Molecular Analysis of Nanoscale Defects and Residue

NCCAVS TFUG: Advances in Metrology

July 28, 2021

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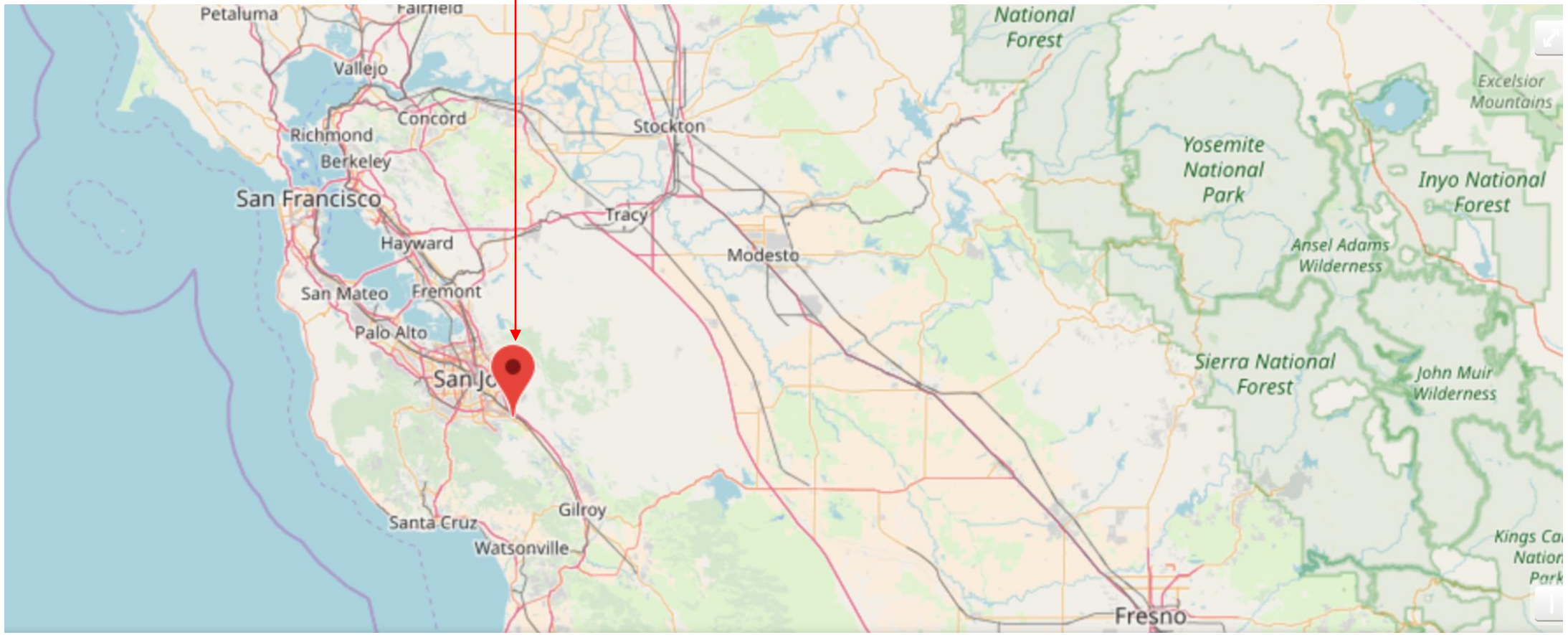
Molecular Vista Inc (Introduction to the Company)

South San Jose



Current Status of Analytical Techniques

	Raman	FTIR	TOF-SIMS	XPS	TXRF	SEM/EDS	TEM	Auger
Species Detected	M.I.	M.I.	M.I.	M.I.	E.I.	E.I.	E.I.	E.I.
Imaging/Mapping	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lateral Resolution	> 0.5 μm	> 10 μm	> 0.2 μm	10 μm – 2 mm	~ 10 mm	1 nm* 0.5μm EDS	0.2 nm	> 10 nm
Depth Probed	> 500 nm	1 μm	1 nm	10 nm	10 nm	1 μm	~ 100 nm	10 nm

* Imaging M.I. Molecular information E.I. Elemental information

Infrared Photo-induced Force Microscopy (IR PiFM)

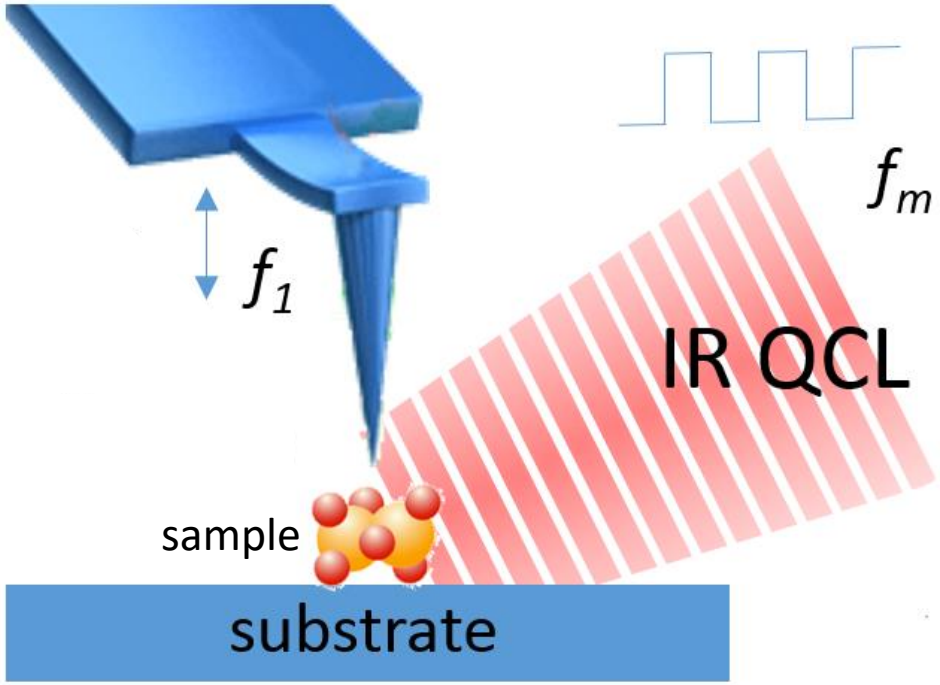
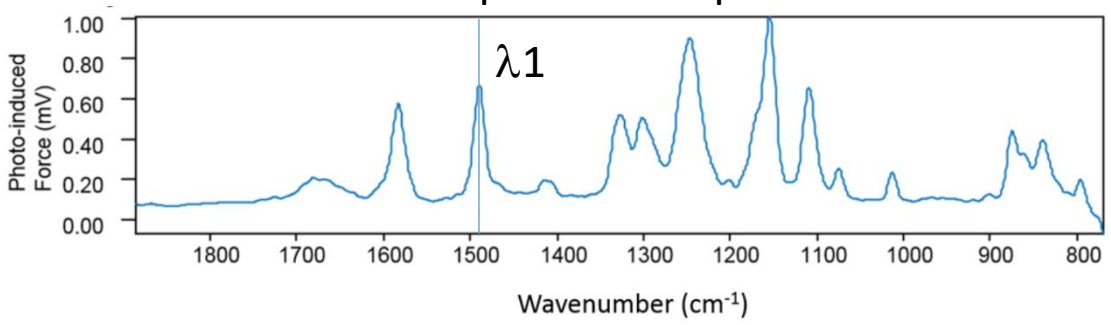
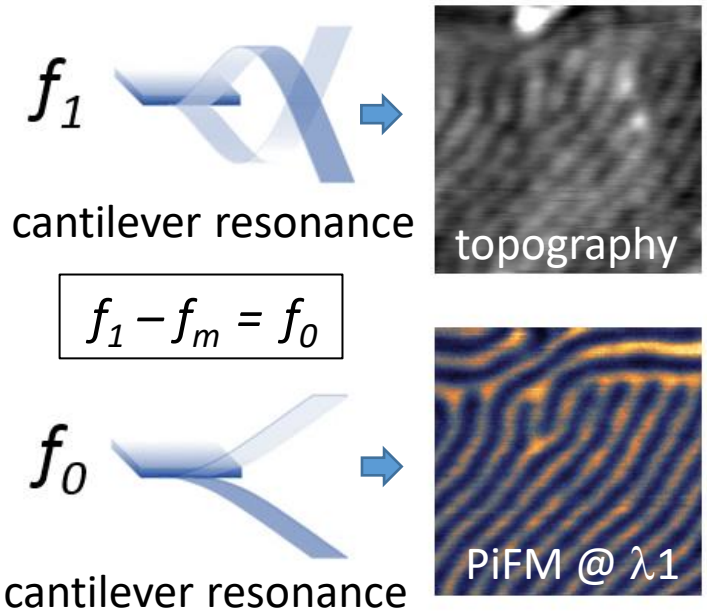


Photo-induced force microscopy (PiFM) measures photo-induced near-field attractive force to acquire infrared absorption spectrum from nanoscale (~10 nm) region of the sample.

Nanoscale IR Spectrum acquired with PiFM





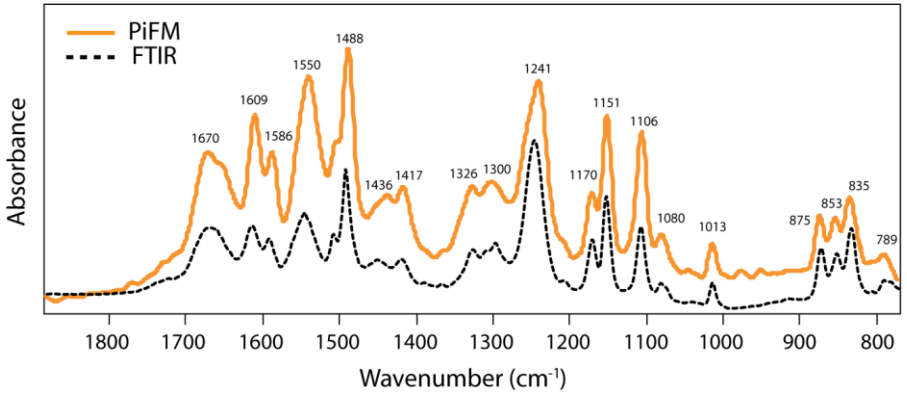
Topography acquired together with PiFM image.

Map of molecules absorbing light of wavelength λ1.

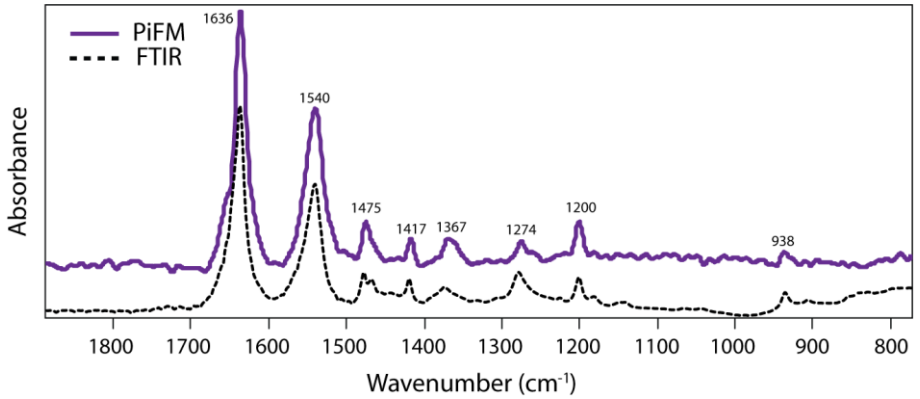
Agreement between Nanoscale PiFM and Bulk FTIR Spectra

The agreement is excellent on homogeneous samples.

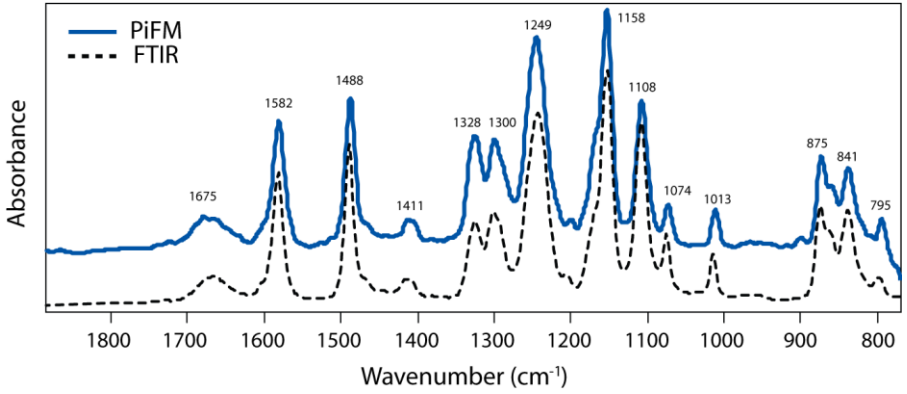
PiFM and FTIR of Polyimide



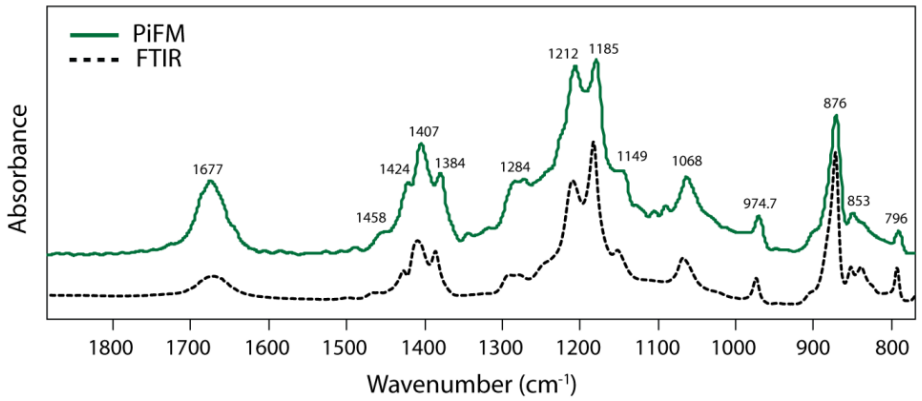
PiFM and FTIR of Nylon



PiFM and FTIR of PES (Polyethersulfone)

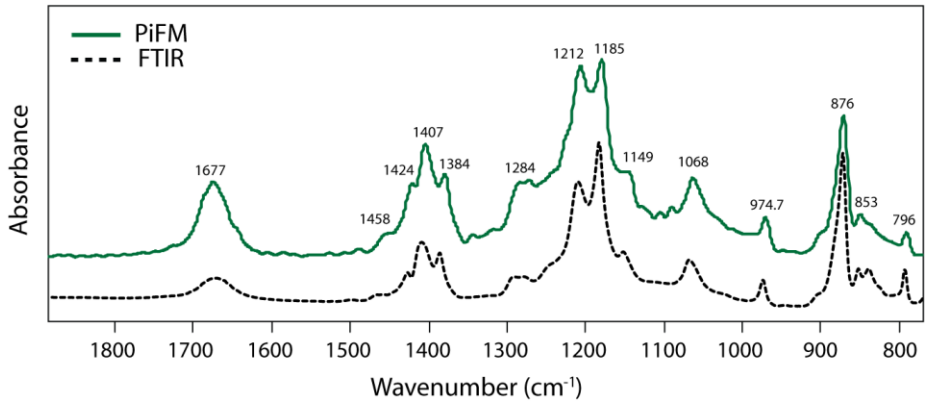


PiFM and FTIR of PVDF (Polyvinylidene difluoride)



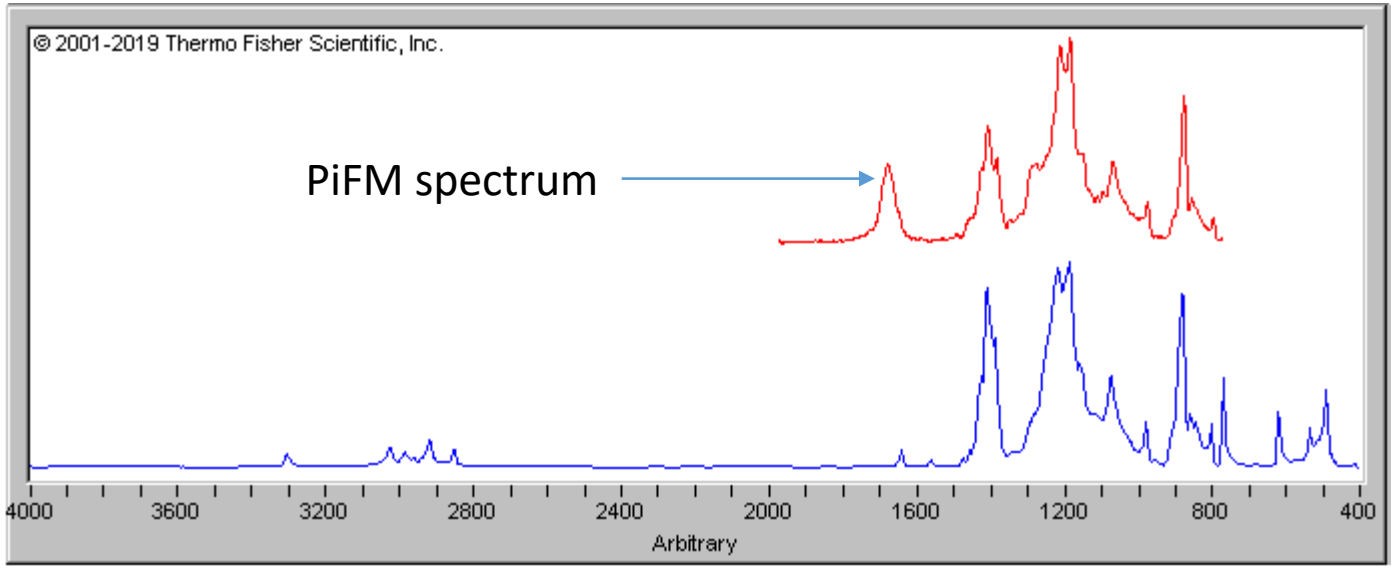
PVDF PiFM Spectrum Verified via Online Spectral Search Library

PiFM and FTIR of PVDF (Polyvinylidene difluoride)



PiFM shows excellent agreement with FTIR and is compatible in FTIR spectral search engines.

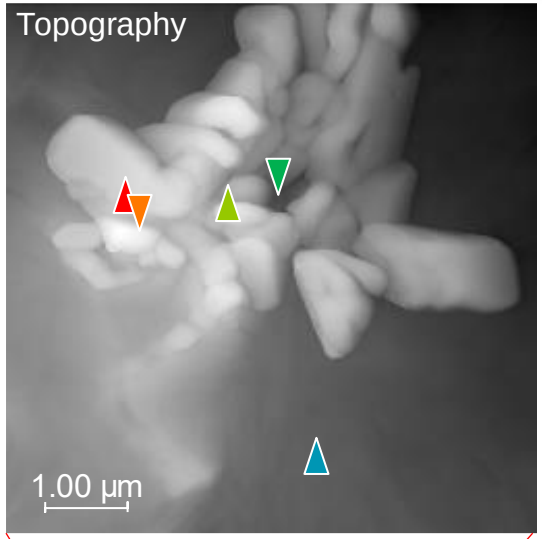
Output from FTIRsearch.com

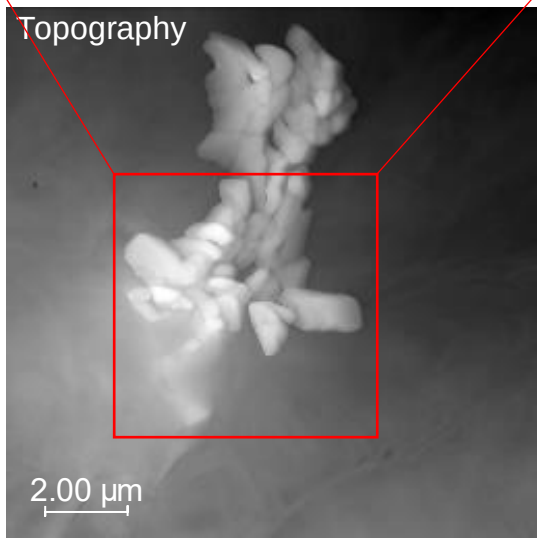


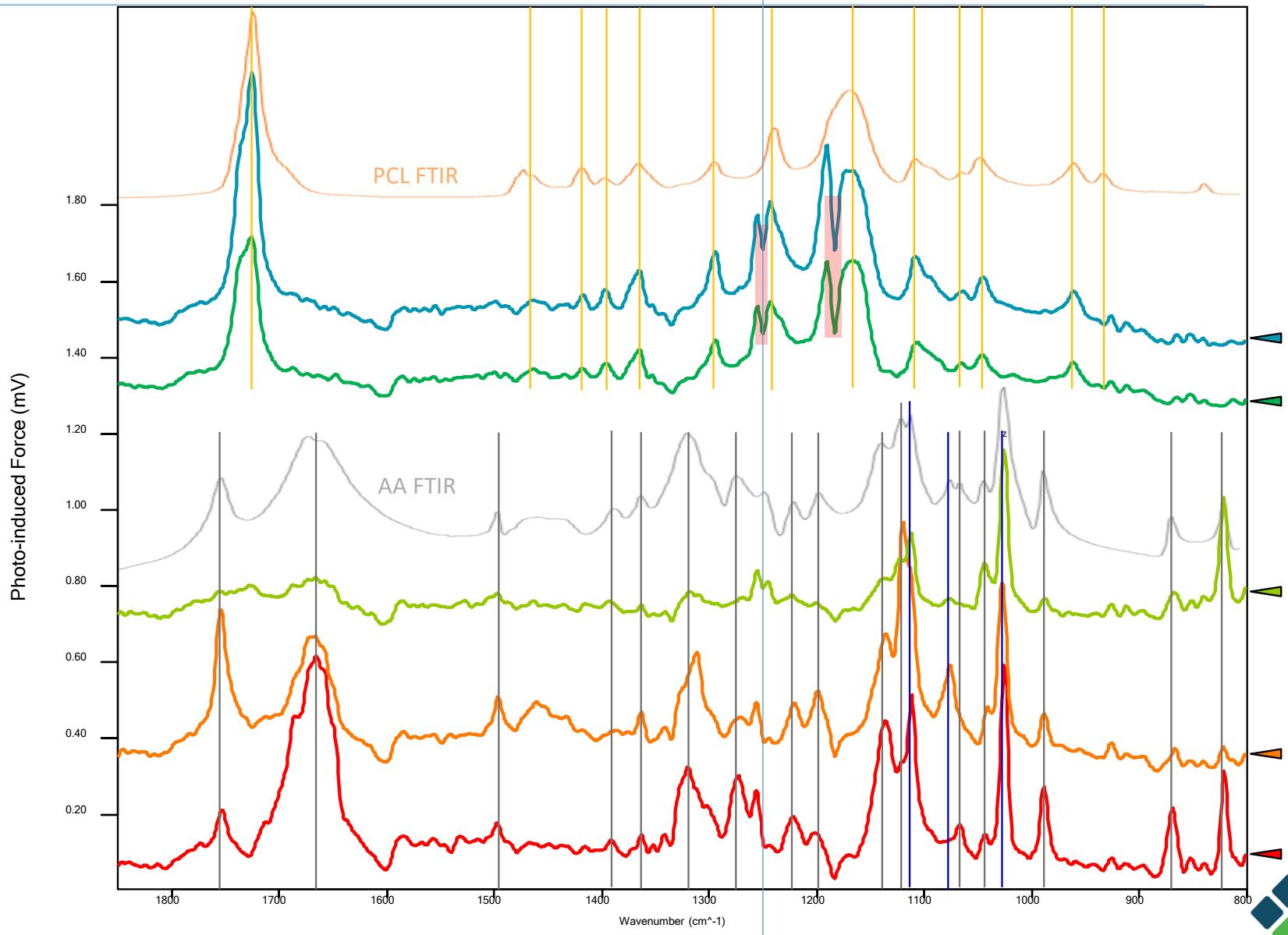
Click on a compound name below to toggle view of: a single spectrum, up to 10 spectra.

Row	HQI	Compound Name	Details
1	0.994	POLYVINYLIDENE FLOURIDE	Details ...
2	0.993	Poly(vinylidene fluoride)	Details ...
3	0.992	CHROMATE(VI); CESIUM; HYDRATE	Details ...
4	0.992	Alkylaryl sulfonate	Details ...
5	0.992	Alkylaryl sulfonate	Details ...
6	0.992	Petroleum sulfonate, Na salt + mineral oil	Details ...

PCL/5AA – Crystals
Topography and PiFM Spectra (Example of PiF-IR Spectra on Inhomogeneous Sample)

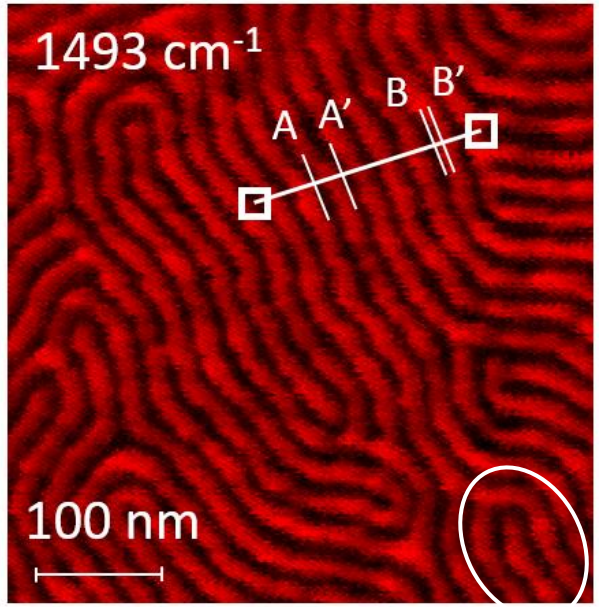


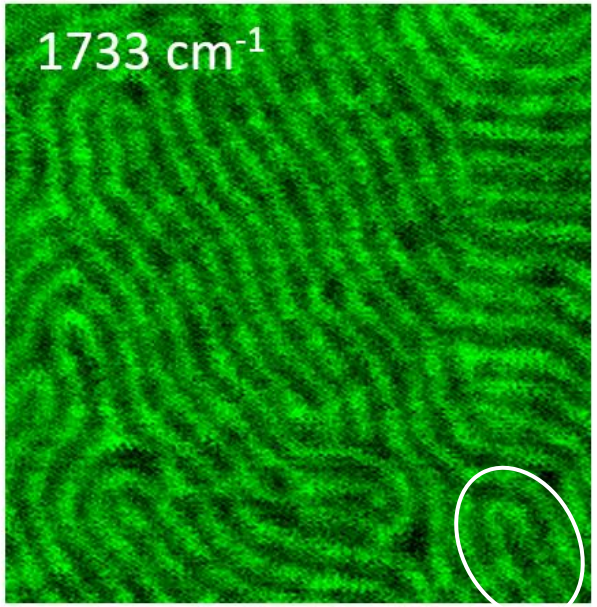


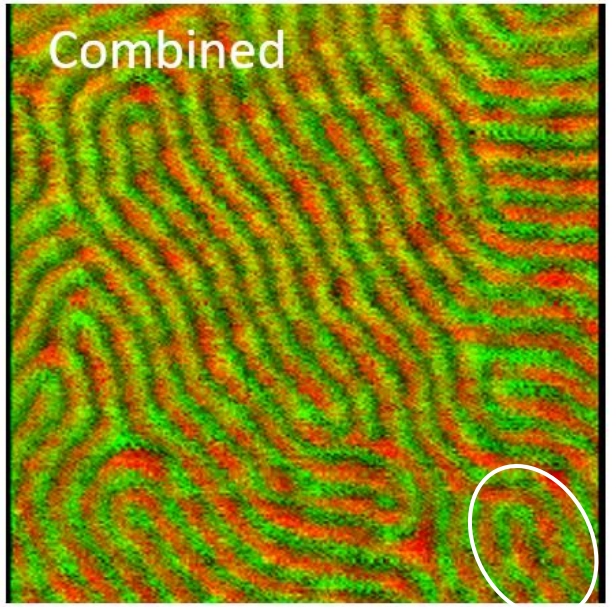


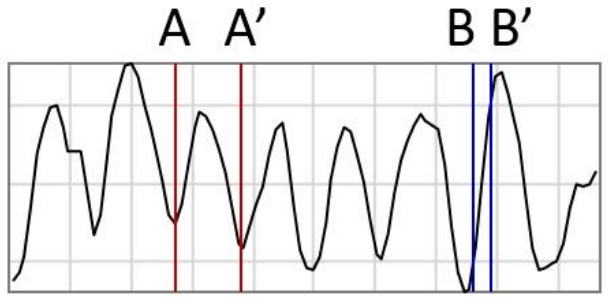
Exceptional Spatial Resolution in Chemical Mapping

Ps-*b*-PMMA Block Copolymer, L_0 = 22 nm









PMMA PS

A-A': 21 nm

B-B': 6.5 nm

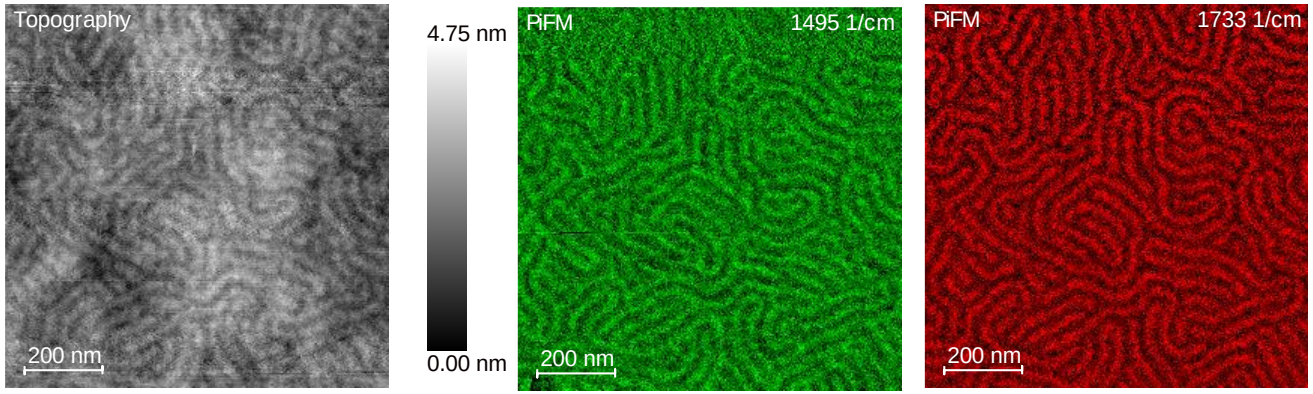
SIS AlO_x PS-b-PMMA (41 nm FP Lamellar) PiFM Images

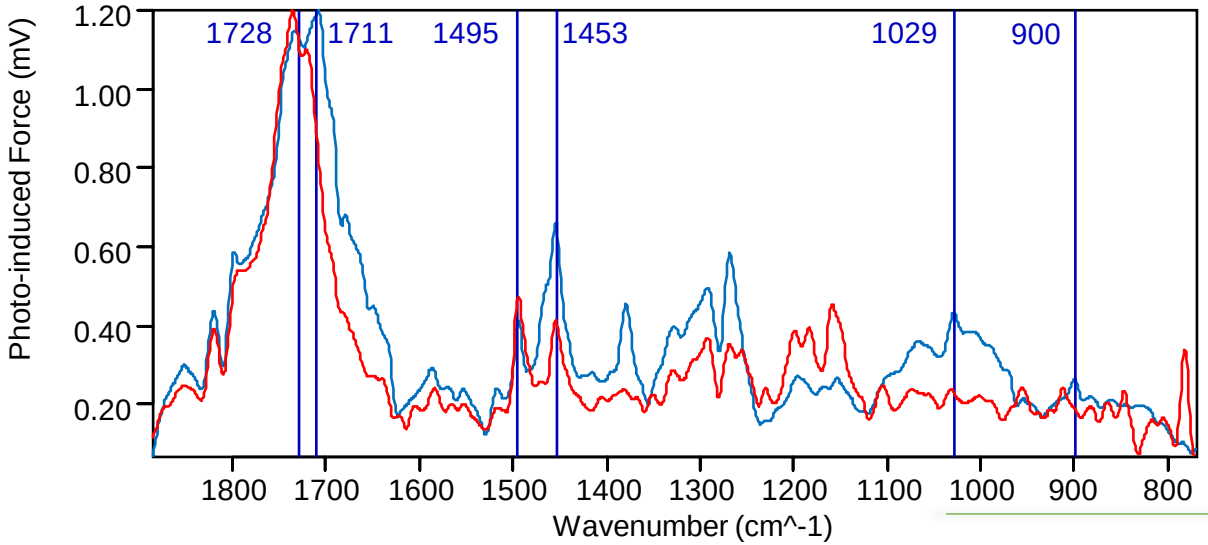
Before SIS

AFM Topography

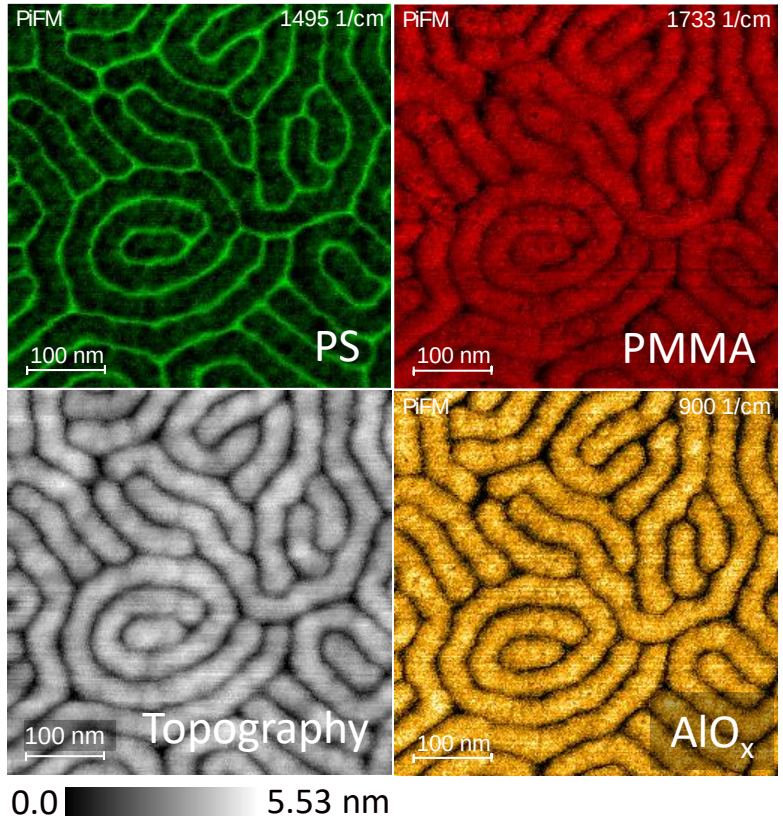
PS

PMMA

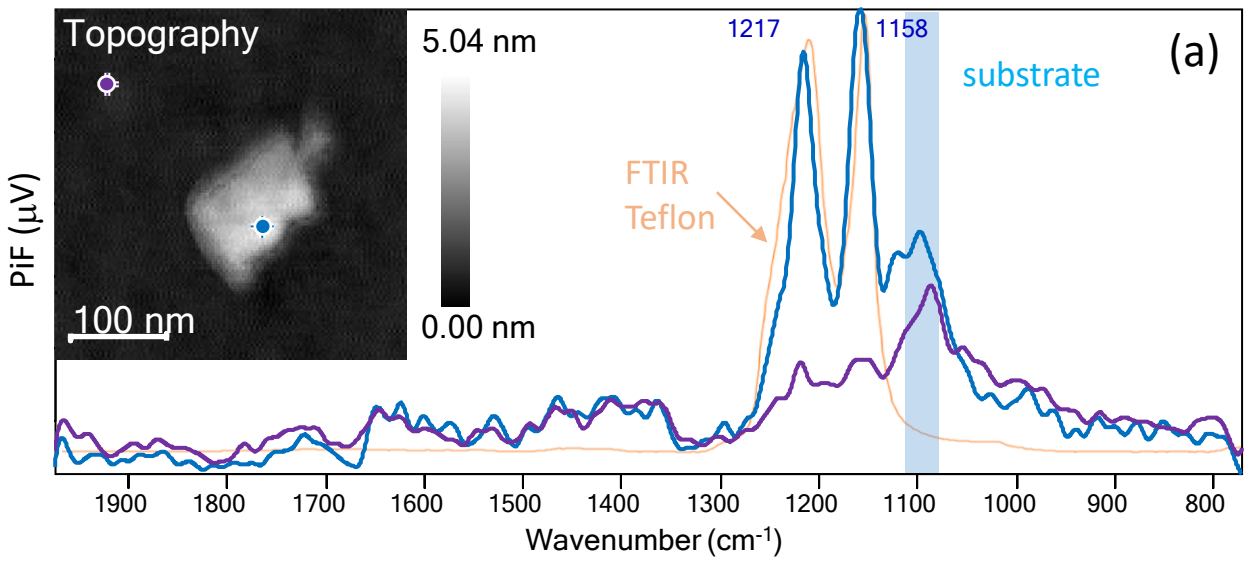


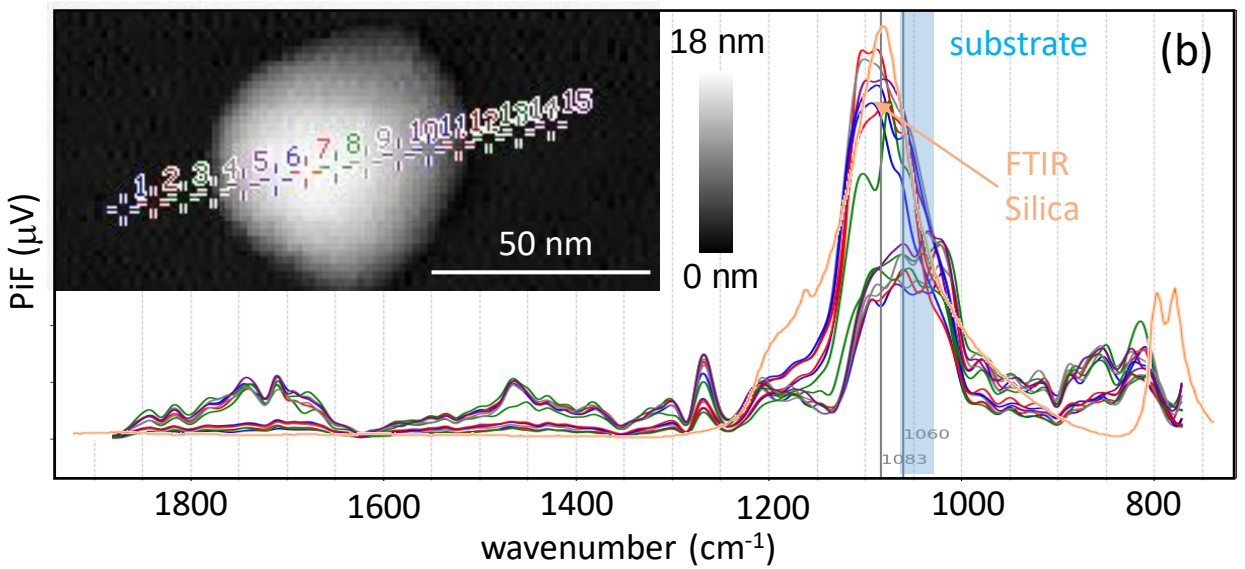


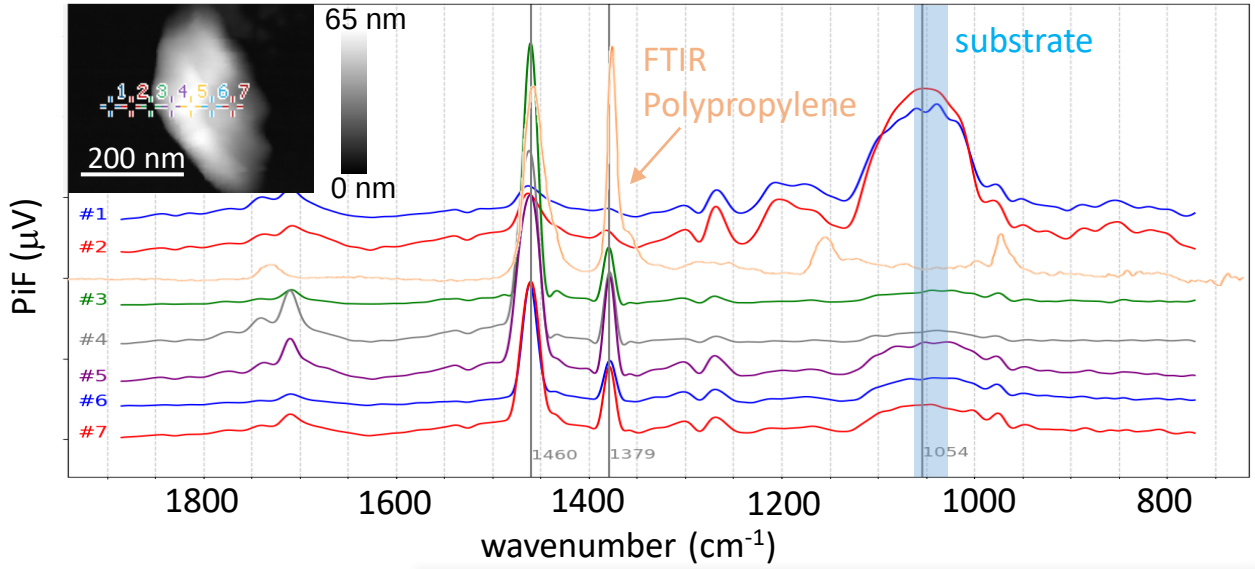
After SIS



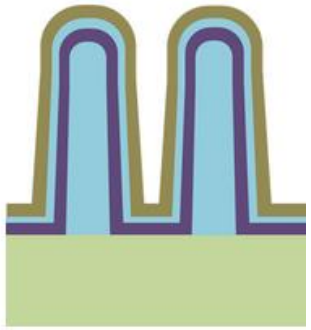
Nanoscale Defect Identification via PiF-IR Spectra



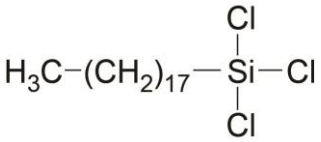




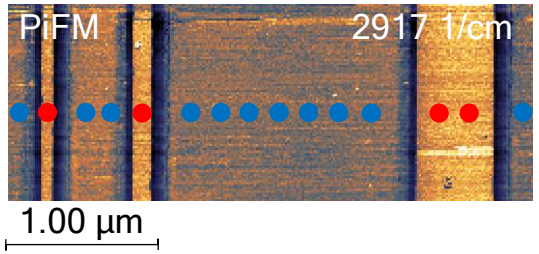
Effect on ODTS Packing Density due to the Nature of Oxide

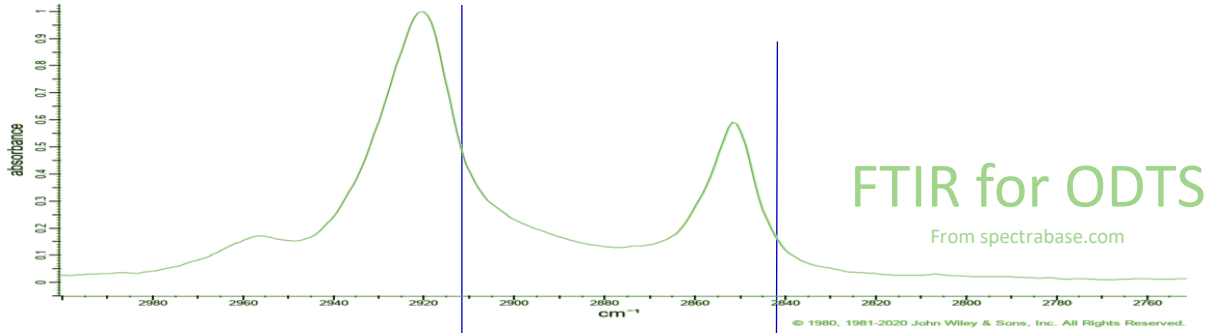


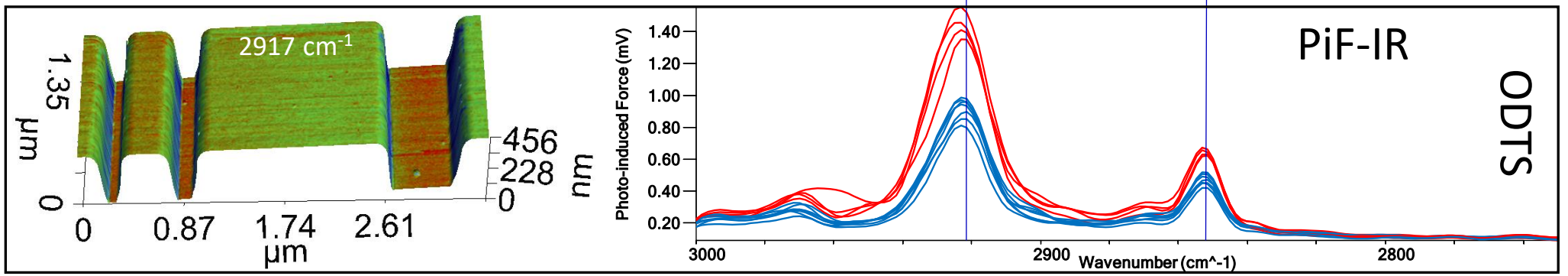
- Si_3N_4 (30 nm)
- SiO_2 (5 nm)
- ODTS (ML)

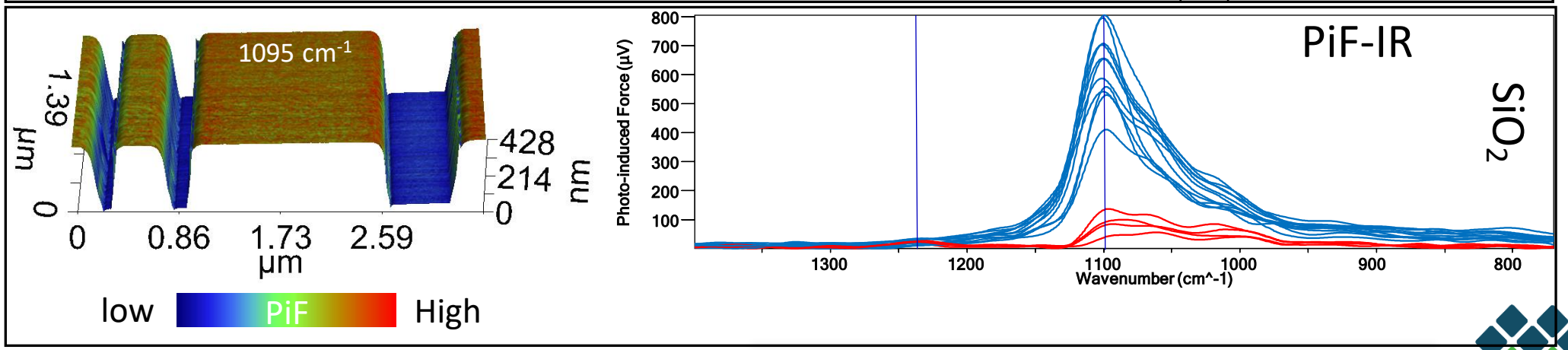


Octadecyltrichlorosilane (ODTS)

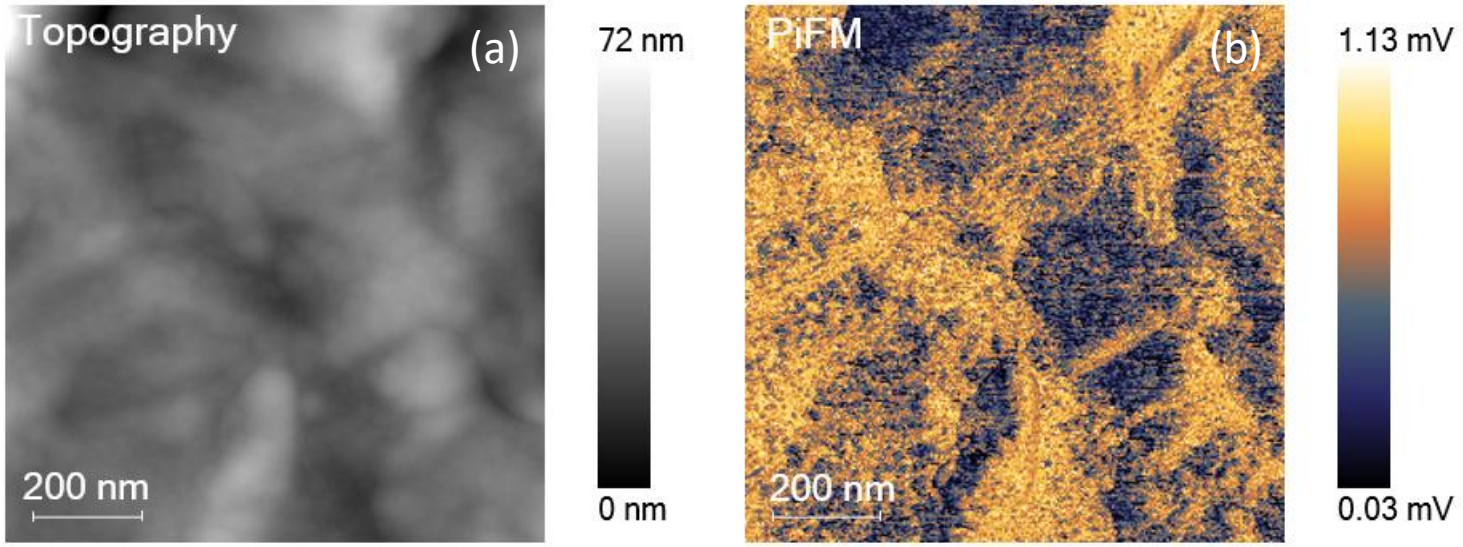




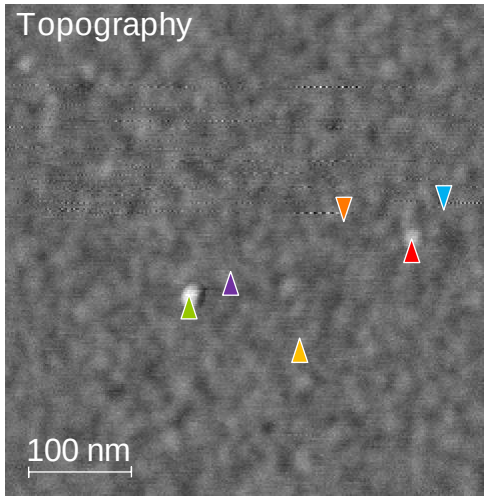


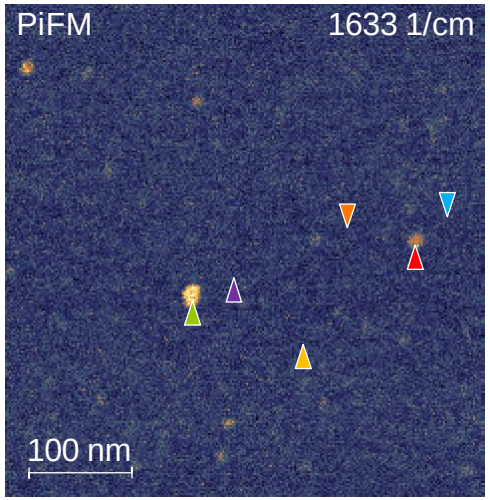


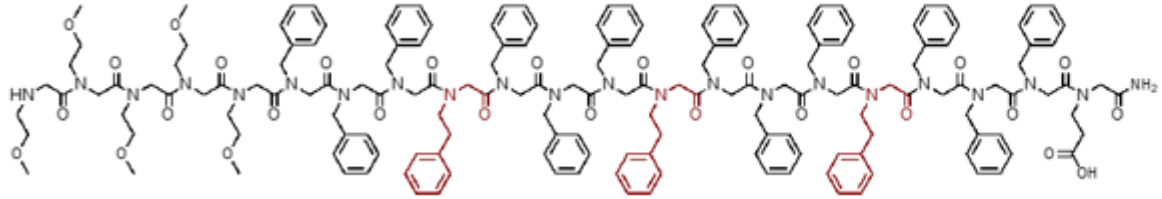
Trace Residue Visualization & Identification



PiFM Sensitivity - Incomplete Monolayer of Peptoid Molecules

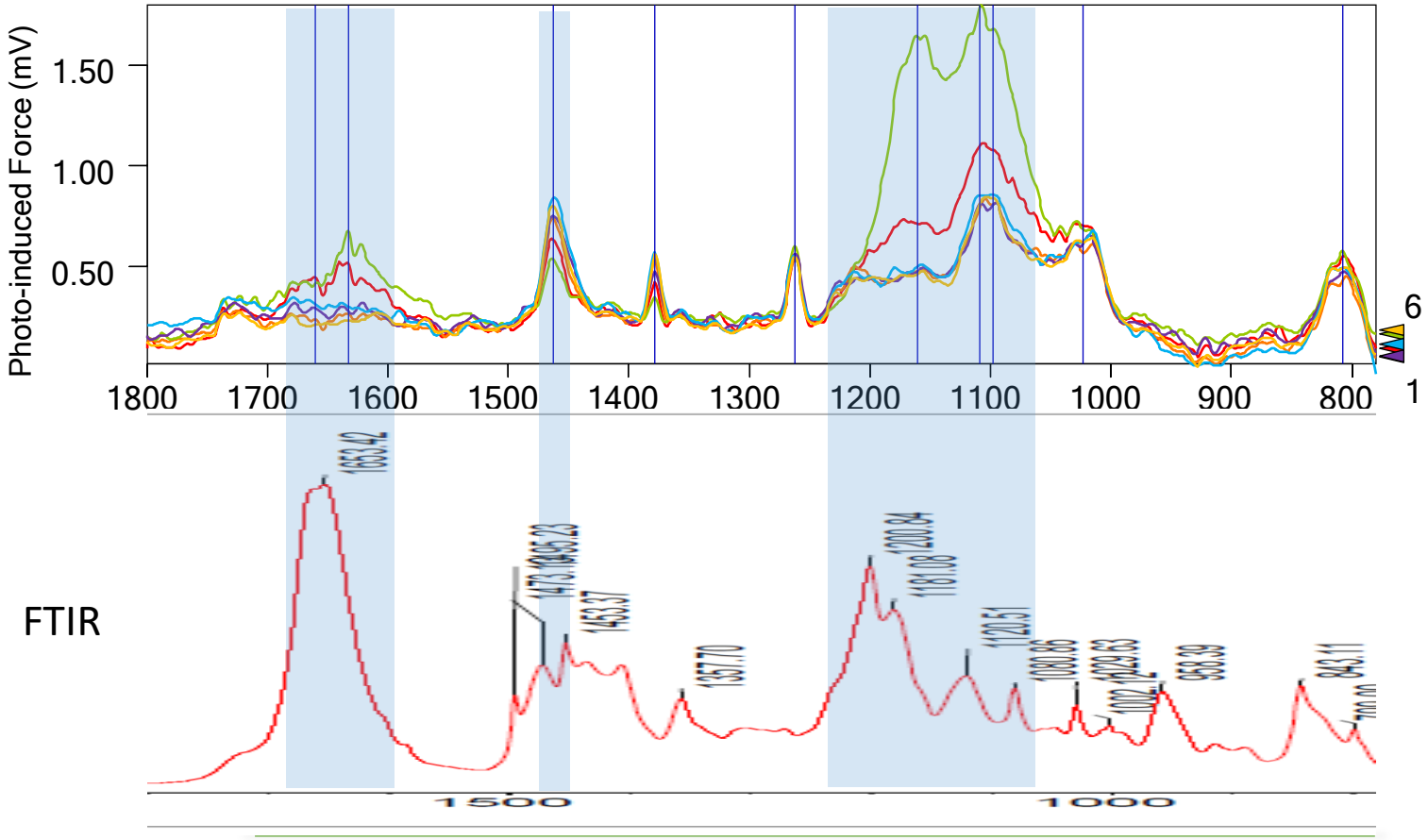






$Nme_5(Npm_3Npe)_3Npm_3Nce$ (MW: 2971.54)

● = Npe (*N*-(phenylethyl)glycine)



Complements other Analytical Techniques

	IR PiFM	Raman	FTIR	TOF-SIMS	XPS	TXRF	SEM/EDS	TEM	Auger
Species Detected	M.I.	M.I.	M.I.	M.I.	M.I.	E.I.	E.I.	E.I.	E.I.
Imaging/Mapping	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lateral Resolution	~ 5 nm	> 0.5 μm	> 10 μm	> 0.2 μm	10 μm – 2 mm	~ 10 mm	1 nm* 0.5μm EDS	0.2 nm	> 10 nm
Depth Probed	20 nm & bulk	> 500 nm	1 μm	1 nm	10 nm	10 nm	1 μm	~ 100 nm	10 nm

* Imaging M.I. Molecular information E.I. Elemental information

Summary

- IR PiFM is introduced.
- PiFM measures sample's IR absorption via mechanical force detection.
- It provides for exceptional spatial resolution (~ 5 nm), excellent surface sensitivity (monolayer), and ease-of-use.
- Vista-IR is a turnkey PiFM systems with visible to mid-IR lasers.
- Vista-IR can chemically map and identify organic and inorganic defects and residues via localized IR spectrum (from < 10 nm x 10 nm region by monolayer volume).