MicroReveal™ RAMAN

MONTANA INSTRUMENTS®
COLD SCIENCE MADE SIMPLE

Variable Temperature Raman Microscope for Revealing Quantum Phenomena

Princeton Instruments

KEY FEATURES:

- Explore temperature-dependent phase transitions, frequency shifts, and linewidth sharpening with precise sample temperature control
- Obtain spectra at user defined intervals through the entire range (4K - 525K). A full set can be obtained in about one hour
- Generate precise Raman maps with low thermal-mechanical drift
- Acquire a full material property profile with simultaneous temperature-dependent spectroscopic and electrical measurements
- Measure weakly emitting materials efficiently with the integrated high NA optics

Many interesting phenomena emerge at cryogenic temperatures, and often, additional or new information about a sample can be revealed with temperature-dependent measurements. This variable temperature Raman microscope system is optimized for high collection efficiency and throughput, offering an automated and controlled environment for characterizing materials with standard spectroscopic techniques.

Applications

Characterization of low-dimensional material properties, enabling work in:

- Quantum Information
- 2D Optoelectronics
- Bio-Sensing

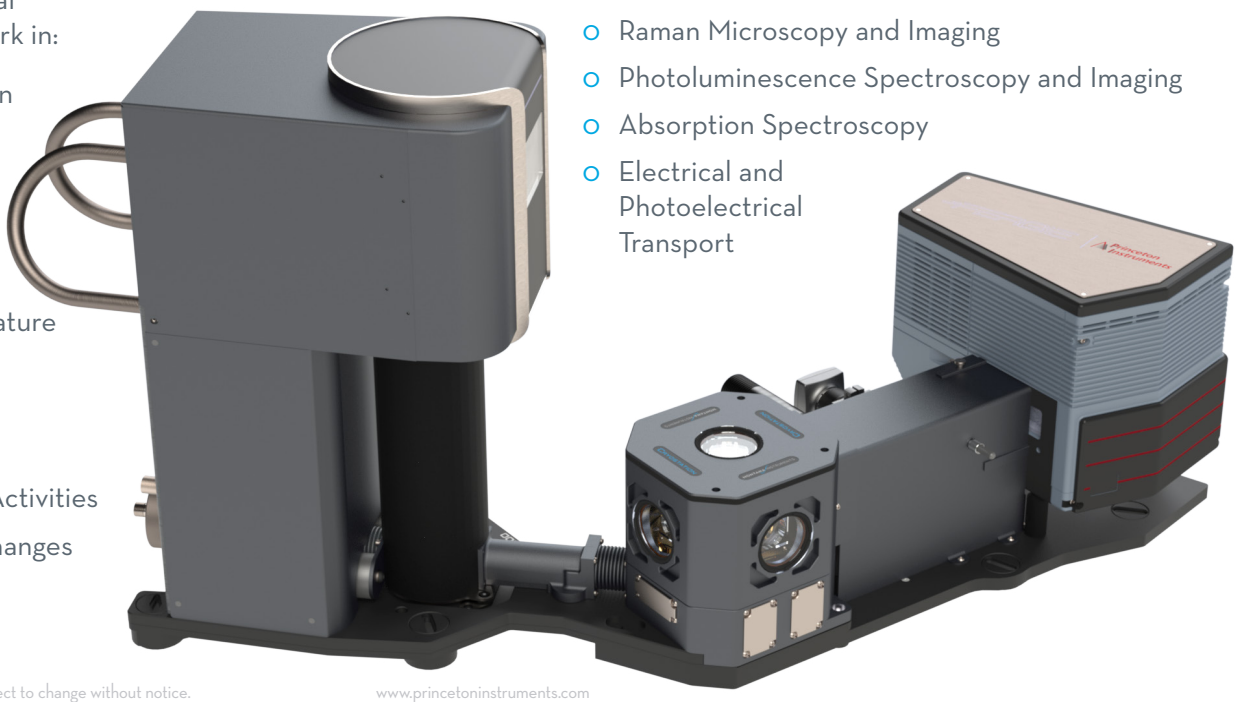
Observations

Precise sample temperature control from 4K - 525K, enabling the study of:

- Phase Transitions
- Molecular Thermal Activities
- Crystal Structure Changes

Measurement Techniques

- Raman Microscopy and Imaging
- Photoluminescence Spectroscopy and Imaging
- Absorption Spectroscopy
- Electrical and Photoelectrical Transport



Specifications and other information subject to change without notice.

www.princetoninstruments.com

Integration & Performance

Due to the low cross section for Raman scattering, optical throughput and detector sensitivity are critically important, particularly when performing 2D mapping or temperature dependent studies on low dimensional materials. Not only does aberration-free imaging improve signal-to-noise ratio and spectral resolution, it gives an unambiguous line-shape, which is important in situations where peak asymmetry is expected.

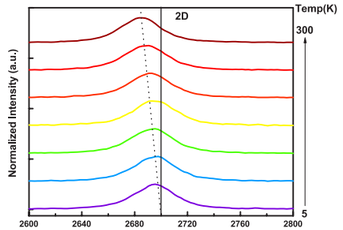


Figure 1: Raman shift of the 2D band on single layer graphene to lower energies as temperature increases from 5K to 300K (IsoPlane)

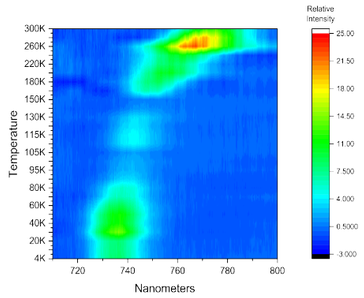


Figure 2: PL spectra of WSe_2 with 532nm excitation, 5s collection time (FERGIE)

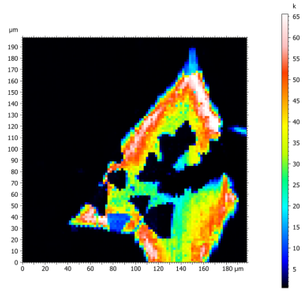
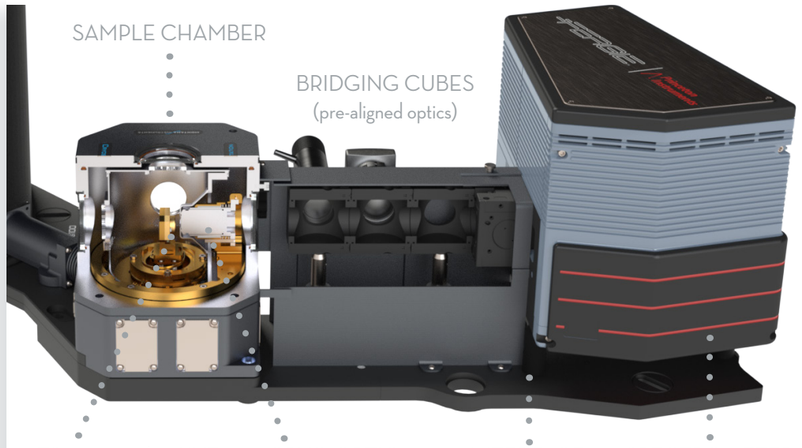
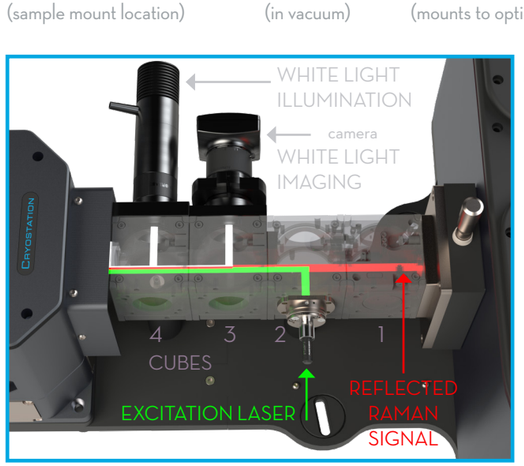


Figure 3: multilayered heterostructures with alternating layers of MoS_2-WS_2 on silicon stacked in a non-epitaxial arrangement
hyperspectral PL map at 150K (IsoPlane)





BRIDGING CUBES:
1) long-pass filter and pre-aligned adjustable lens
2) 90/10 beam splitter at 45° for incoming laser
3) 90/10 beam splitter at 45° for white light
4) 90/10 beam splitter at 45° for white light

VARIABLE TEMPERATURE

Cryostat System: Cryostation® s100

- Low cost, helium-free operation requires no cryogenic experience
- Fully-automated, push-button temperature control & readout
- Flexible tabletop mounting for straightforward setup & user access

Sample Mount & Temperature Control: ATSM™

- Low thermal mass sample stage equilibrates within seconds of reaching temperature setpoint, reducing the need for time-consuming drift-compensation adjustments

RAMAN MICROSCOPE

Optical Integration: Bridging Cubes

- High-precision, pre-aligned optical cubes provide direct coupling of free-space optics between the cryogenic sample space and spectrometer (excitation laser, witness camera, and reflected signal)

White Light Imaging: 3 MP Camera & HB LED with variable intensity

- Locate and focus on a feature of interest with simultaneous white light and laser spot imaging of the sample

Excitation: Single Mode Fiber Coupled DPSS Laser

- 532nm (785nm option for samples with fluorescence background)

Reflected Signal Collection: Cryo-Optic®

- Aberration-free high NA (0.75) imaging for characterization of low quantum efficiency materials

Spectrograph: FERGIE® or IsoPlane® SCT 320

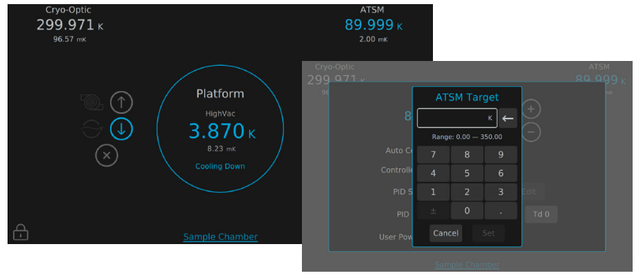
- FERGIE provides high sensitivity and low noise to address a wide range of spectroscopy applications
- IsoPlane offers exceptional image quality and spectral resolution to ensure maximum throughput and signal-to-noise performance

USER CONTROL

Measurement Throughput

- Access & exchange samples while maintaining alignment of all components by simply lifting off the cryogenic housing
- Input, monitor & change the sample temperature on a single touchscreen interface (shown right)
- Navigate across the sample & set mapping parameters (via integrated XYZ nanopositioners) directly within the LightField spectroscopy software to ensure accurate positioning & scanning control that is synchronized with spectral acquisition

TEMPERATURE READOUT SCREEN

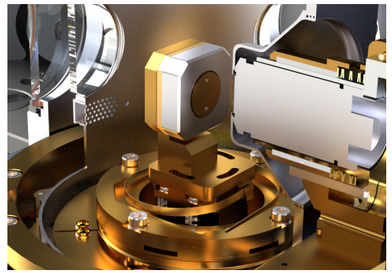


TEMPERATURE INPUT SCREEN

ADDITIONAL CAPABILITIES

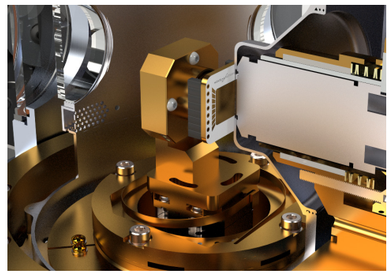
High Temperature (525K)

For samples with interesting transitions above 350K, reach temperatures up to 525K with the high-temp ATSM option.



Electrical Measurements

Consolidate workflows and reduce environmental variability between experiments by running temperature-dependent electrical and Raman measurements simultaneously in the same setup. Immediately verify interesting phenomena by obtaining a full set of spectroscopic and electrical data at each temperature setpoint. The CryoChip16 mounts directly to the ATSM, providing 16 DC signal lines to the sample.



Polarization

Easily swap the Raman filter cube (#2) with a polarization cube to extract the orientation of molecules in ordered materials, such as crystals, 2D materials, and thin films.

Specifications

Last Updated: August 6, 2019

	Full System
Temperature Range	4 K - 350 K (525 K option)
Objective-Sample Displacement across 4.2 – 350 K	< 20 µm along optical axis < 32 µm in focal plane
Stabilization Time*	~30 seconds w/ ATSM for 50K temperature change (over full temp range)
Sample Drift	< 1 µm / degree over full temperature range < 100 nm peak to peak during stable platform temperature conditions
Raman Excitation Wavelength	532 nm or 785 nm +other wavelengths available upon request
Raman Spot Size	380 nm
Field of View	> 30 µm
Fluorescence Source (optional)	Quartz Tungsten Halogen
Max Sample Size	10 x 10 x 2.5 mm (10 grams) +larger samples can be accommodated on request
Nanopositioner Travel Range (XYZ)	5 x 5 x 5 mm

To learn more about the MicroReveal technology -

Read the Technical Guide:
Optical Characterization of Low-Dimensional Materials
www.montanainstruments.com/help/TG101

To learn more about the experimental setup and review additional sample data -

Explore the Application Notes:
/Applications/Raman

To learn how the MicroReveal solution can be used to enhance your research -

Submit Your Sample to the Applications Lab for a Free Preliminary Analysis:
/Applications/Applications-Lab

	FERGIE†	IsoPlane SCT320†
Focal length	80.8 mm	320 mm
Aperture ratio	f/4	f/4.6
Wavenumber Resolution	3 cm^{-1}	0.8 cm^{-1}
Usable wavelength range	400 - 1100 nm with VIS-NIR option 200 - 1100 nm with UV-NIR option	190 nm to mid-IR with available mirror coatings, gratings, and detectors
Grating mount / size	Interchangeable, rotatable single-grating turret	Interchangeable triple-grating turrets with on-axis grating rotation: 68 x 68 mm gratings
Astigmatism/coma aberration	Zero aberration at all wavelengths, grating angles over entire focal plane	Zero (0) at all wavelengths
Spatial resolution (MTF)	38.5 line pairs/mm @ 50% contrast over entire focal plane (Nyquist limited)	≥15 line pairs/mm @ 50% modulation, measured at focal plane center ≥ 8 line pairs/mm @ 50% modulation, measured over 27 x 8 mm focal plane
Slits	10, 25, 50, 100, 150, 200, 300, 500 µm; 3.3 mm tall Interchangeable, laser-cut slits	Standard manual (10 µm – 3 mm) Optional motorized (10 µm – 3 mm and 10 µm – 12 mm versions)
Wavelength accuracy*	0.26 nm | With IntelliCal®: 0.05 nm	Mechanical: ± 0.2 nm | With IntelliCal®: ± 0.01 nm
Wavelength repeatability*	0.13 nm | With IntelliCal®: 0.015 nm	Mechanical: ± 0.015 nm | With IntelliCal®: ± 0.0015 nm

†Third party add-on integration: Configuration may affect system's typical system performance.
*with 1200 groove/mm grating @ 436 nm

Please refer to www.princetoninstruments.com for more detailed spectrometer specifications.