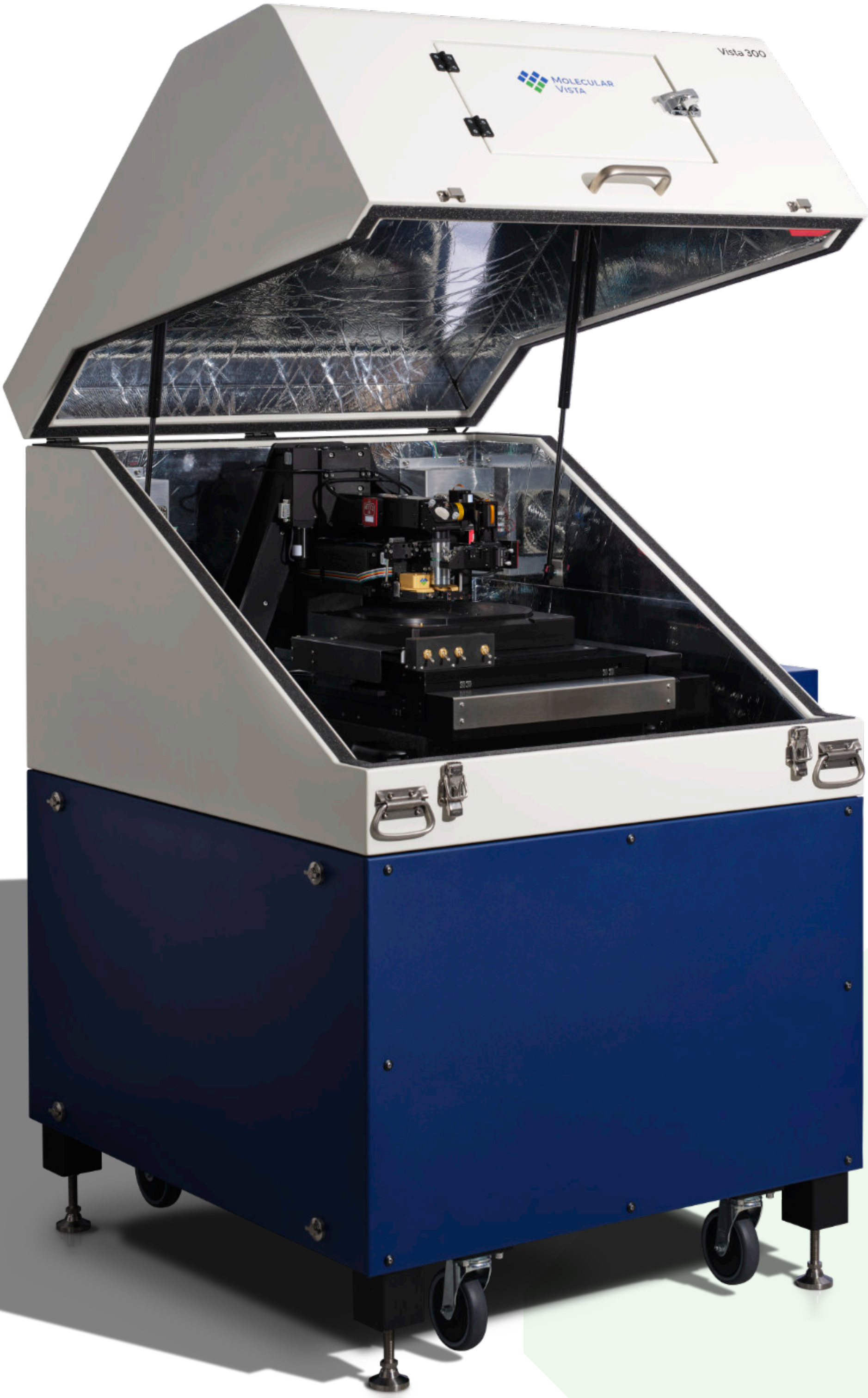
MOLECULAR VISTA



Vista 300

IR-PIFM • PIF-IR • AFM-IR

Nano-chemical metrology for R&D and failure analysis

Vista 300: industry leading usability

Exceptional AFM performance

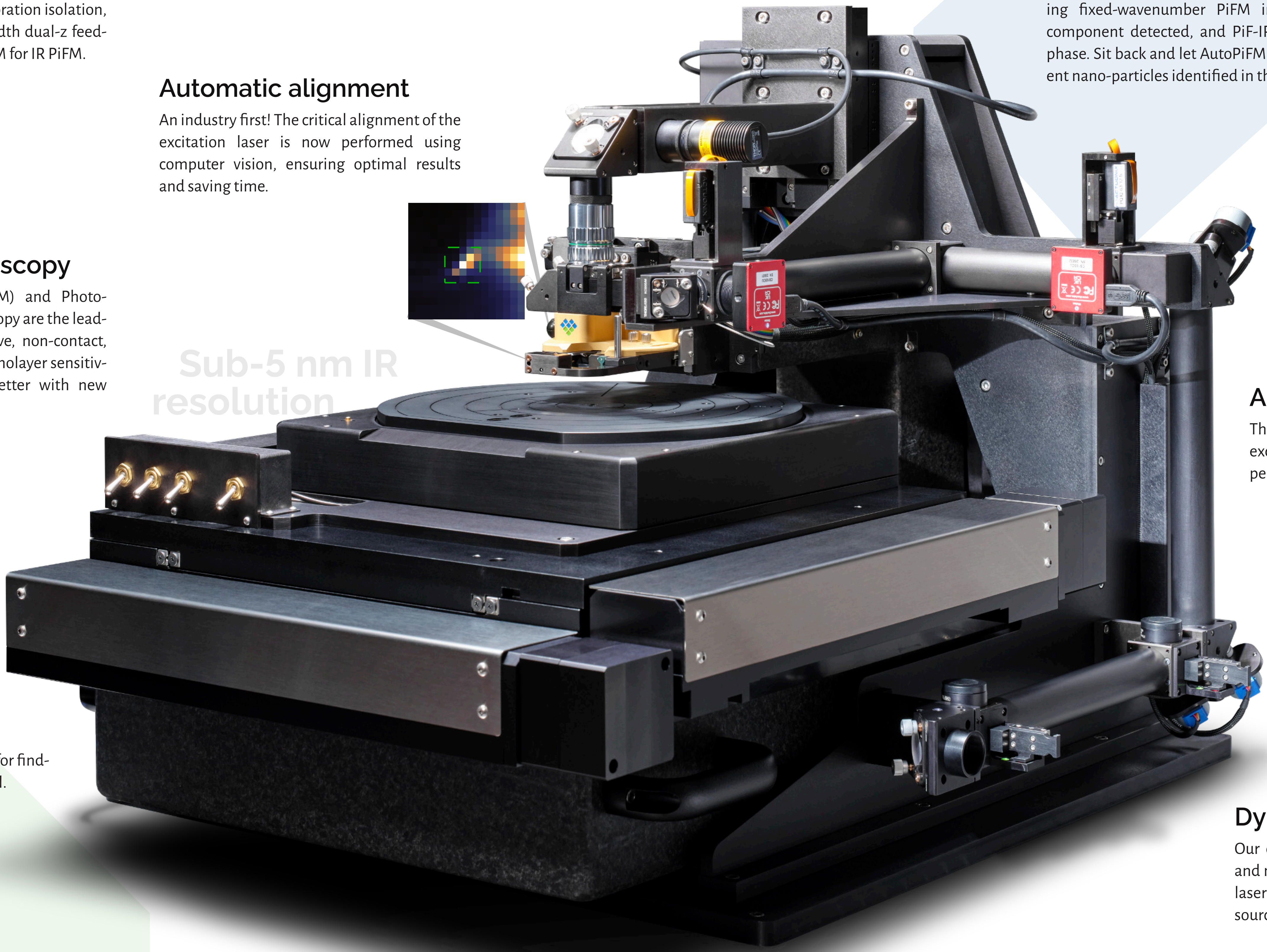
Automated features save time, but they still need to be built on a solid foundation. With a 90 µm xy-scanner, 12 µm sample z-scanner, and integrated vibration isolation, our AFM is top notch. The high-bandwidth dual-z feedback system allows true non-contact AFM for IR PiFM.

Automatic alignment

An industry first! The critical alignment of the excitation laser is now performed using computer vision, ensuring optimal results and saving time.

Ultimate spectro-nanoscopy

Photo-induced force microscopy (PiFM) and Photo-induced force infrared (PiF-IR) spectroscopy are the leading nano-IR techniques. Non-destructive, non-contact, and from the first company to show monolayer sensitivity, our instrument is only getting better with new automatic features.



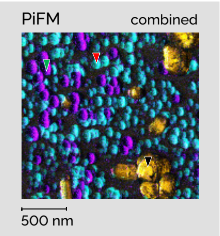
Sub-5 nm IR resolution

KLARF file navigation

Vista 300 support KLARF file navigation for finding defects across 300 mm of stage travel.

AutoPiFM

AutoPiFM generates a complete dataset from scratch, including fixed-wavenumber PiFM images of every chemical component detected, and PiF-IR spectra in each chemical phase. Sit back and let AutoPiFM do the work, like the different nano-particles identified in the example to the right.



Automatic beam set up

This beam alignment system ensures that the excitation laser always hits the focusing optics perfectly.

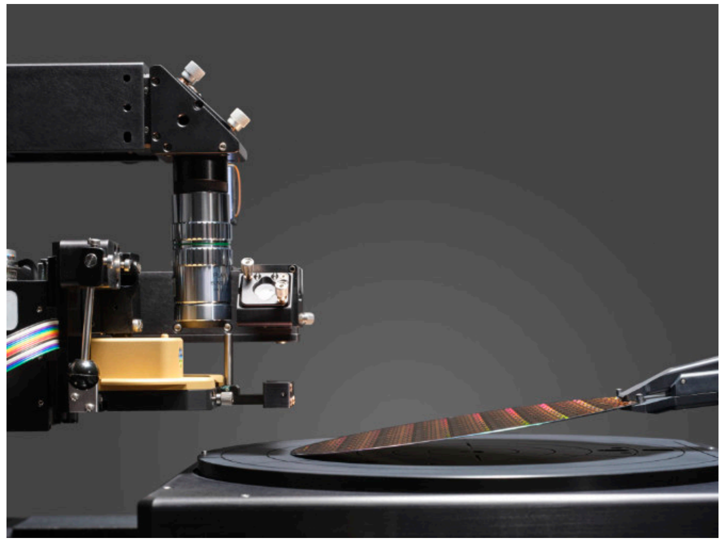
Dynamic laser control

Our optical multiplexer handles polarization and normalization automatically for effortless laser control, allowing you to choose a light source while keeping everything co-aligned.

A solid foundation for excellent IR

Controlled environment

The 400 mm wide sample access door allows you to maximize throughput while minimizing thermal disturbances that can cause drift. The insulated metal enclosure ensures acoustic isolation and stable temperature control within 0.1 °C, while also being clean room compatible.

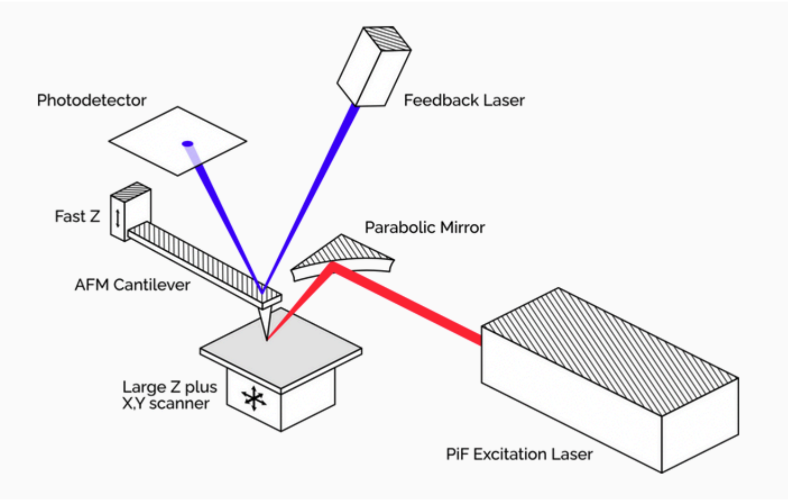


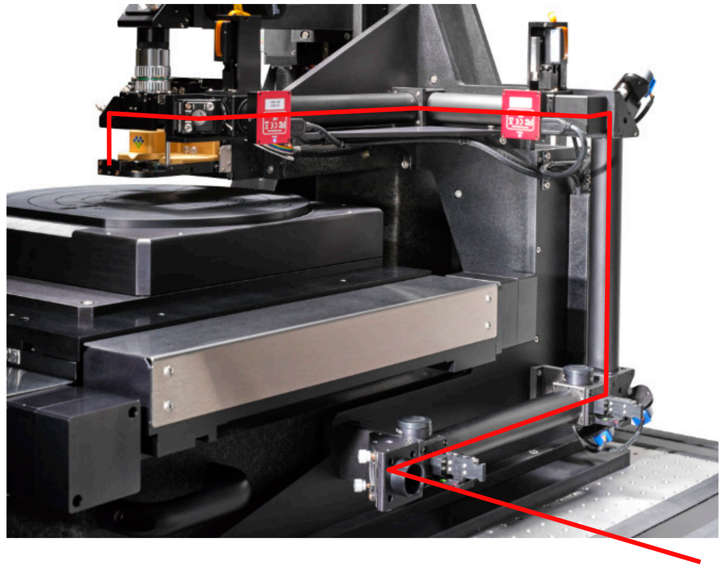
Exceptional stage access

Our forward-moving stage design makes it easy to load and unload samples. With a maximum sample height of 24 mm, and a maximum weight of 3 kg, the possibilities are limitless.

Dual-z sample scanning

This is the only 300 mm AFM-IR on the market that scans the sample in X, Y, *and* Z. This ensures that the IR alignment is guaranteed to be stable, no matter what the surface roughness of the sample is, and the z-scanner is neither limited in bandwidth nor travel range.



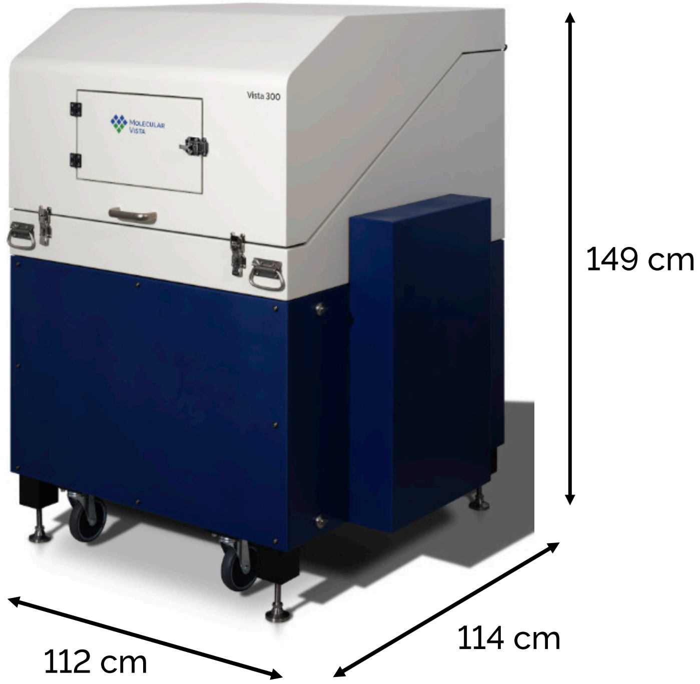


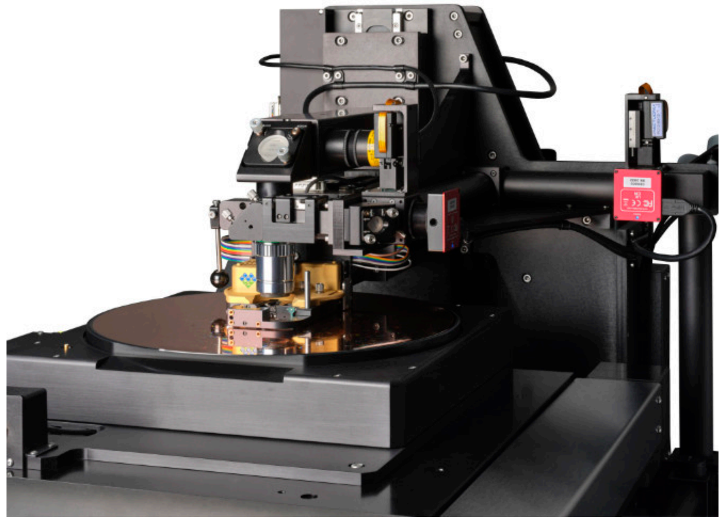
Clear IR signal

Our fully enclosed light path maximizes infrared transmission by eliminating atmospheric interference from water vapor, dramatically improving signal-to-noise ratio (SNR). Better yet, the purged beam path isn't affected by changing samples or AFM probes so you never have to wait for excellent spectra.

Compact footprint

Because of our automated beam alignment and integrated multiplexer, we can package the lasers below the main instrument. This creates a more compact design without compromises. Vista 300 supports up to two lasers to cover the full IR spectral range (see back cover).





Powerful yet non-destructive

PiFM is the only true non-contact AFM-IR mode available. The AFM probe doesn't touch your pristine samples, so they stay clean – and so does the tip.

Ideal for 12 inch wafers

Made for your samples

Choose between a vacuum chuck with magnetic mounts or an EUV mask holder to suit the needs of your lab. This instrument is perfect for 4-, 6-, 8-, or 12-in wafers.

The perfect companion

PiFM does for molecular materials what EDX does for identifying and mapping atomic species. While EDX can detect the presence of certain elements, PiFM can identify individual molecular components. PiFM is also non-destructive and non-contaminating, making it the perfect addition to materials analysis labs also using SEM/EDX, ToF-SIMS, Raman, Auger, XPS, etc.

Streamlined process

Our scripting API allows custom recipes, and our files are open so integration with 3rd party software is easy. Our included data analysis software allows your team to go from measurements to presentation-ready results quickly.

Single-molecule-level sensitivity

Scientific principles PiFM & PiF-IR

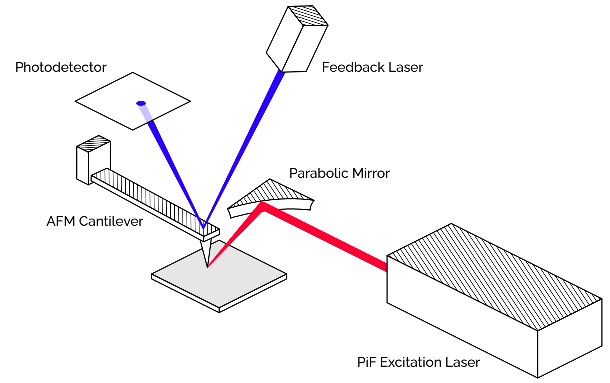


FIGURE 1. A pulsed and tunable IR laser is focused onto the apex of a metal coated AFM tip. The laser is modulated at a frequency carefully calculated based on the resonance frequencies of the cantilever.

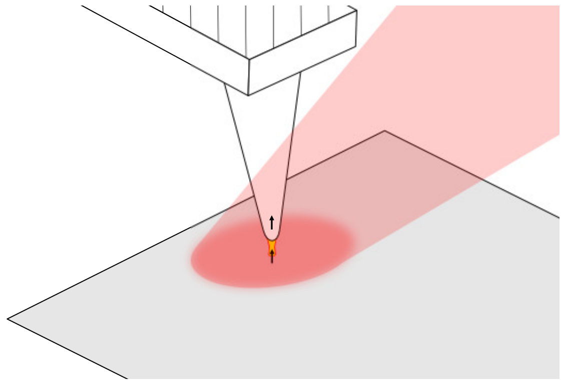


FIGURE 2. The metal-coated AFM tip acts as an antenna and creates a highly local enhanced field (yellow). This field locally polarizes the sample, resulting in an attractive force whose magnitude depends on the absorption strength of the sample.

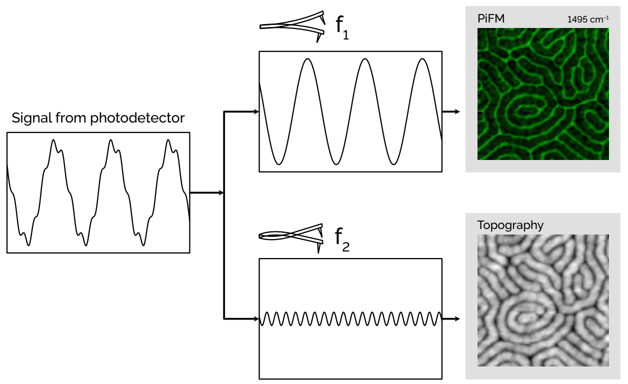


FIGURE 3. One resonance of the cantilever is used to detect the PiFM signal. Simultaneously, another resonance is used to collect the standard AFM topography and phase in a non-contact manner (no tip/sample contamination).

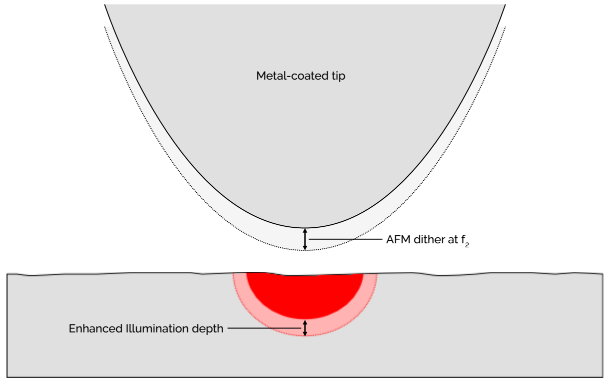


FIGURE 4. The depth of the tip-enhanced illumination depends heavily on the spacing between the tip and the sample. By detecting the attractive forces in non-contact mode, the measurement is made extremely sensitive – capable of detecting monolayers of material.

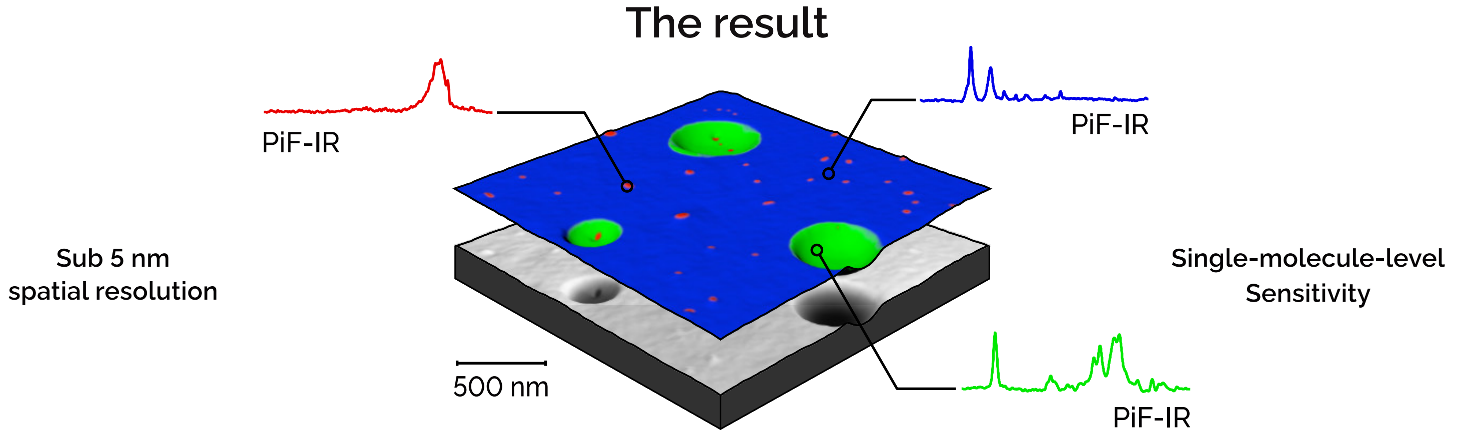


FIGURE 5. PiF-IR nanoscale spectra are made by measuring the strength of the attractive photo-induced forces as a function of wavenumber. PiFM chemical maps are created by scanning the surface with a fixed-wavenumber to measure absorption strength as a function of position. The color layer over the AFM topography is three fixed-wavenumber PiFM images combined.

PiFM chemical mapping

Reveal hidden structure in color

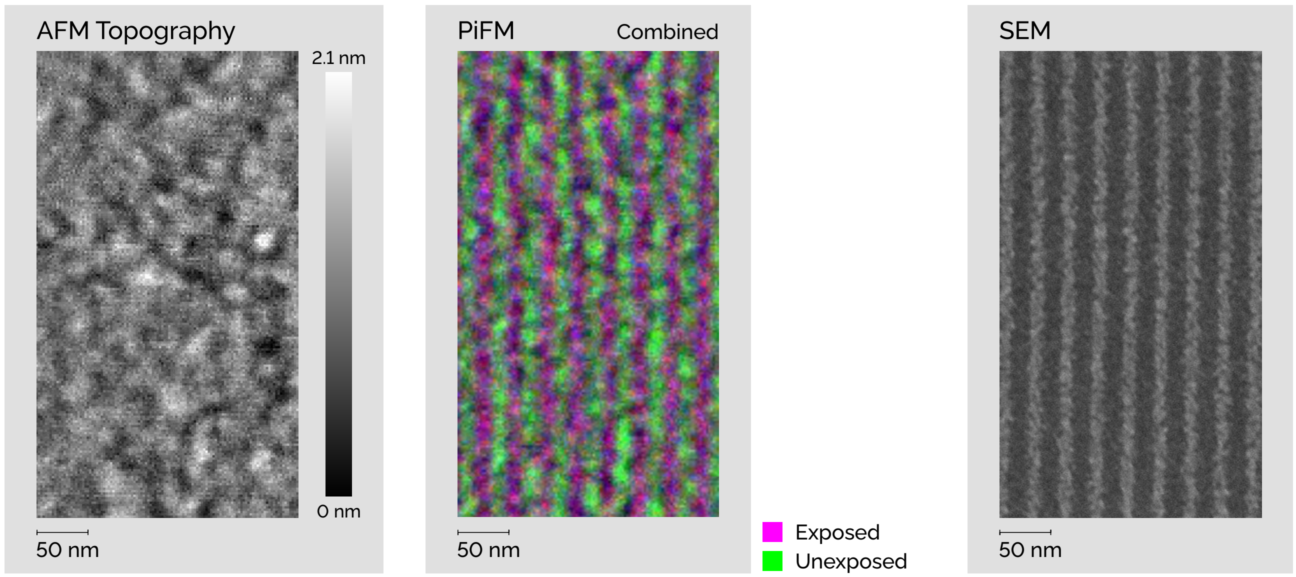


FIGURE 6. PiFM images are infrared absorption maps which can be used to locate materials. In this example, an EUV photoresist has been exposed with a low dose. The surface is scanned with PiFM before the resist is developed, so the latent image in the photoresist does not appear in the topography. However, two combined PiFM chemical maps can reveal the 16 nm half-pitch structure. Once the resist is developed, the final product can be verified with SEM imaging. *Scan dimensions: 300 nm × 600 nm × 2.1 nm.*

Sub-5 nm spatial resolution

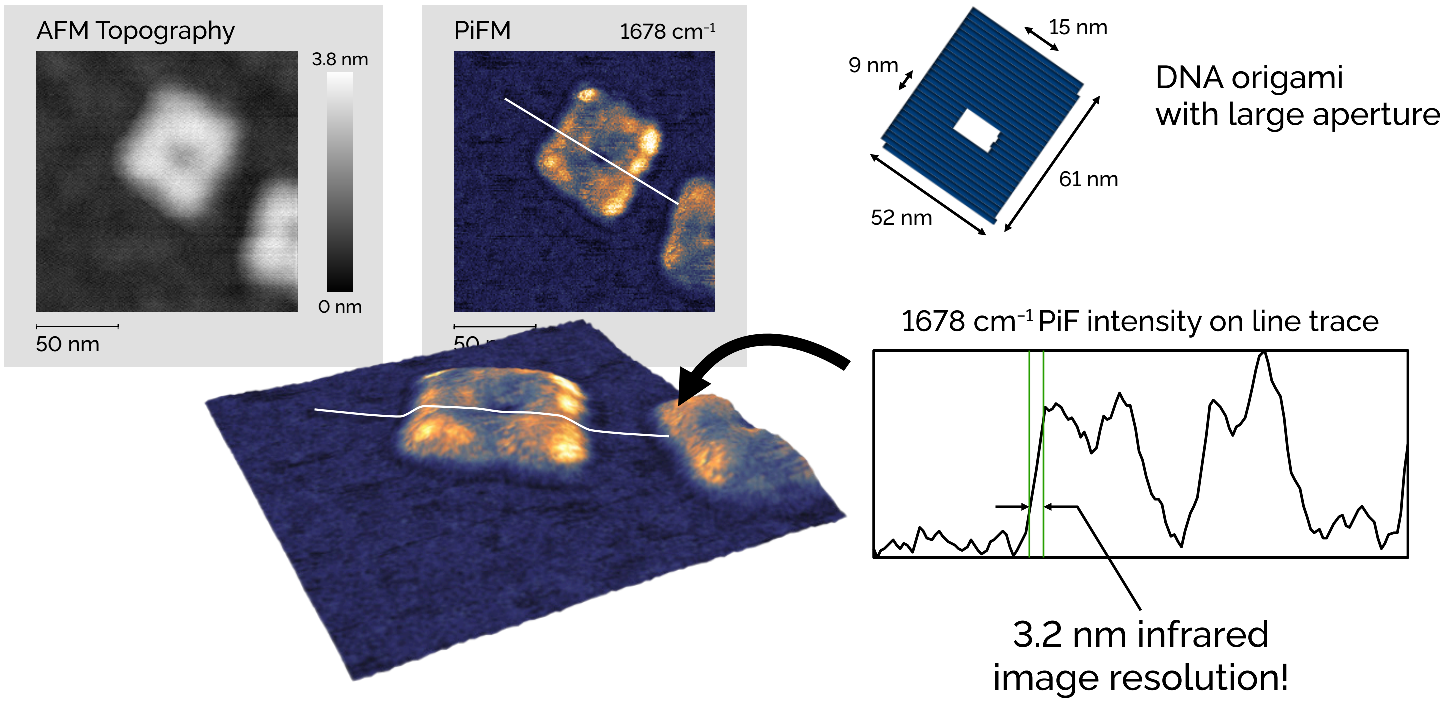


FIGURE 7. A DNA origami molecule on a silicon substrate. The line trace plots the intensity of the data in the PiFM image (as opposed to the cross section of the topographic height). The steep rise in absorption intensity at the edge of the molecule shows a spatial resolution of less than 5 nm in the infrared imaging capabilities of Vista 300. *Scan dimensions: 200 nm × 200 nm × 3.8 nm.*

PiF-IR nano-spectroscopy

Single-molecule-level sensitivity

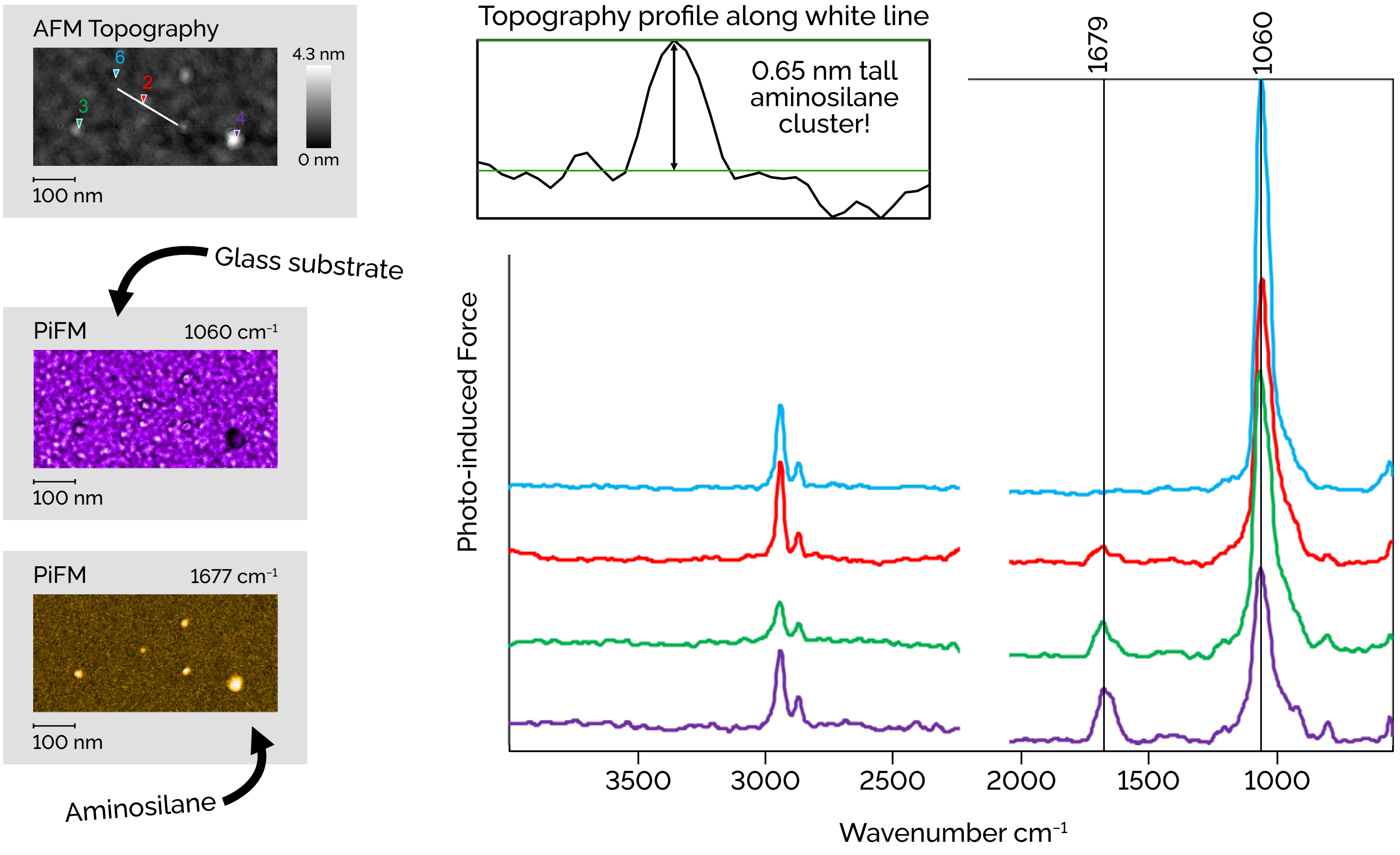


FIGURE 8. Aminosilane monolayers are a popular for surface functionalization. Conventional wisdom is that the aminosilane will form a uniform monolayer on a clean glass substrate. However, when analyzing some of these functionalized surfaces with PiFM, a different story appears. Instead, it seems that the aminosilane has formed small clusters that are distributed across the surface. The smallest cluster in this image is only 0.65 nm tall! The spectra show that the intensity of the aminosilane peak at 1677 cm^{-1} grows as the clusters get thicker. Similarly, the intensity of the substrate's peak at 1060 cm^{-1} shrinks as that material is hidden under thicker clusters of aminosilane. Scan dimensions: 600 nm × 300 nm × 4.3 nm.

Excellent agreement with FTIR

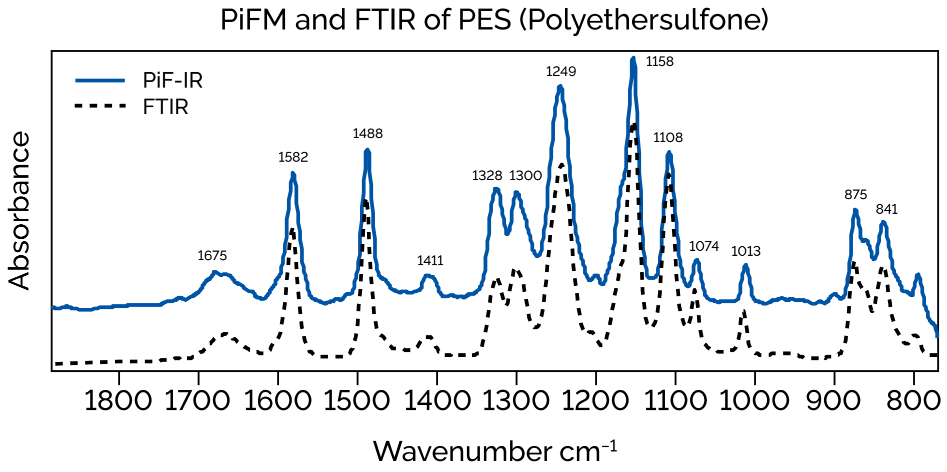


FIGURE 9. On homogeneous samples, PiF-IR spectra agree with FTIR extremely well.

Excellent performance on inorganic materials

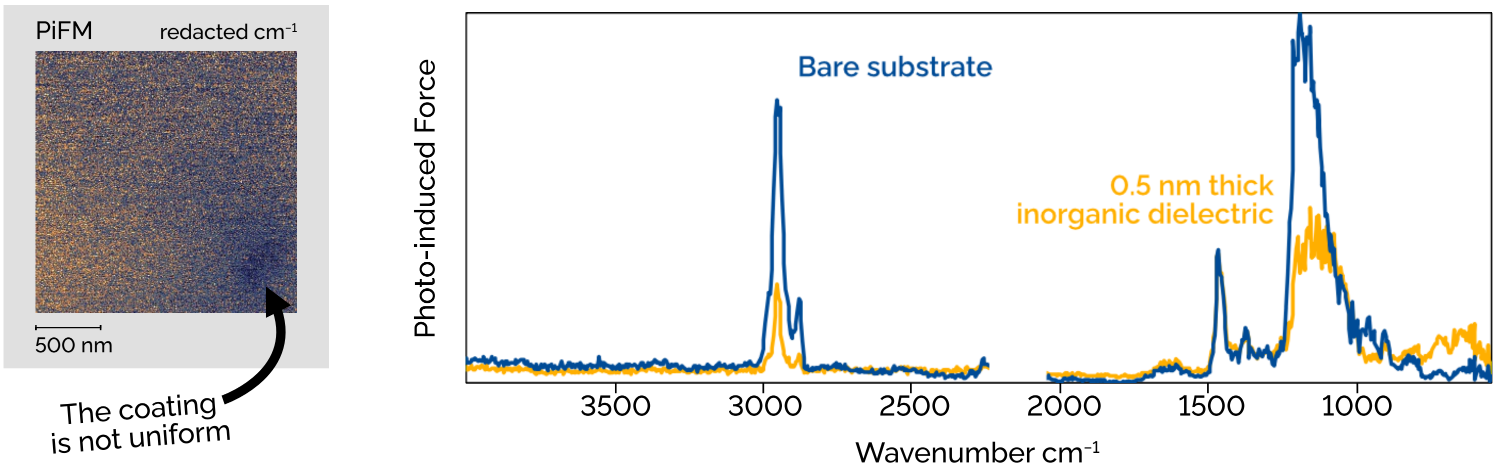


FIGURE 10. Both organic and inorganic samples can be analyzed equally well using PiFM and PiF-IR. Here, the blue spectrum is a baseline measurement on a clean substrate. Then, a 0.5 nm thick layer of an inorganic high-K dielectric material is applied to the substrate. The gold spectrum shows the chemical changes from the dielectric. Mapping the absorption at a low wavenumber with PiFM shows that, unfortunately, the coating is not uniformly thick. *Scan dimensions: 2 µm × 2 µm × 1.1 mV.*

Defect analysis

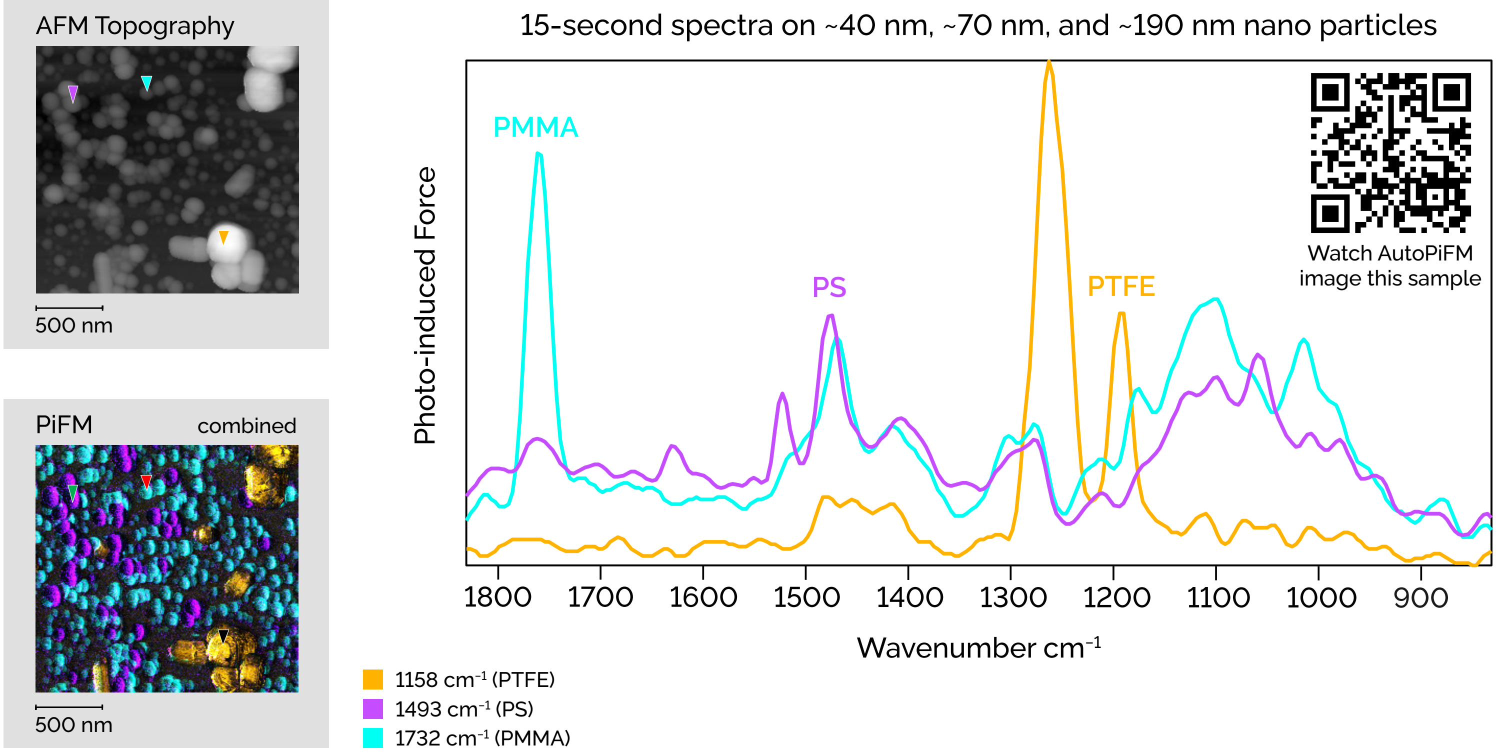


FIGURE 11. This is a reference sample with different types of nanoparticles. Each of the PiF-IR spectra taken at the markers on the AFM topography image correlate very well with FTIR reference spectra allowing one to identify the materials as polystyrene (PS), polymethyl methacrylate (PMMA), and polytetrafluoroethylene (PTFE). With nanoparticles ranging in size from about 40 nm up to about 200 nm, this demonstrates how PiFM and PiF-IR can work together for nano defect analysis. *Scan dimensions: 2 µm × 2 µm × 280 nm.*

Comparisons

Comparing surface analytical techniques

	PiFM & PiF-IR	Raman	FTIR	TOF-SIMS	XPS	TXRF	SEM/ EDS	TEM	Auger
Species Detected	Molecular	Molecular	Molecular	Molecular	Molecular	Elemental	Elemental	Elemental	Elemental
Chemical Mapping	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lateral Resolution	Sub 5 nm	> 0.5 µm	> 10 µm	100 nm	Sub 5 µm	~10 mm	1 nm *0.5 µm EDS	0.2 nm *1 – 20 nm EDS	8 nm
Depth Probed	20 nm & bulk	> 500 nm	1 µm	1 nm	10 nm	10 nm	1 µm	~100 nm	10 nm

TABLE 1. PiFM & PiF-IR bring molecular analysis to the realm of true nanoscale resolution, providing both IR absorption spectra and chemical mapping with sub-5 nm spatial resolution and monolayer sensitivity, complementing XPS or ToF-SIMS in any high-end lab. *For SEM and TEM, EDS measurements are not as high resolution as is possible for imaging.

Vista 300 specifications

Stage and scanner

Sample stage travel	300 mm × 300 mm square.
Scan size	90 × 90 µm.
Dual Z feedback	12 µm z-scanner with 600 nm fast z-scanner provides both high bandwidth and a large z-range.

Physical requirements

System dimensions	Approximately 1.1 m × 1.1 m × 4.9 m (3’ 7.3” × 3’ 7.3”× 5”)
Enclosure	400 mm × 200 mm access door minimizes thermal drift. The enclosure is removable without disconnecting cables.

Functionality

Imaging modes	Non-contact AFM, PiFM, KPFM, cAFM, nano DMA, FvD (force vs distance) mapping.
Spectroscopy modes	PiF-IR, FvD.
PiF Laser options	QCL (770 – 1840, 1995 – 2395 cm^{-1}), OPO/DFG (590 – 2050, 2250 – 4400, 5000 – 7000 cm^{-1}).
Depth Probed	20 nm in surface mode & greater than 100 nm in bulk mode.