BRUKER

Tip in Feedback

Tip Retracted

AFM-Raman Solutions

● The Highest Performance AFM-Raman Systems

Innovation with Integrity

Leading AFM-Raman Technology

Aided by proprietary Bruker technology, atomic force microscopy has advanced past providing just nanoscale topographical data to the quantitative characterization of electrical, thermal, and mechanical information of sample surfaces. Similarly, Raman spectroscopy has emerged as a direct, label-free nondestructive probe of chemistry that augments the infrared approach to vibrational spectroscopy with higher resolution as well as the ability to interrogate nonpolar bonds and in situ systems in aqueous solutions. The advances in AFM and spectroscopy techniques are quite complementary to each other, not only because different information can be obtained from each technique, but also because the data acquired are interrelated in terms of spatial resolution. Bruker has combined the most advanced AFM and Raman techniques into powerful, seamlessly integrated research solutions.
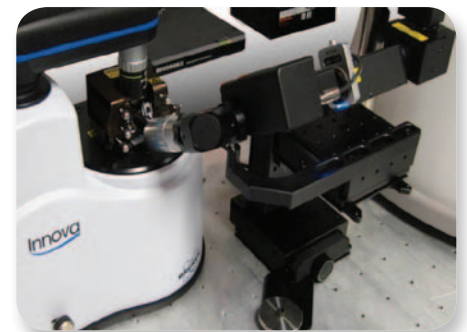
Bruker's wide range of optimized AFM-Raman configurations includes IRIS (Integrated AFM-Raman Imaging System) models that enable the emerging technique of tip-enhanced Raman spectroscopy (TERS), as well as AFM-Raman dedicated colocalized systems that integrate the highest performance, large-sample atomic force microscopy with uncompromised confocal micro-Raman spectroscopy.

Innova-IRIS TERS AFM-Raman system for materials science.

The Bruker IRIS models are proven TERS systems, whereby the AFM tip becomes the light source and delivers the Raman chemical information at a significantly smaller spatial scale. The Innova-IRIS is best for opaque samples, and the Catalyst-IRIS is designed specifically for transparent samples. The Dimension Icon® AFM-Raman system, on the other hand, is a new milestone in colocalized surface characterization. This system combines advanced confocal μ-Raman imaging with Bruker's proprietary ScanAsyst® ease of use and PeakForce QNM® quantitative nanomechanical mapping capability.

Catalyst-IRIS AFM-Raman system for biology and transparent samples. (Image courtesy of Aleksander Balter, Physics Department, UMK, Torun, Poland.)

Bruker's AFM-Raman solutions provide:

- Most complete TERS solution with Bruker-exclusive high-contrast IRIS TERS probes

- Highest performance, most complete AFM capabilities

- TERS-proven AFM-Raman integration

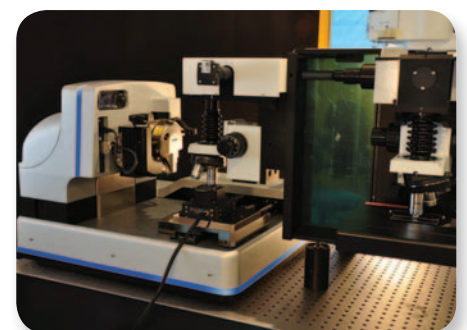- True nanoscale spectroscopy targeted to your application

Dimension Icon colocalized AFM-Raman system for correlated property imaging.

Colocalized AFM-Raman Solution
Dimension Icon-Raman with PeakForce QNM

The Dimension Icon AFM utilizes an open-access platform, large- or multiple-sample holders, and numerous ease-of-use features to deliver uncompromised performance, robustness, and flexibility at scales previously only possible with extensively customized systems. With the introduction of integrated Raman spectroscopy capability, the Icon again sets a new standard in high-performance surface characterization, enabling colocalized measurements with unsurpassed efficiency and ease.

The Icon-Raman's full complement of techniques, advanced features and µ-Raman capabilities perfectly address the needs of researchers investigating the mechanisms that composition or crystalline structure have on relevant material properties. The configuration enables the full complement of Icon upgrades, AFM modes, and ease-of-use features, including Bruker-exclusive ScanAsyst. Bruker's proprietary PeakForce QNM instantly reveals the distinct mechanical signature of a given polymer phase, thus complementing the Raman map and effectively providing higher resolution chemical information.

Dimension Icon-Raman in AFM measurement position. Here acquiring quantitative nanomechanical data on a polymer blend.
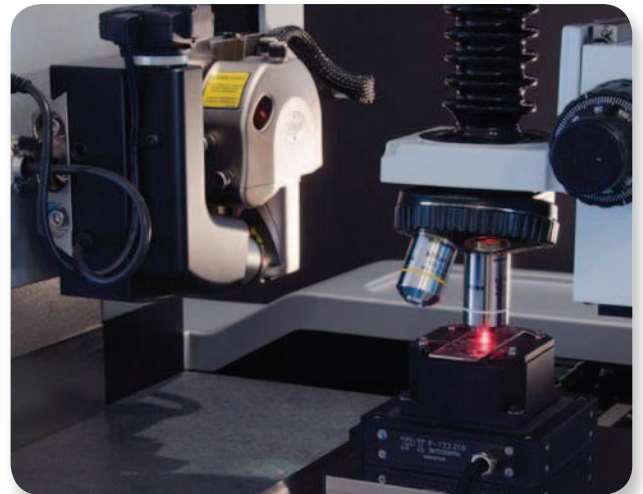

PeakForce QNM modulus image of a polystyrene/polypropylene structure (left), and Raman map of the same area (right, polystyrene in green, polypropylen in red). Variations in material properties are seen to correspond with different chemical compositions, allowing the quantitative nanomechanical information in the modulus image to serve effectively as a higher resolution chemical map.

Dimension Icon-Raman in Raman measurement position. Here acquiring a correlated Raman chemical map of the same polymer blend.

Dimension Icon-Raman Key Features

■ Fully integrated system delivers convenient correlation of advanced AFM data with information on chemical composition or crystallographic structure

■ High-resolution X-Y stage permits fast and accurate positioning between the AFM and Raman instrument

■ Full range of AFM capabilities provides more features than any other system

■ PeakForce QNM enables quantitative nanoscale mechanical property mapping

■ Wide-open access to tip and sample accommodates a large variety of standard and customized experiments

■ ScanAsyst enables dramatically more productive imaging with fully automatic parameter optimization, guaranteeing best results on the most delicate samples

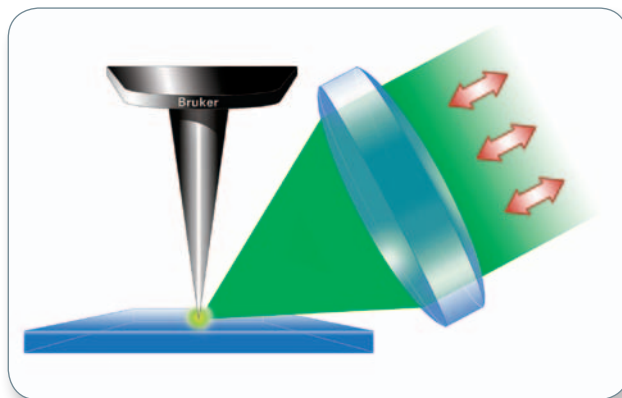# TERS System for Material Science
Innova-IRIS with IRIS TERS Probes

To combine AFM and Raman spectroscopy techniques successfully for use on opaque samples, or to be able to explore the full capabilities of TERS, an AFM platform must fulfill a set of fundamental requirements. First, optical access to the tip-sample junction is needed, maximizing light capture and far-field to near-field coupling while fully accounting for tip-shadowing and polarization effects. Second, the optical "hot-spot" alignment must be retained during scanning (i.e., a stationary tip system).
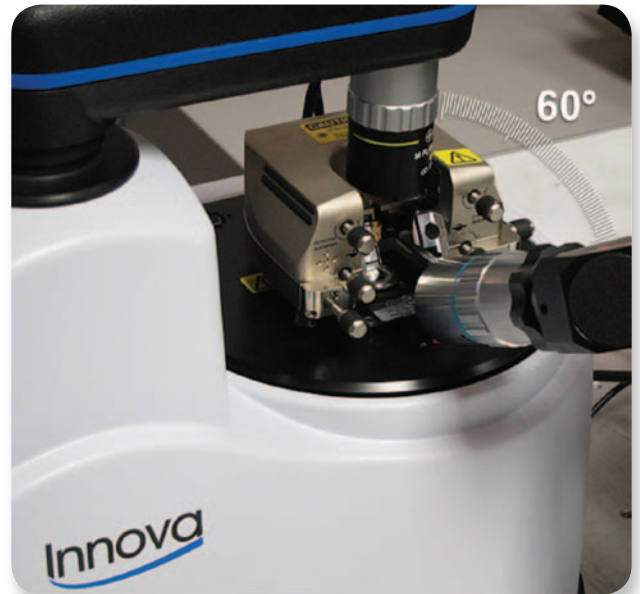
Innova-IRIS is designed from the ground up to fulfill these requirements. The publication record proves that a high numerical aperture and off-axis access from the front side of the probe at angles of 50-70 degrees from the tip-axis is the ideal optical setup. The unique open head geometry of the Innova-IRIS provides exactly this optimized optical geometry and alignment for best TERS sensitivity. In addition, the Innova-IRIS provides:

Optimized TERS configuration on Innova-IRIS.

■ **Easiest to use AFM for spectroscopy in nanostructured materials**

– Ergonomic hardware and streamlined software with integrated setup diagnostics deliver instant research quality results

– Experiment selector distills decades of knowledge into preconfigured settings, mitigating the complexity of traditional TERS setups

■ **Highest performance, most complete AFM capabilities in the world**

– Fully featured suite of advanced topographic, electrical, mechanical, and thermal AFM capabilities enables correlated property mapping

– System design for noise and drift elimination enables high-resolution imaging and long Raman integration times

■ **True nanoscale spectroscopy targeted to your application**

– Modular accessories tailor system to targeted applications

– Optimized optical access enables capture of weak Raman signals for nanoscale chemical mapping, even on challenging samples

■ **Most Complete TERS Solution**

– Innova-IRIS is compatible with Bruker's new high-contrast IRIS TERS probes, providing a complete TERS solution with highest sensitivity and spatial resolution

Schematic view of ideal optical configuration for TERS on opaque samples.
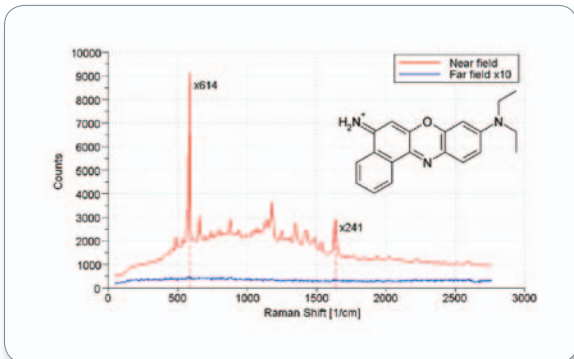
An Optimized Solution

The Innova-IRIS provides exceptionally easy setup and use, even with the full AFM-Raman integration in place. The system also exhibits the stringent performance required for both advanced atomic force microscopy and Raman spectroscopy, while preserving the tip to enable tip-scattering optical techniques. Modular integration software ideally coordinates the actions of the Innova AFM and spectrometer to allow combined experiments without technique interference.
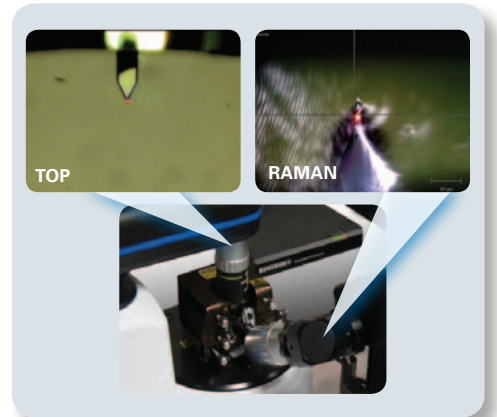
At the same time, the hardware and software of the Innova-IRIS system preserve the full power and flexibility of both AFM and spectrometer, providing the most complete characterization possible. Combining Raman spectroscopy with AFM-based nanoscale electrical, mechanical, thermal characterization on the same sample is fast, simple, and effective.

Proven TERS Systems

To create a TERS AFM-Raman spectroscopy system for opaque samples, combine Innova-IRIS with a leading Raman system. However you tailor your system, your application will benefit from the best tip preservation and lowest drift, guaranteeing that alignment is preserved even over the optical integration times necessary to interrogate weak Raman scatterers.
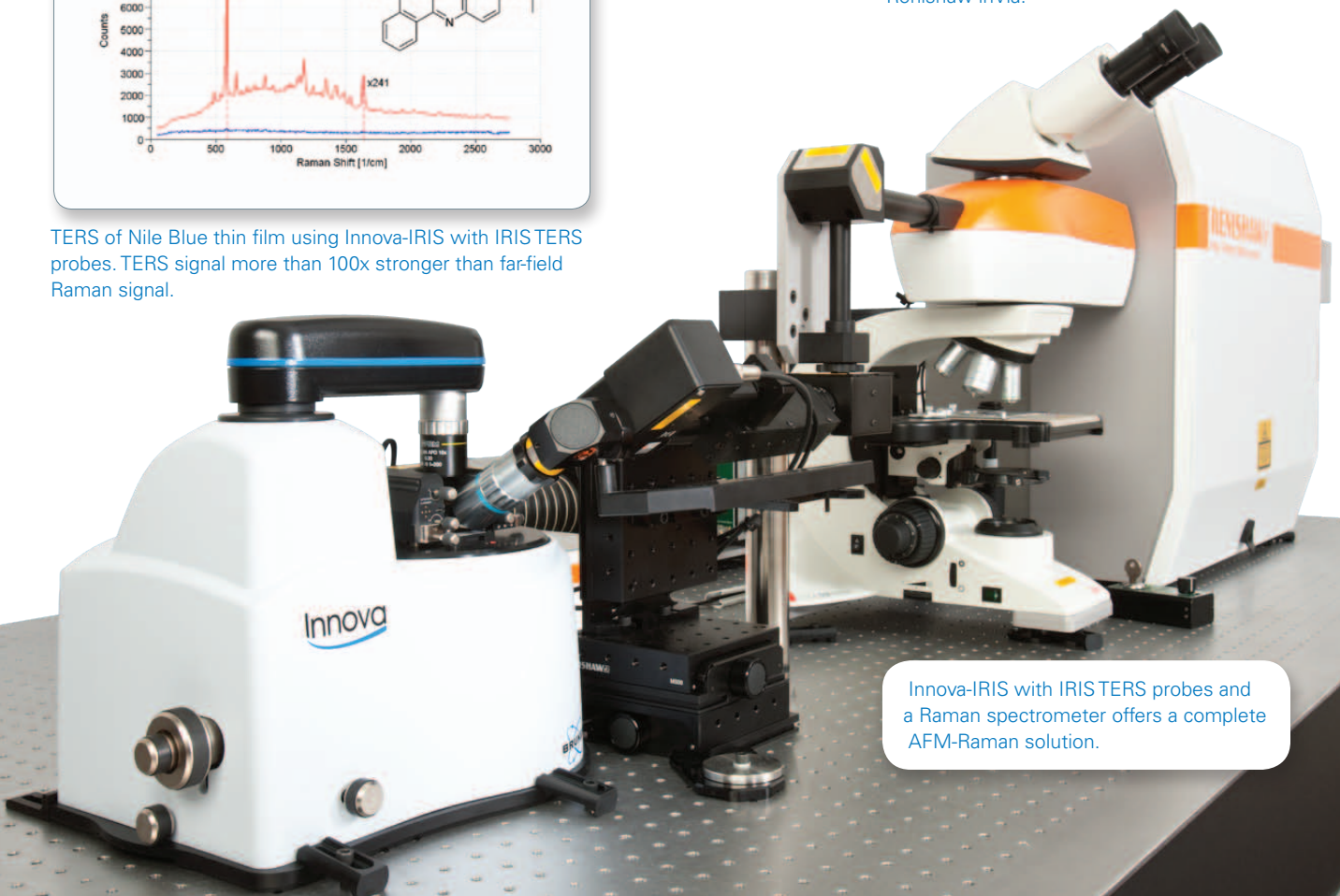

TOP / RAMAN

Simultaneous optical views enabling TERS alignment.
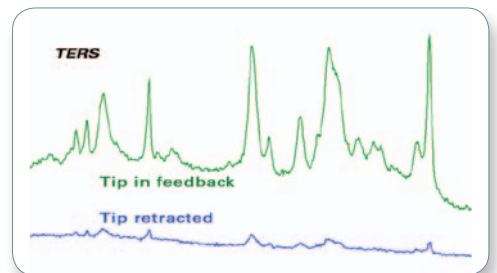
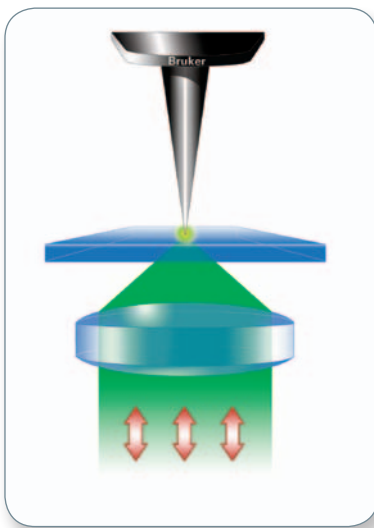TERS spectra of malachite green on gold, acquired with Innova-IRIS combined with Renishaw inVia.

TERS of Nile Blue thin film using Innova-IRIS with IRIS TERS probes. TERS signal more than 100x stronger than far-field Raman signal.

Innova-IRIS with IRIS TERS probes and a Raman spectrometer offers a complete AFM-Raman solution.

TERS System for Biology
Catalyst-IRIS Life Science AFM

The creation of integrated Raman and AFM capabilities for transparent samples requires a design that allows the AFM to function seamlessly as an integral part of an inverted optical microscope. This opens the door to the full power of optical spectroscopy. Enabling TERS adds the fundamental requirement of retaining tip-sample alignment, and thus scanning the sample. Finally, a well-designed system addresses compatibility with samples and their carriers.

The innovative open head of the BioScope Catalyst-IRIS accomplishes all of these requirements, allowing unmatched and virtually unrestricted optical and physical access from below and above the sample to maximize objective and condenser access. Designed entirely for operation on top of an inverted microscope, the Catalyst AFM exhibits the force control and stability required to preserve tip and alignment in biological, combined-setup environments. The system is built from the ground up around a sample scanning geometry to retain alignment between tip and optics during imaging, which provides uncompromised performance for advanced applications such as TERS.

Schematic view of ideal optical configuration for TERS on transparent samples.

Catalyst-IRIS provides:

■ Easiest to use AFM for spectroscopy in life sciences

– ScanAsyst makes in situ liquid imaging dramatically easier while retaining best force control for the most delicate samples

– Experiment selector distills decades of knowledge into preconfigured settings, mitigating the complexity of traditional TERS setups

■ Highest performance, most complete AFM capabilities in the world

– Exclusive PeakForce QNM imaging mode uniquely provides highest resolution mechanical property mapping

– System design for noise and drift elimination enables high- resolution imaging and long Raman integration times

■ Best TERS AFM-Raman system integration available

– Modular system integration interface provides tools for most effective setup optimization, real-time control, and data acquisition

– Flexible system architecture offers the widest compatibility with leading Raman microscopy suppliers
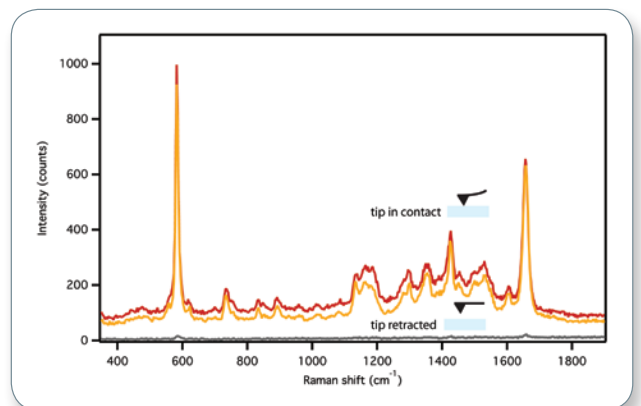
TERS of Cresyl Blue using Catalyst-IRIS showing contrast factor of 99.532nm excitation at 64uW. (Data courtesy of L. Opilik, C. Blum, T. Schmid, and R. Zenobi.)

Complete Catalyst-IRIS system, including AFM, inverted optical microscope and Raman spectrometer. (Image courtesy of Aleksander Balter, Physics Department, UMK, Torun, Poland.)

Optimized For Life Sciences

In addition to all these features, the Catalyst-IRIS supports a number of accessories to provide the complete solution for your biological samples:

- Perfusing Stage Incubator enables researchers to maintain ideal cell culture conditions for long- duration live cell studies

- Proprietary MIRO (Microscope Image Registration and Overlay) software utilizes optical images to guide AFM imaging and force measurements to targeted regions of interest, accurately registering optical and AFM images in real time, even when there are no obvious common features

- Exclusive ScanAsyst automatically adjusts scan parameters, such as setpoint, feedback gains, and scan rate, to make Bio-AFM imaging dramatically easier, even in fluids

Tailored Systems

Combine the Catalyst-IRIS with your choice of inverted optical microscope and leading Raman system to create the most integrated AFM-spectroscopy system optimized for your application. However you tailor your system, you will benefit from the best tip and sample preservation pushing the frontier to more fragile samples with smaller Raman scattering cross sections.
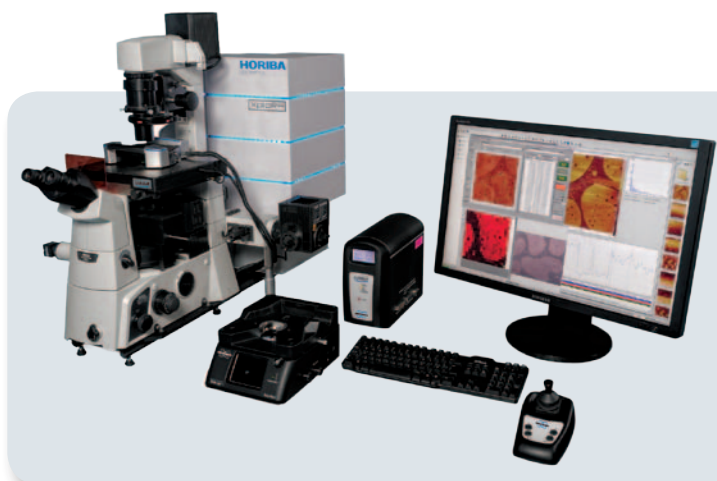
Catalyst-IRIS TERS AFM-Raman system for biology and transparent samples.

Catalyst head with perfusion accessory for long-term live cell studies.
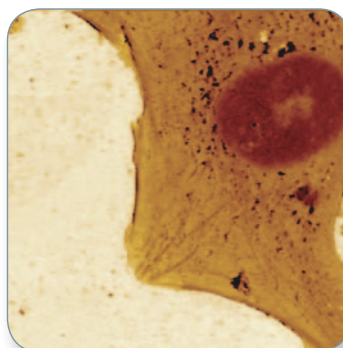
In situ nanomechanical map of fixed MDCK cell in PBS buffer acquired using Catalyst with ScanAsyst and PeakForce QNM.
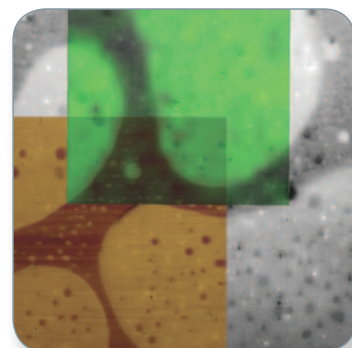

Overlaid AFM ScanAsyst image (brown), Raman chemical map (green) and optical view (grey) of a polymer blend containing polystyrene and low-density polyethylene. (Raman data courtesy of J. Schreiber, Horiba.)

AFM-Raman Configurations

System	Key Features	Applications
Innova-IRIS with Renishaw inVia or Horiba LabRAM	AFM-Raman system for TERS and material science research applications Bruker exclusive, high-contrast IRIS TERS probes	Materials research, nanoparticles, graphene
BioScope Catalyst-IRIS with Renishaw inVia or Horiba XploRA INV	Inverted optical microscope configuration for transparent samples and life science applications	Life science applications from single molecule DNA and protein investigations-to cell biology
Dimension Icon with Renishaw inVia or Horiba LabRAM	High-performance, research-grade instrument Most advanced capabilities using PeakForce QNM, and ScanAsyst	Materials research and development, polymers, composites, semiconductors

An AFM-Raman System Designed Specifically for Your Research

Bruker's IRIS solutions integrate the highest atomic force microscopy performance seamlessly with micro-Raman systems to address your specific nanoscale spectroscopy application needs. Bruker's Icon-Raman systems provide an enormous wealth of information, from mechanical to electrical properties to chemical ID or structural information, taking the quality of material characterization to a new level.
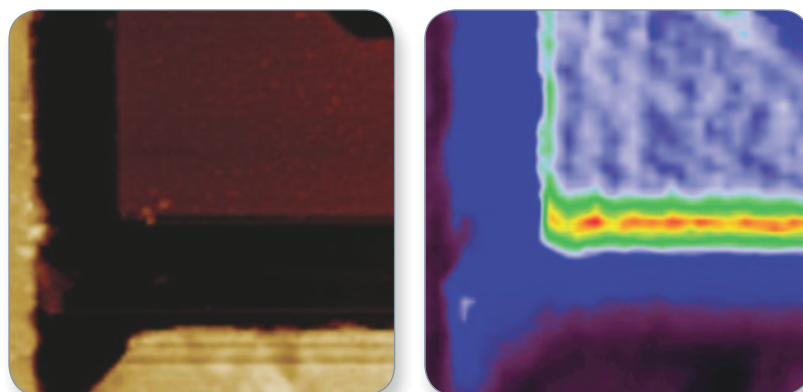
Correlated AFM topography (left), and Raman chemical map (right) of Silicon semiconductor sample acquired with Innova-IRIS and inVia. Image size 35µm, Raman excitation at 532nm.

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Cover images: Spectra overlaid on the illustration show TERS of Malachite Green on gold acquired with Innova-IRIS.