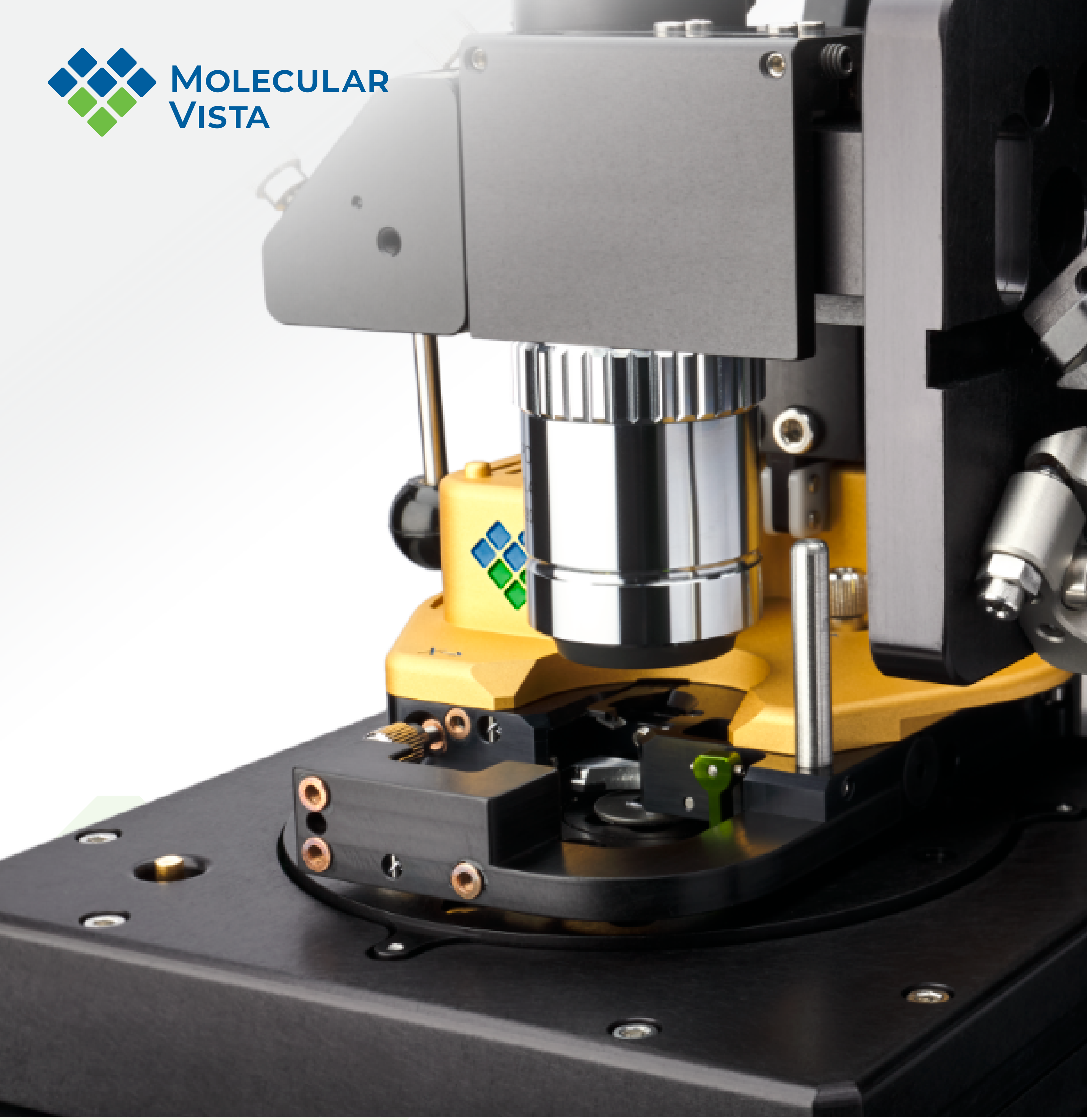


Vista 75

IR-PIFM • PIF-IR • AFM-IR

Sub 5 nm IR spatial resolution • Single-molecule-level sensitivity

Vista 75: small and mighty

Accessible design

Easy sample access and a one-handed AFM head clamp make tip and sample exchanges a breeze. The lightweight removable enclosure and open design makes difficult optical alignments easy.

Quick-change optics

Pre-aligned optics make switching between PiFM + PiF-IR, s-SNOM, and Raman effortless.

Self-contained system

No need for a special environment. Vista 75 is complete with built in vibration isolation, and a temperature controlled acoustic enclosure with dry air.

75 mm sample stage travel

Sample size no longer matters. If it fits on the stage, Vista 75 can provide results.

Dynamic laser control

Our optical multiplexer handles alignments, polarization, and normalization automatically for effortless laser control.

Ultimate spectro-nanoscopy

Photo-induced force microscopy (PiFM) and Photo-induced force infrared (PiF-IR) spectroscopy are the leading nano-IR techniques.

Exceptional AFM performance

With an 80 µm (optional 100 µm) xy-scanner and a dual z feedback system, our AFM is top notch.

Scientific principles PiFM & PiF-IR

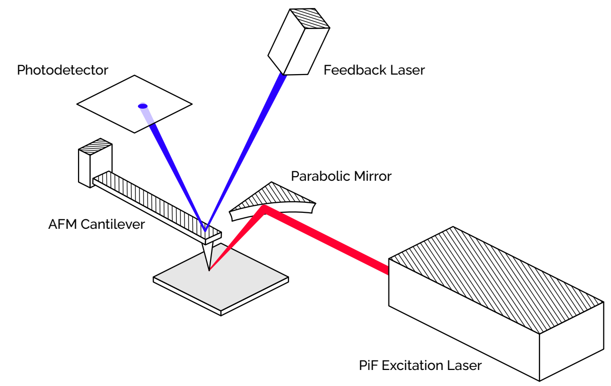


FIGURE 1. A pulsed and tunable IR laser is focused onto the apex of a metal coated AFM tip. The laser is modulated at a frequency carefully calculated based on the resonance frequencies of the cantilever.

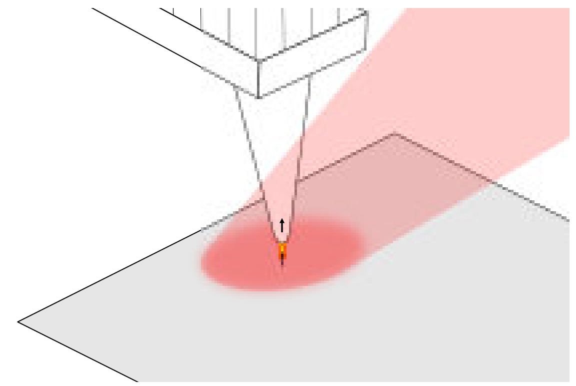


FIGURE 2. The metal-coated AFM tip acts as an antenna and creates a highly local enhanced field (yellow). This field locally polarizes the sample, resulting in an attractive force whose magnitude depends on the absorption strength of the sample.

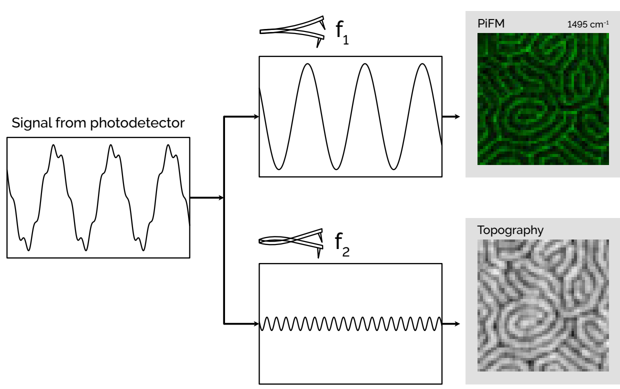


FIGURE 3. One resonance of the cantilever is used to detect the PiFM signal. Simultaneously, another resonance is used to collect the standard AFM topography and phase in a non-contact manner (no tip/sample contamination).

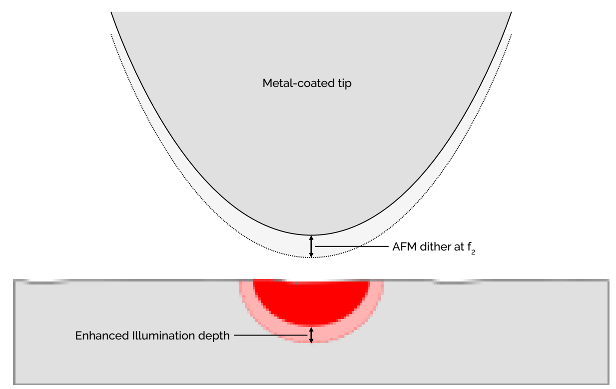


FIGURE 4. The depth of the tip-enhanced illumination depends heavily on the spacing between the tip and the sample. By detecting the attractive forces in non-contact mode, the measurement is made extremely sensitive – capable of detecting monolayers of material.

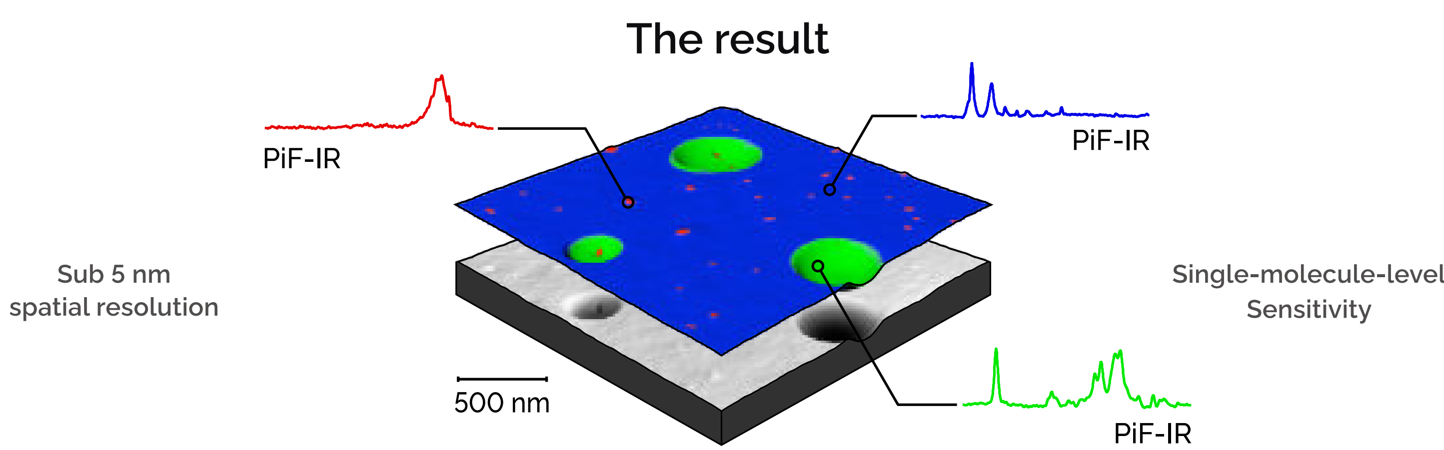


FIGURE 5. PiF-IR nanoscale spectra are made by measuring the strength of the attractive photo-induced forces as a function of wavenumber. PiFM chemical maps are created by scanning the surface with a fixed-wavenumber to measure absorption strength as a function of position. The color layer over the AFM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

PiFM chemical mapping

Reveal hidden structure in color

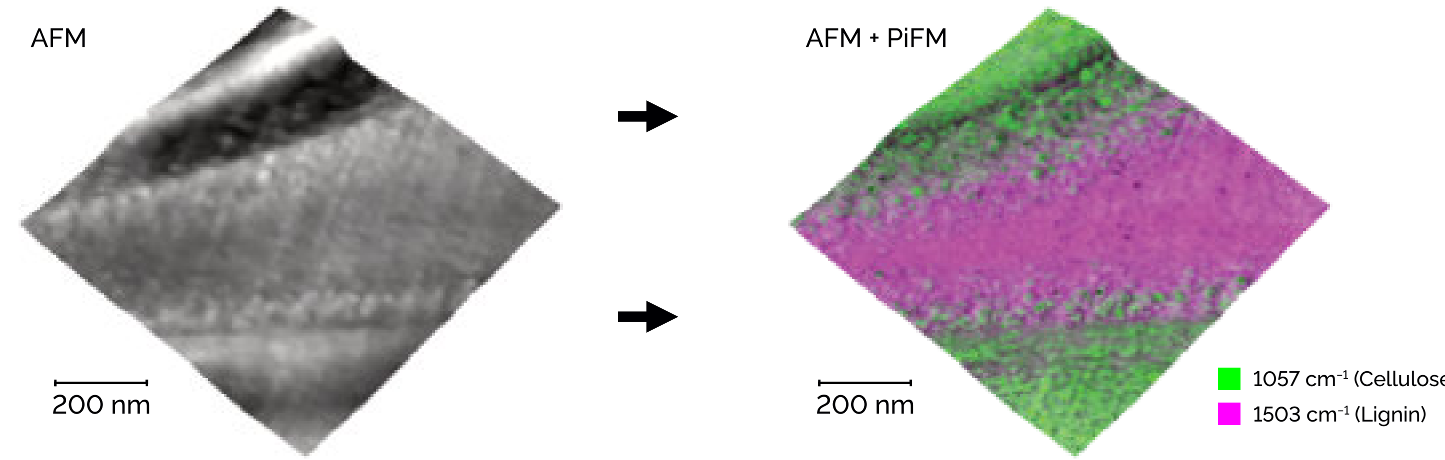


FIGURE 6. 3D visualization of the AFM topography of a cell wall from an ultra-thin cross section of spruce wood. An overlay of two PiFM images shows the chemical composition of the surface where lignin and cellulose mix. This PiFM overlay reveals how the materials are distributed, and it shows how some of the topographic features are related to the local chemistry. *Scan dimensions: 1 μm × 1 μm × 0.034 μm.*

Sub-5 nm spatial resolution

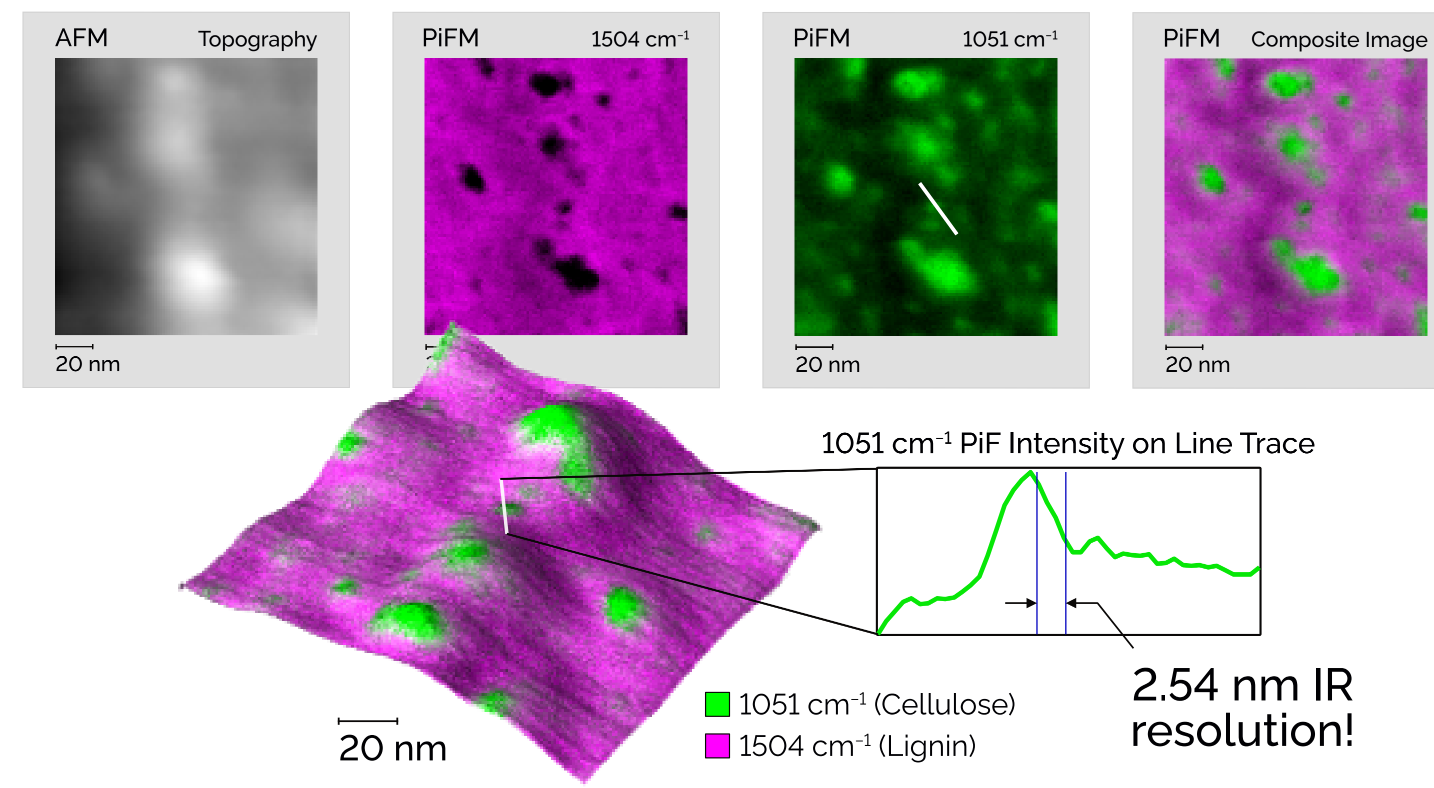


FIGURE 7. A zoomed-in region of the spruce wood cell wall. At only 150 nm square, this scan area is over 50 times smaller than in figure 6! PiFM images show the chemical distribution of lignin and cellulose on the surface. A line trace plotting the intensity of the data in the green image shows an IR spatial resolution of less than 5 nm. Notice how the PiFM images bring the topography alive with precise chemical detail while the topography itself is unremarkable. *Scan dimensions: 150 nm × 150 nm × 10.5 nm.*

PiF-IR nano-spectroscopy

Single-molecule-level sensitivity

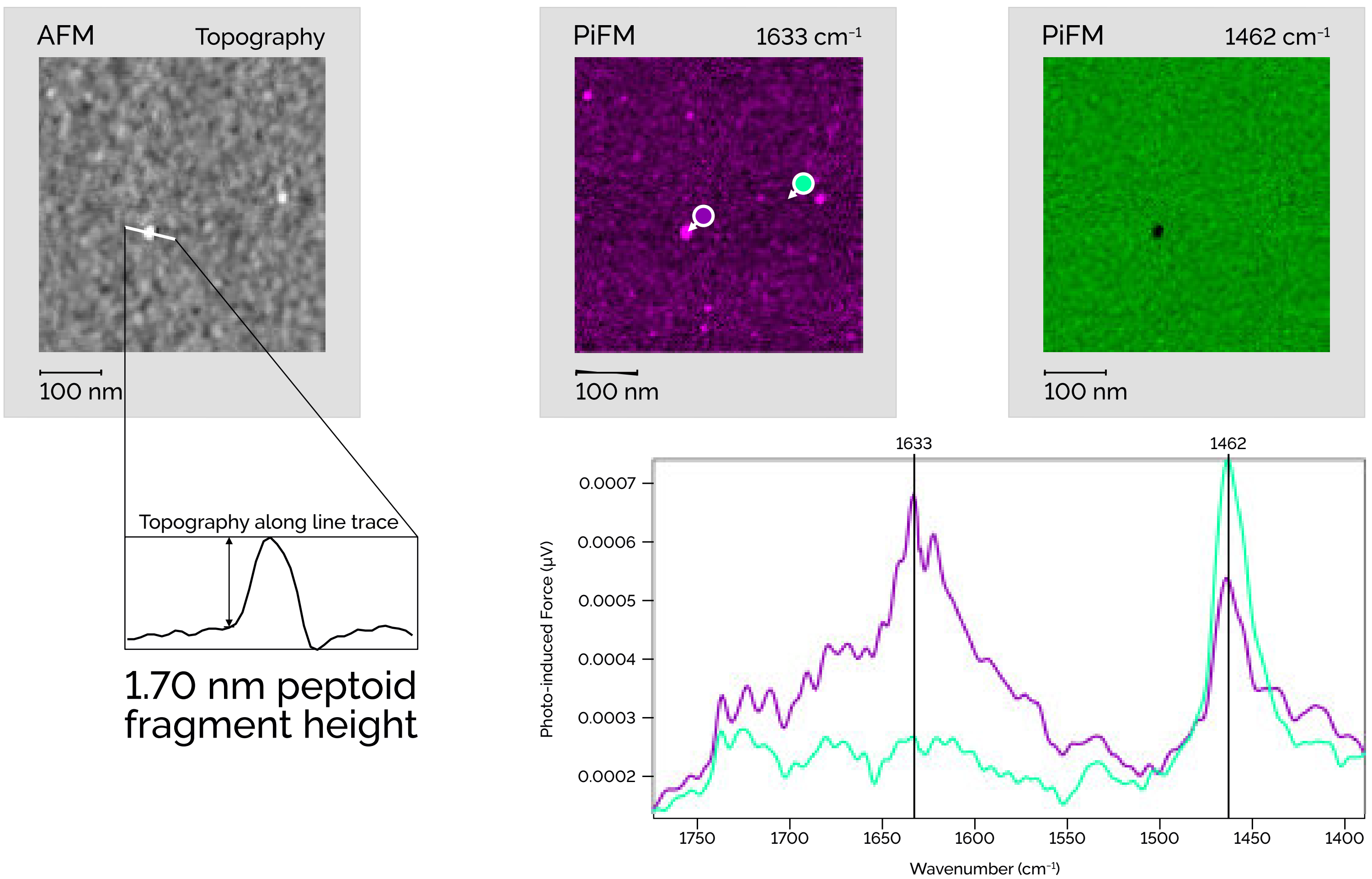


FIGURE 8. This sample was intended to be a uniform monolayer of peptoid molecules; however, initial PiF-IR analysis indicated that actual peptoid coverage was very sparse. Therefore, a PiFM image was taken at 1633 cm^{-1} which should highlight any peptoid molecules present. This image reveals tiny peptoid fragments on the surface. A PiF-IR spectrum taken on one of those points shows the characteristic peak at 1633 cm^{-1} despite the peptoid fragment being only 1.7 nm tall! The black spot in the green PiFM image shows that the fragment is sitting on top of the substrate material. Scan dimensions: 500 nm × 500 nm × 1.7 nm.

Excellent agreement with FTIR

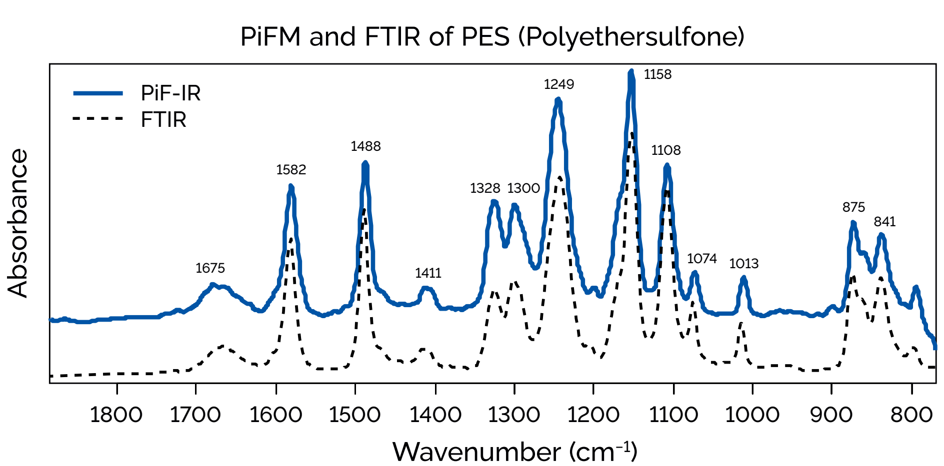


FIGURE 9. On homogeneous samples, PiF-IR spectra agree with FTIR extremely well.

Analyze organic and inorganic materials

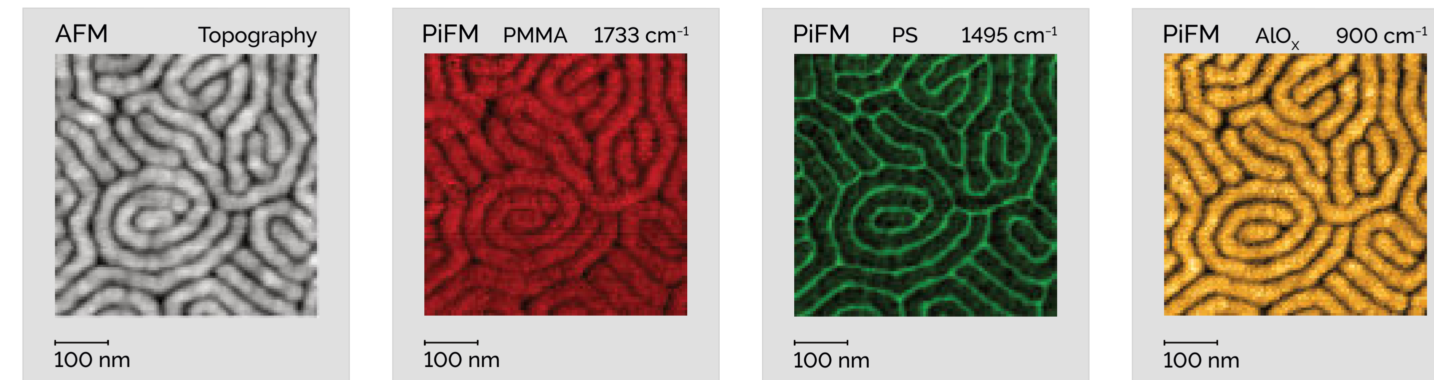
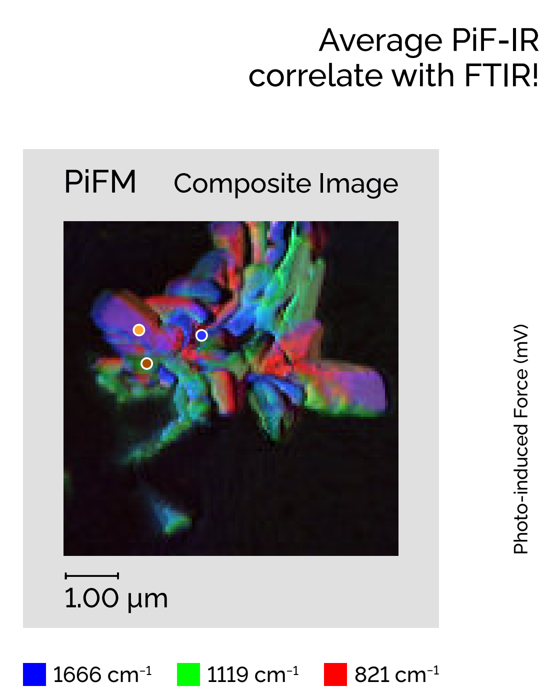


FIGURE 10. Both organic and inorganic samples can be analyzed equally well using PiFM and PiF-IR. Here, a PS-*b*-PMMA block copolymer has undergone sequential infiltration synthesis to produce aluminum oxides in the PMMA block. The sample was exposed to a vapor of trimethyl aluminum, which should only react with carbonyl groups in the PMMA. Subsequent exposure to water vapor converts the trimethyl aluminum into aluminum oxide. PiFM analysis after this process confirms the block-selective infiltration by the presence of a new broad peak from 800 to 1100 cm^{-1} (not shown). A PiFM image taken at 900 cm^{-1} (yellow image) highlights the infiltrating alumina in the PMMA blocks, demonstrating the exceptional resolution of PiFM chemical mapping even on inorganic samples. *Scan dimensions: 500 nm × 500 nm × 5.5 nm.*

Orientation discrimination



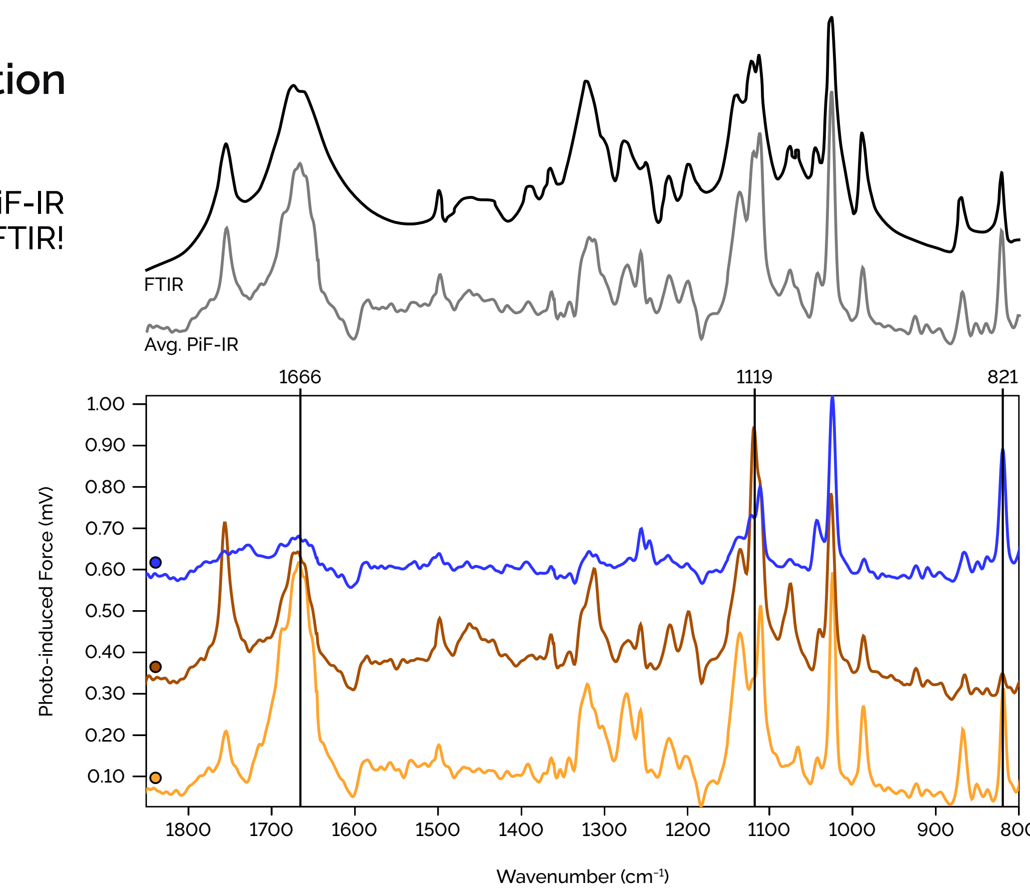


FIGURE 11. Similar to polarized FTIR, PiF-IR spectra are orientation sensitive due to the tip-enhanced field. The PiF-IR spectra above were acquired at different crystal faces on a vitamin C sample. They exhibit the local IR bands associated with the specific crystal faces. The average of these three distinct local PiF-IR spectra compare nicely with the bulk FTIR spectrum, which is the equivalent of an ensemble average of billions of PiF-IR spectra. *Scan dimensions: 640 nm × 640 nm × 1025 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 resolutions, providing both IR absorption spectra and chemical mapping with sub-5 nm spatial resolution and monolayer sensitivity.
*For SEM and TEM, EDS measurements are not as high resolution as is possible for imaging.

Vista 75 specifications

Stage and scanner

Sample stage travel	75 mm, max sample 140 mm square.
Scan size	80 × 80 µm (100 × 100 µm option).
Dual Z feedback	12 µm z-scanner with 100 nm fast z-scanner provides both high bandwidth and a large z-range.

Physical requirements

Table size	1.2 m × 2.4 m (4 ft × 8 ft) optical breadboard for complete system.
Enclosure	About 13 kg, removable, acoustic insulation, temperature controlled with dry air.

Functionality

Imaging modes	Non-contact AFM, PiFM, KPFM, FvD (force vs distance) mapping, Raman, s-SNOM.
Spectroscopy modes	PiF-IR, FvD, Raman.
PiF Laser options	QCL (760 – 1900 cm^{-1}), OPO/DFG (550 – 2050, 2250–4400 cm^{-1}).
Depth Probed	20 nm & bulk.

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