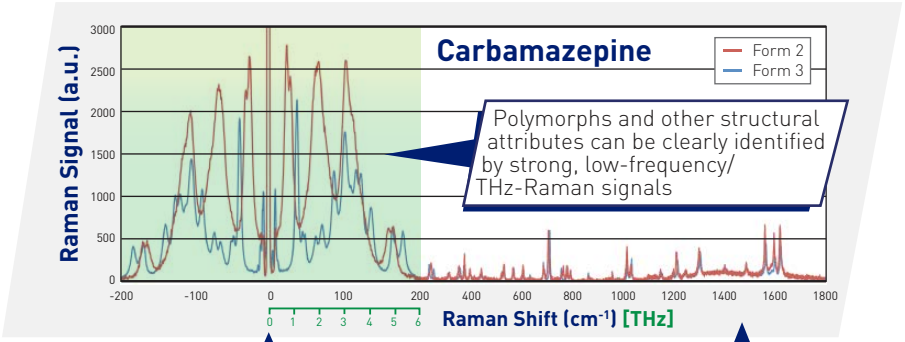
EXTENDING RAMAN INTO THE THz REGIME

DELIVERING BOTH CHEMICAL COMPOSITION AND STRUCTURAL INFORMATION IN A SINGLE MEASUREMENT



Structural Fingerprint
± 5 cm^{-1} to 200 cm^{-1}

Chemical Fingerprint
200 cm^{-1} to 2,000 cm^{-1}



NoiseBlock™

SureBlock™

SureLock™

CleanLine™

SIMULTANEOUS MEASUREMENT OF BOTH CHEMICAL AND STRUCTURAL PROPERTIES

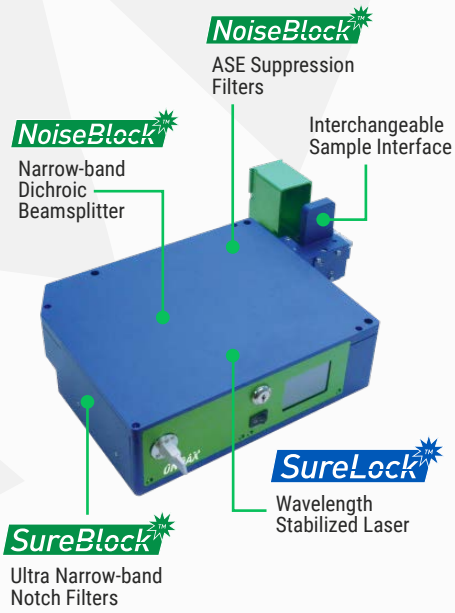
Ondax patented[1] **THz-Raman**® systems boost both the efficiency and reliability of materials characterization, in a single, real-time, non-destructive measurement. By unveiling the low-frequency (low wavenumber) range of the Raman spectrum, often referred to as a secondary "structural fingerprint," it is possible to directly observe and differentiate key structural properties of materials, while preserving the complete chemical fingerprint.

Key applications include:

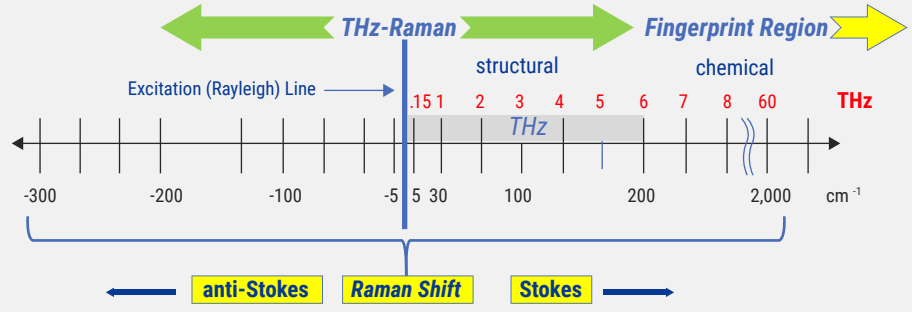
- > Differentiation and screening of polymorphs
- > Monitoring and quantifying degree of crystallinity
- > Characterizing and observing co-crystal formation
- > Process monitoring and analysis of chemical reactions
- > Characterizing thickness and orientation of few-layer nanomaterials
- > Structural characterization of polymers
- > Explosives detection and analysis, including determination of formulation methods
- > Advanced forensic analysis of materials

Ondax THz-Raman® Spectroscopy Modules are designed as integrated, ultra-compact, plug-and-play solutions to upgrade your existing Raman spectrometer. Comprising an ultra-narrowband ASE-free laser source, NoiseBlock™ 90/10 beamsplitter, and dual-stage SureBlock™ notch filters, the system delivers >OD9 Rayleigh attenuation and signal capture of both Stokes and anti-Stokes signals down to 5cm^{-1}. (Fig 2)

Fig. 1 Benchtop THz-Raman module



The **THz-Raman** region (±5cm^{-1} to 200cm^{-1}) corresponds to the THz-energy vibrations (150GHz-6THz) of inter-molecular/intra-molecular vibrations, including phonon modes, lattice modes, and/ rotational modes. These are often 5-10 times stronger than normal vibrational modes, significantly boosting signal strength. By capturing both Stokes and anti-Stokes signals, spectral features can be validated and the excitation wavelength (0cm^{-1}) can be precisely determined due to signal symmetry, eliminating the need for system re-calibration.



SureBlock™

Ultra-narrow-band Notch Filters & Filter Systems

Ondax patented[1] **SureBlock**™ ultra narrow-band notch filters are the enabling technology for highly selective wavelength applications like low frequency THz-Raman spectroscopy. With laser line attenuation of up to 99.9999% (optical density: OD 6) and a transition width of ~5 cm^{-1}, SureBlock™ filters are more than 10 times narrower than available thin-film notch filters. High transmittance on both sides of the notch enables both Stokes and anti-Stokes Raman spectra to be simultaneously observed. Designed to fit into standard 1" optical mounts or incorporated into any **XLF** or **TR Series** THz-Raman® platform, SureBlock™ notch filters never degrade and are designed for high efficiency and excellent transmission. Available in standard wavelengths of 488nm, 532nm, 633nm, 785nm, 808nm, 976nm and 1064nm, Custom wavelengths available upon request.

Fig. 2 THz-Raman spectra of Carbamazepine shows clearly differentiated polymorphic and hydrated forms[2]

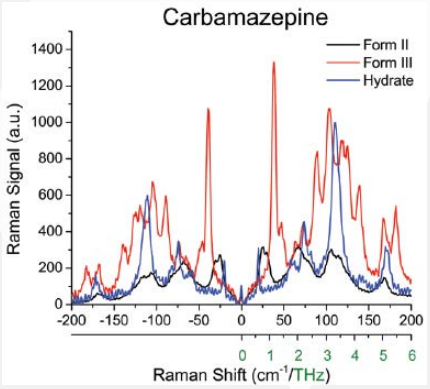
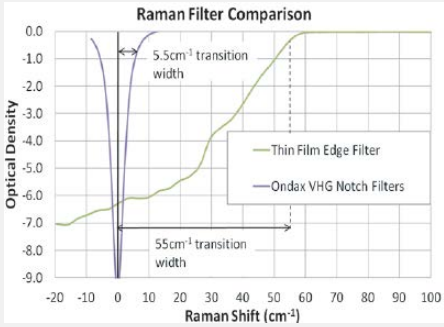


Fig. 3 SureBlock™ wavelength selectivity at 785nm compared to a thin-film edge filter shows 10x improvement in resolution



1 US Patents 7,986,407 and 8,184,285

2 Data taken using Ondax SureBlock™ notch filters and a single-stage spectrometer at 785 nm

SYSTEM CONFIGURATIONS

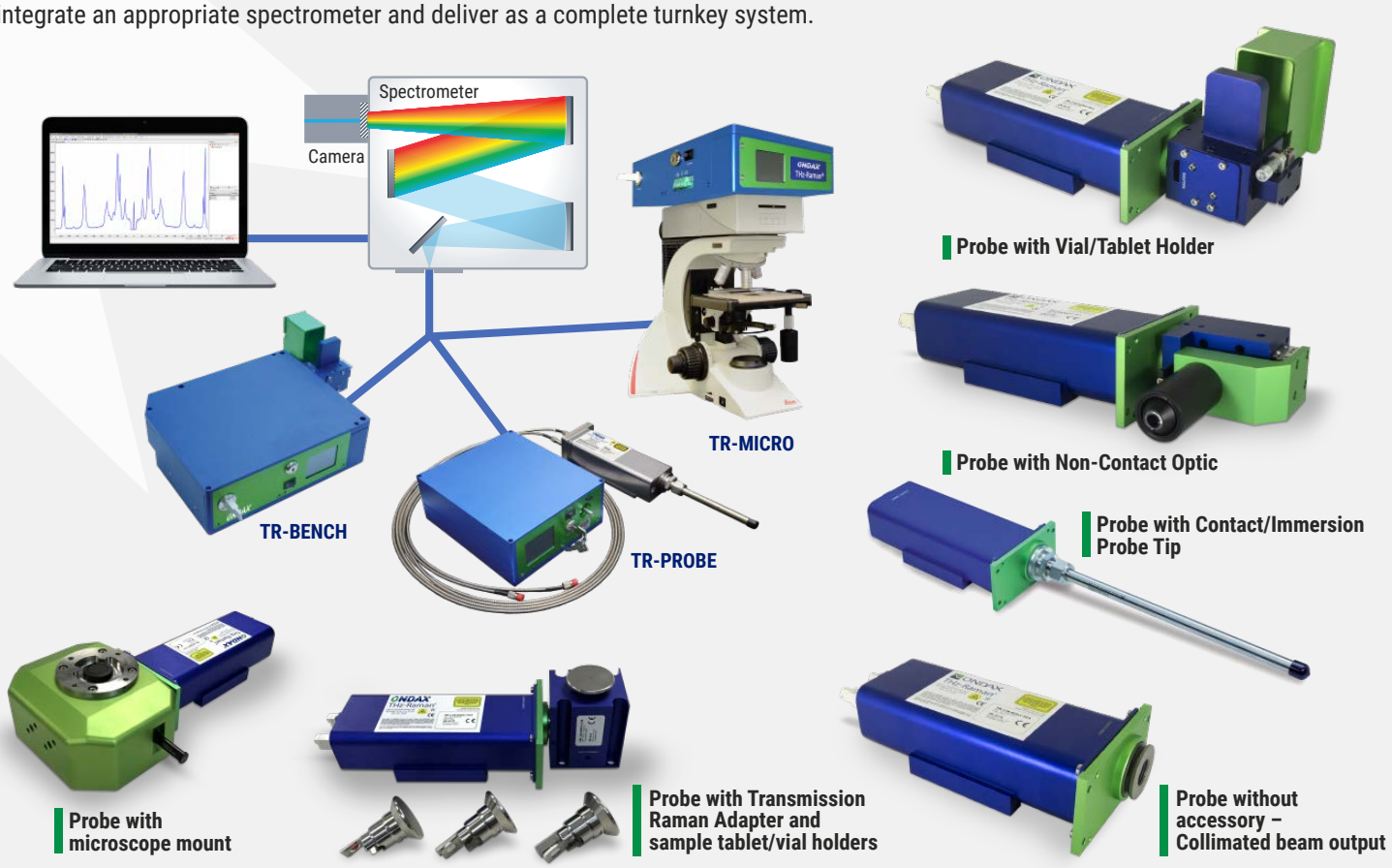
All **TR-Series** THz-Raman® modules are ultra-compact and simple to connect via fiber to almost any spectrometer or Raman system. A high-power, wavelength-stabilized, single-frequency laser source is precisely matched to the ultra narrow-band ASE, beamsplitter and notch filters to assure maximum throughput and exceptional attenuation (>OD 9) of the excitation source. Systems are available in 532nm, 633nm, 785nm, 808nm, 976nm and 1064nm excitation wavelengths.

The **TR-PROBE** is a compact, robust THz-Raman® probe that enables in-situ reaction or process monitoring, and can also be flexibly configured with a variety of sample interface accessories, including immersion or contact probe tips, a convenient vial/tablet holder, a Transmission Raman adapter, a microscope mount, or a steerable non-contact optic (see options below). A separate CleanLine™ laser provides ASE-free excitation via a multimode fiber, enabling the probe to operate in harsher environments where electrical connections are not permitted.

The **TR-BENCH** is configured for benchtop use and offers a similar range of interchangeable sample interface accessories holder for fast, easy measurements. The system also comes with a standard cage mounting plate (centered on the collimated output beam) to allow for customized collection optics or easy integration into a customized system. Options include circular polarization or a dual-port/dual polarization output for simultaneous measurement of both S and P polarizations.

The **TR-MICRO** mounts directly to a broad range of popular microscope platforms and micro-Raman systems, and can be easily switched in and out of the optical path. Linear polarization is standard, circular polarization is optional.

Ondax THz-Raman® modules are compatible with virtually any commercial Raman system or spectrometer, and Ondax can recommend or integrate an appropriate spectrometer and deliver as a complete turnkey system.



A variety of sample interface accessories enable the TR-PROBE and TR-BENCH to be easily configured to match a broad range of applications. Immersion or contact probe tips may be mounted with either a fixed SwageLok mount, or for longer probes that may need alignment, an adjustable tip/tilt probe mount. The Vial/Tablet Sample Holder incorporates an adjustable steering mirror, interchangeable focusing lens, and safety shutter, and the Steerable Non-contact Optic Mount allows for projection and steering of the output beam with precision alignment and interchangeable focusing optics, for applications requiring long-range collection paths. New accessories include a Transmission Raman adapter (Probe only) which s ideal for bulk sampling of tablets or vials, and a Microscope mount with in/out optical switching and beam steering adjustments.

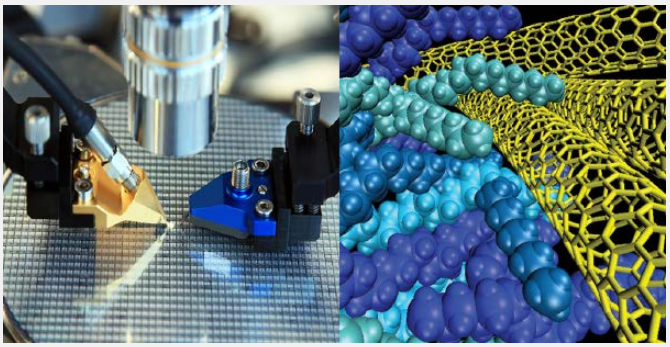
THz-Raman® ADDITIONAL APPLICATIONS

Pharmaceutical Applications

Key challenges for the pharmaceutical industry includes polymorph identification, reaction monitoring, raw material quality control, and counterfeit detection. THz-Raman® reveals "structural fingerprints" that can rapidly differentiate polymorphs, isomers, co-crystal, and other structural variations of substances and compounds.

Explosives Detection, Forensics and Source Attribution

THz-Raman® goes beyond chemical detection to reveal a "structural fingerprint" that can be attributed to specific ingredients, methods of manufacture, and storage/handling of many popular home-made explosive (HME) materials, revealing clues about how and where they were formulated.



Semiconductor and Nanomaterials

Graphene and carbon nanotubes are just two of the many nanomaterials that exhibit strong low-frequency signals. For Graphene, THz-Raman® analysis can determine the number of monolayers, and for carbon nanotubes, the diameter of the structure. Differences in structural characteristics and defects in crystals can also be detected.

Crystallization and Reaction Monitoring

Low-frequency THz-Raman® signals undergo clear, rapid shifts corresponding to changes in molecular structure, enabling highly sensitive, real-time monitoring of crystal form, phase, or structural transformations.

Industrial and Petrochemical

THz-Raman® delivers additional sensitivity and information about molecular structure to control processes, improve yields, and monitor crystallization or structural transformation during manufacturing.

Gas Sensing

Rotational modes of gases such as Oxygen provide signal intensities up to 10x those in the fingerprint region. Stokes/anti-Stokes ratios can also be used for remote sensing of temperatures in gases, plasmas, liquids and solids.

ONDAX
850 E. Duarte Rd. Monrovia, CA 91016
626.357.9600 (Tel)
626.513.7494 (Sales Fax)
www.ondax.com
www.THz-Raman.com