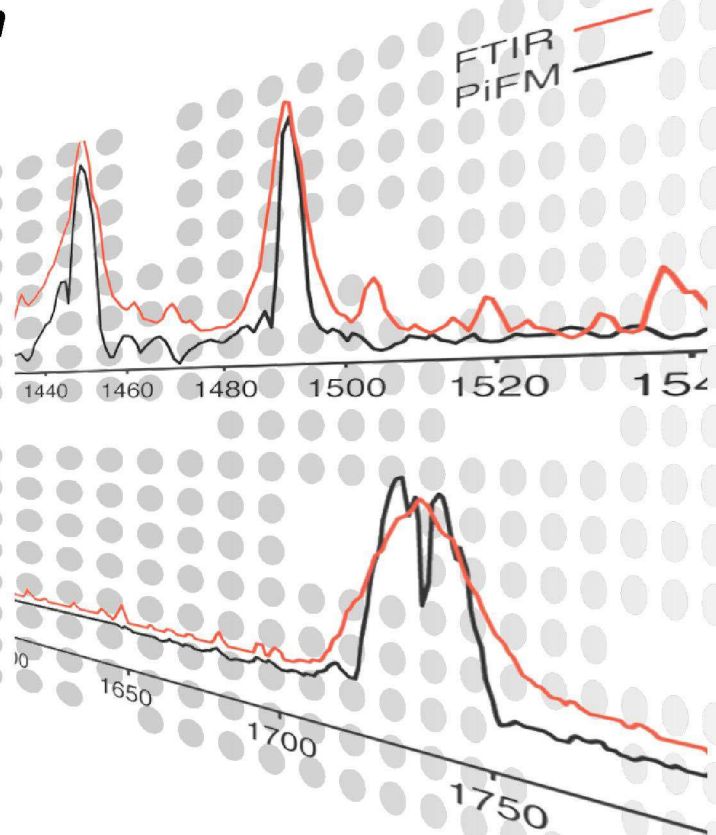
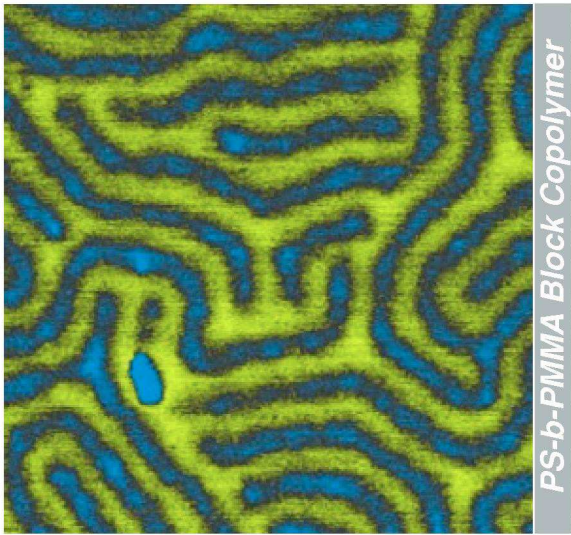


PiFM / AFM-IR / s-SNOM / Raman



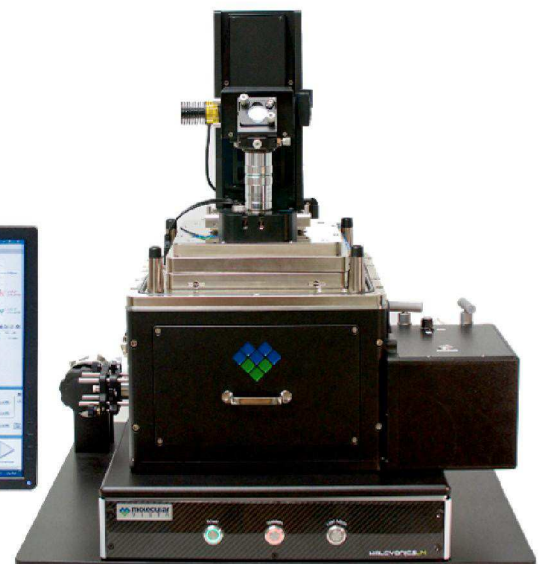
VISTA-IR

Photo-induced Force Microscope

Sub-10nm FTIR Imaging & Spectroscopy

Scattering SNOM

AFM-Raman & TERS



PiFM / AFM-IR / s-SNOM / Raman



AFM & PiFM (specific wavelength absorption / polarization)

Sub-10nm IR Hyperspectral Imaging & UV-Vis Spectral Imaging

Scattering SNOM (optical amplitude & phase)

AFM-Raman & Fluorescence (TERS & TEFS)

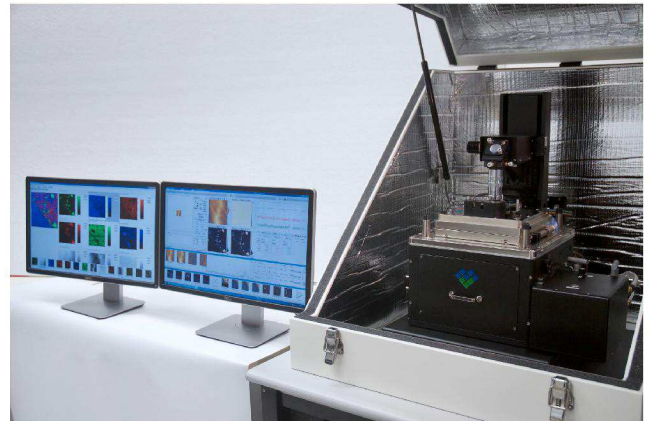
Full Optical Access (Top, Side, Bottom)

Optical Beam Deflection & Tuning Fork

Vacuum, Atmosphere, Liquid

Multi-frequency SPM (KPFM, EFM, MFM)

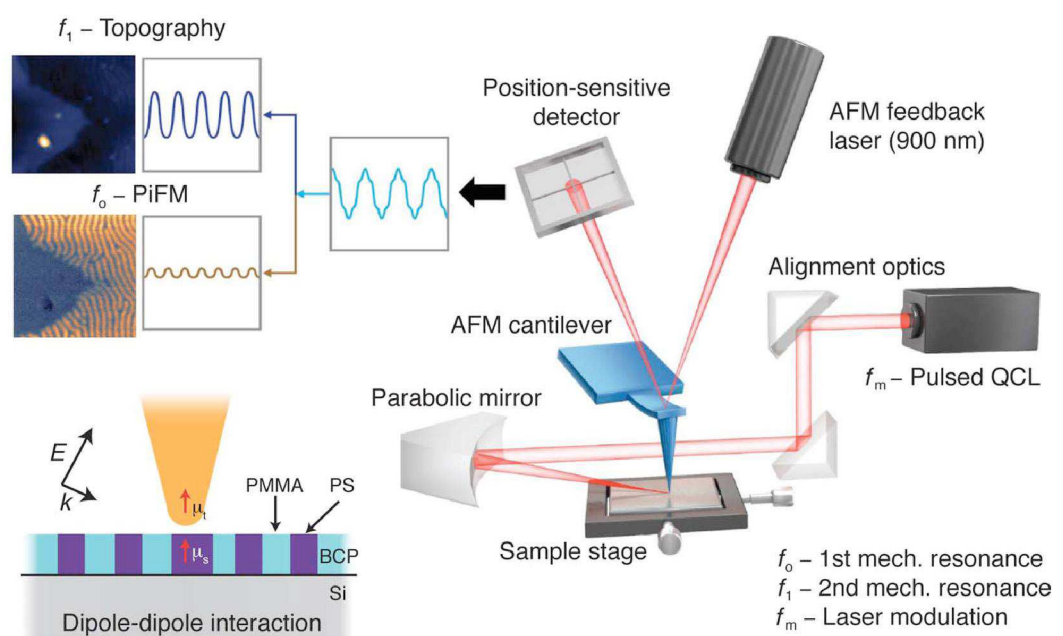
CAFM, PFM, Contact Resonance, Force Curve



Configuration with VistaScope

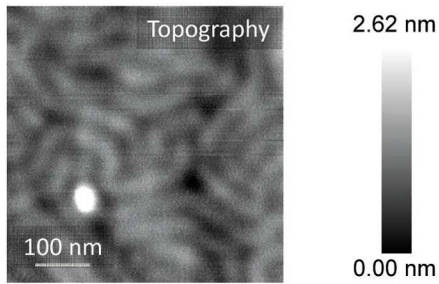
PiFM, Photo-induced Force Microscopy, Non-contact dipole-dipole Interaction Without Thermal Diffusion or Far Field Optical Detector, used as easy as AFM

A tunable quantum cascade laser illuminates on the sample and tip from side by parabolic mirror. It measures photo-induced dipole-dipole interaction between the tip with sample via mechanical force detection by using AFM cantilever in a multi-frequency mode. PiFM can generate amazing results with topography and chemical hyperspectral imaging or plasmonic polarization in sub-10 nm spatial resolution reliably.



Sub-10nm Chemical Spectral Imaging of Polymer and Biology

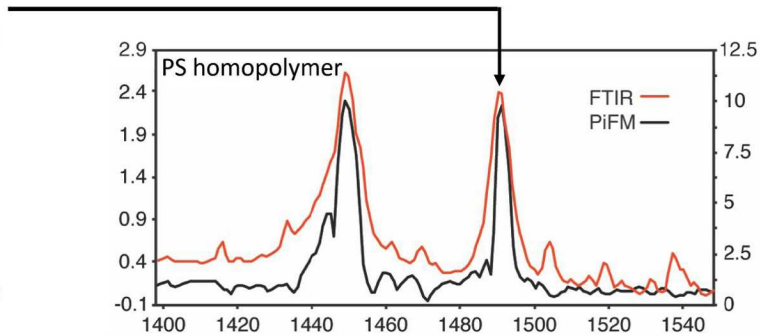
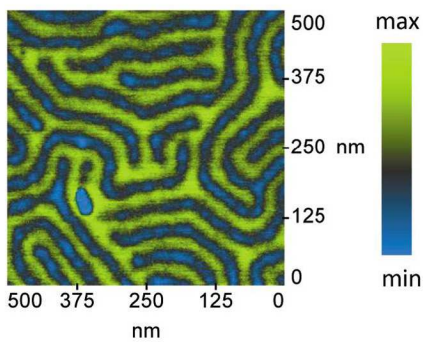
■ *PS-b-PMMA Fingerprint Patterns*



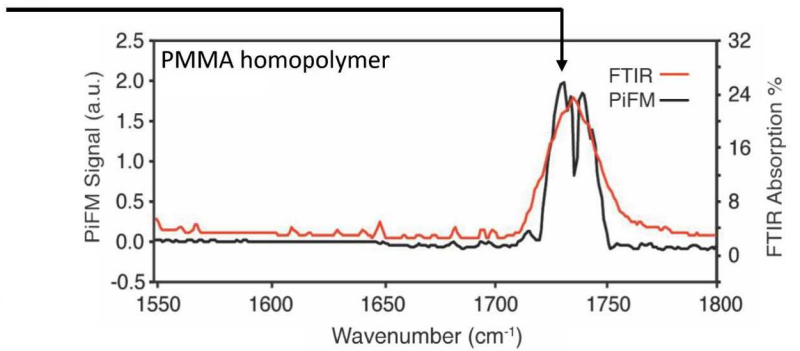
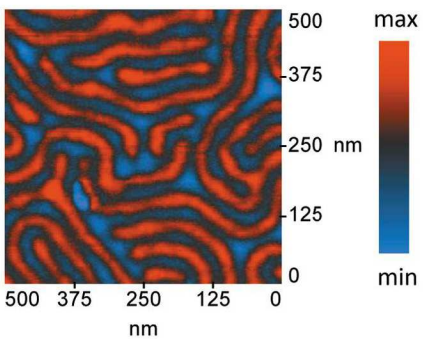
PS-b-PMMA is of interest for applications in nextgeneration lithography for semiconductors. A lamellae-forming film of PS-b-PMMA with a thickness of approximately 30nm.

Tuning the excitation laser to one of its absorption bands at 1492cm⁻¹ or 1733 cm⁻¹. PiFM selectively images the PS and PMMA polymer domains showing the predicted periodicity, including the ability to resolve a small bridge defect, measured to be only ~7 nm wide.

Polystyrene highlighted @ 1490 cm⁻¹

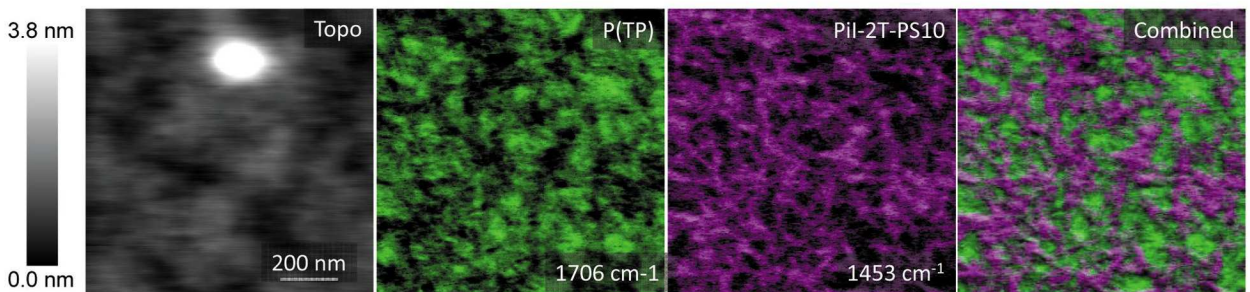


Polymethylmethacrylate highlighted @ 1733 cm⁻¹



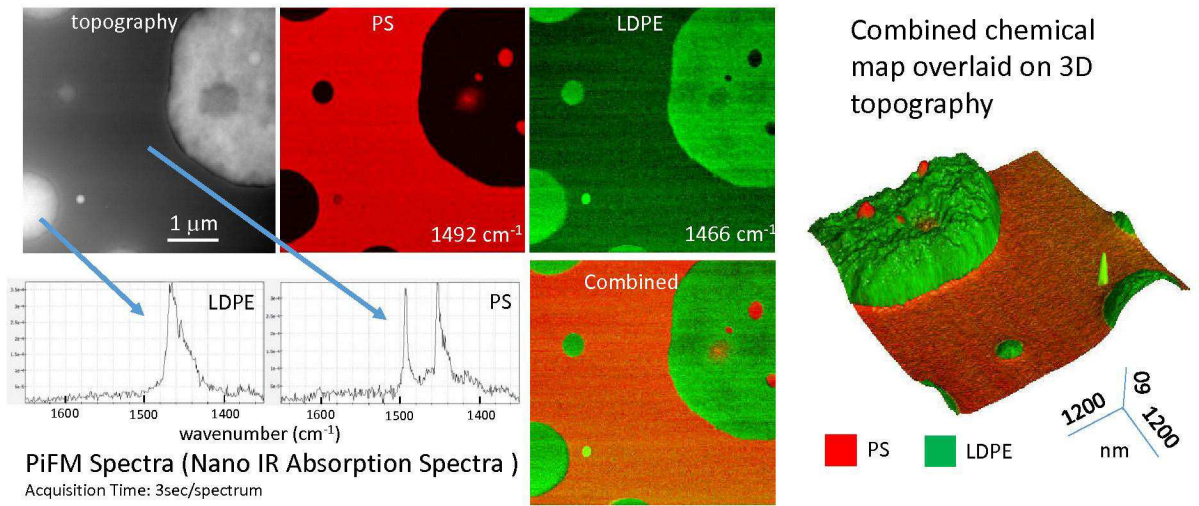
■ *Polymer Polymer Blend Solar Cell*

The two polymer components can not be identified via AFM topography or AFM phase imaging. That can be uniquely identified via PiFM.

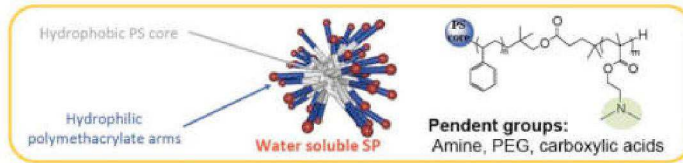


■ PS-LDPE Blend Copolymer

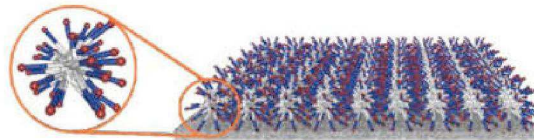
Polystyrene (PS)-Low Density Polyethylene (LDPE) blend copolymer is imaged via PiFM. Revealing PS and LDPE components unambiguously on their bulk absorption bands PiFM spectra for each component from the indicated nanoscale region match the bulk absorption spectra.



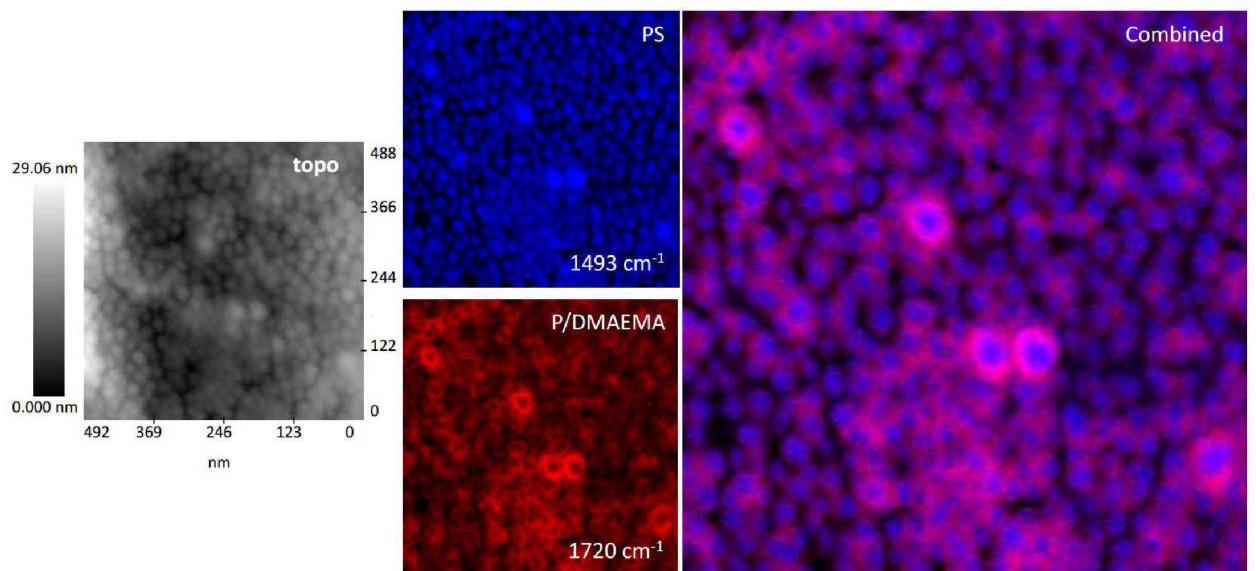
■ Core-Shell Star Block Copolymer (Drug Delivery)



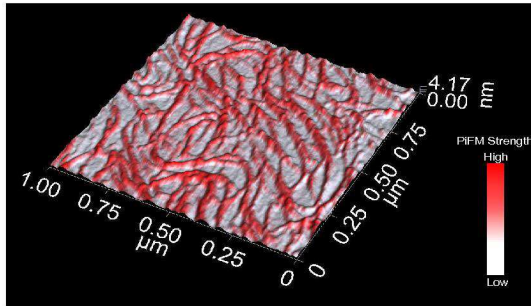
Star polymer, 500nm field, PS-P/DMAEMA
Whether the P/DMAEMA as shell is correctly attached on the PS as core.



AFM can not answer this question but PiFM can.
PiFM imaging breakthrough: clear imaging of PS core VS P/DMAEMA shell never seen before.

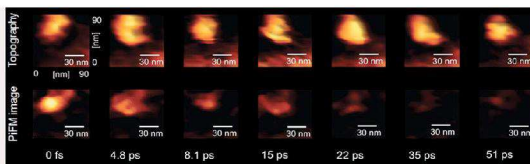


Single Collagen Molecules

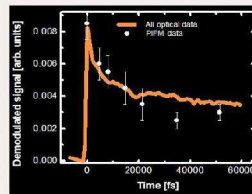


Excitation laser set to 1666 cm^{-1} , Amide I peak

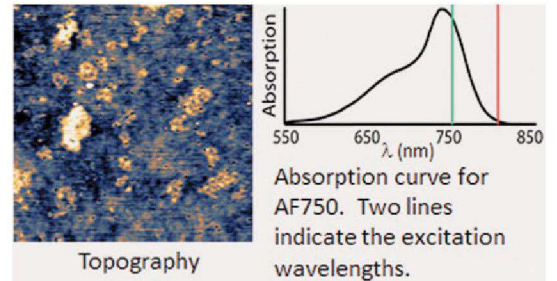
Time Resolved PiFM



Time-resolved PiFM images of Si-naphthalocyanine molecules at different probe delay (above) and comparison with all optical data (right). Data courtesy of Eric Potma lab at UC Irvine.



Fluorescent Dyes



Topography

Absorption curve for AF750. Two lines indicate the excitation wavelengths.

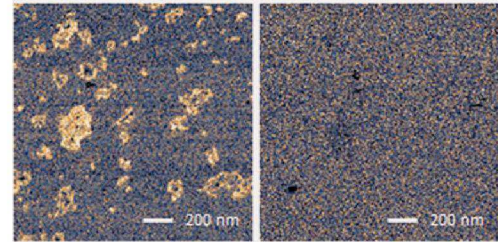


Image-Dipole Force @ 764 nm excitation

Image-Dipole Force @ 835 nm excitation

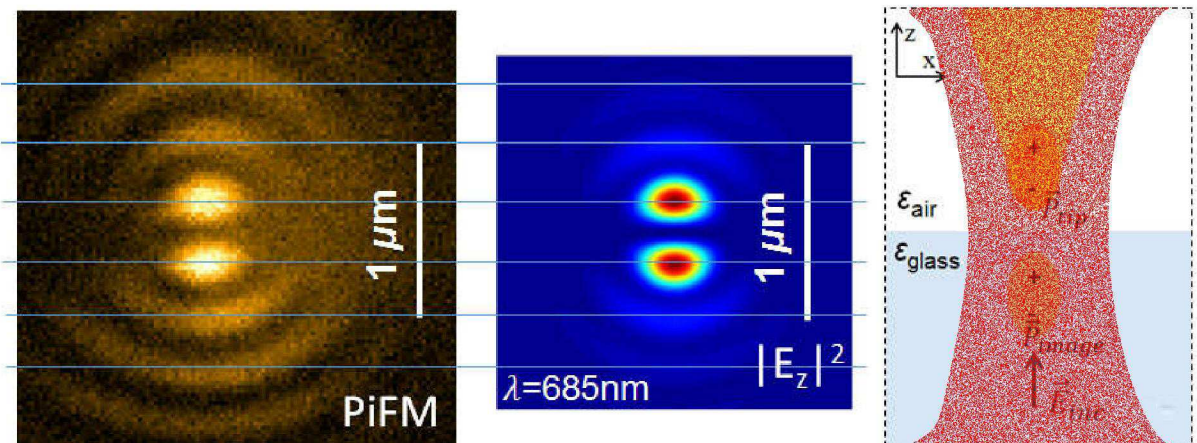
764nm strongly absorption 835nm no absorption
PiFM imaging matches the vis-spectrum well

Ultrafast Spectroscopy !
Linear & Nonlinear Spectroscopy !
All of them are available for PiFM !

Direct Optical Field Imaging of Nanoplasmonics and 2D Materials

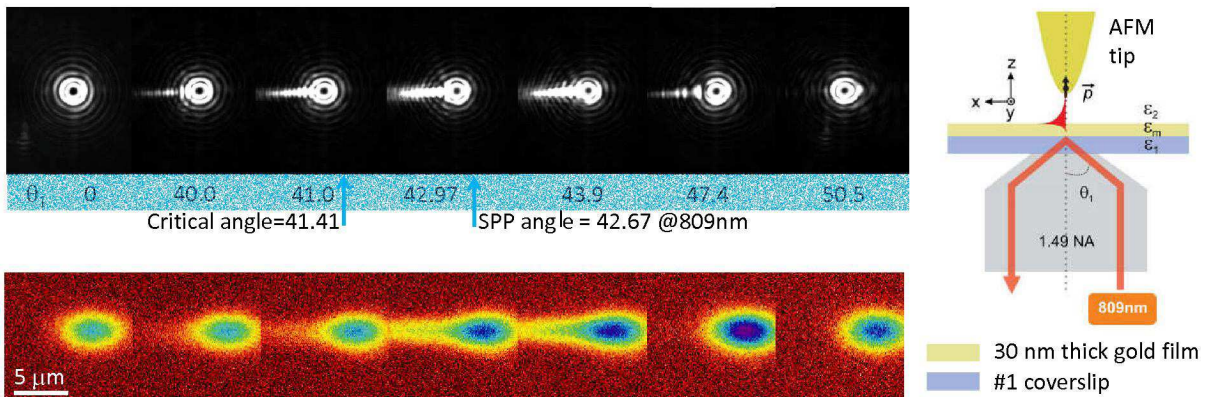
Longitudinal Focal Field of Laser Beam

The longitudinal focal field of a tightly focused light via high NA (1.45 NA) objective lens is imaged via PiFM. The measured PiFM result agrees well with the longitudinal field calculated from the dipole-dipole interaction between the polarized tip and the glass substrate.

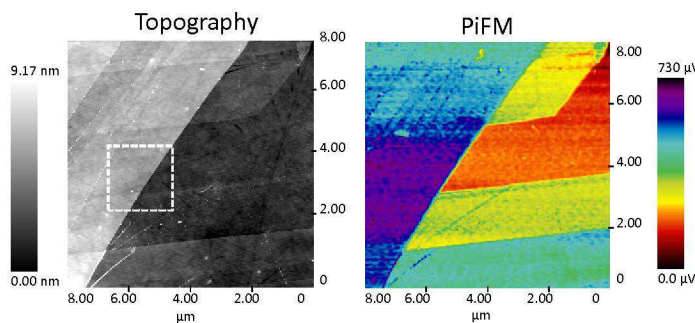


■ Surface Plasmon Polaritons of Gold Film

Surface plasmon polaritons (SPP) at the gold/air surface imaged via PiFM. p-polarized 809 nm laser beam is focused via 1.49 NA objective lens with a varying incident angle (controlled via a linear translation stage). (bottom) images show the CCD (PiFM) images of the illumination spot.

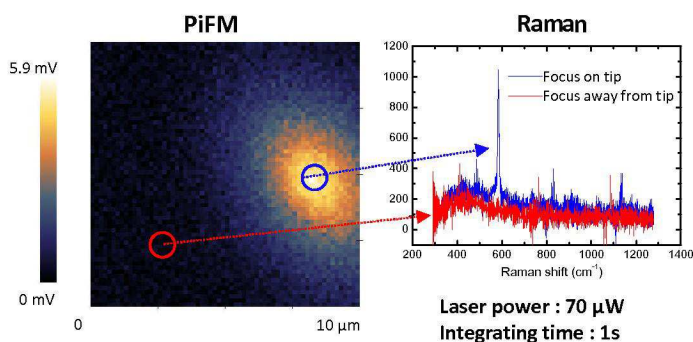


■ Graphene Plasmonics



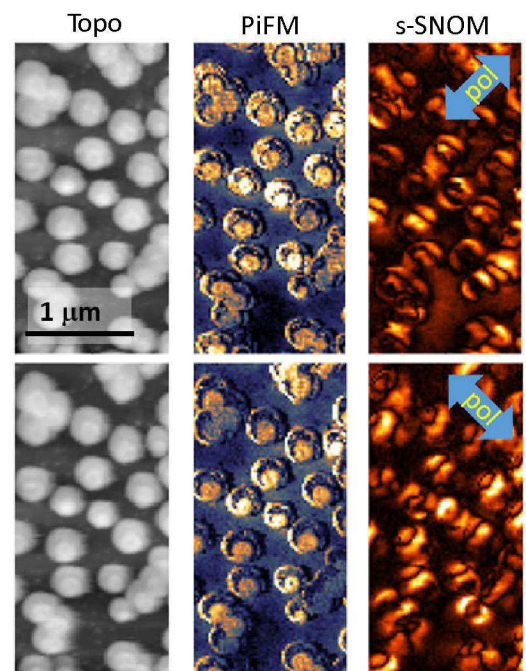
Excitation laser set to 800 nm
PiFM strength indicates the layer number

■ PiFM & TERS



TERS signal is observed when we align the tip to the maximum of the PiFM signal. Raman signal from BCB on Au is strongly enhanced at weak laser power.

■ Plasmonic Gold Discs

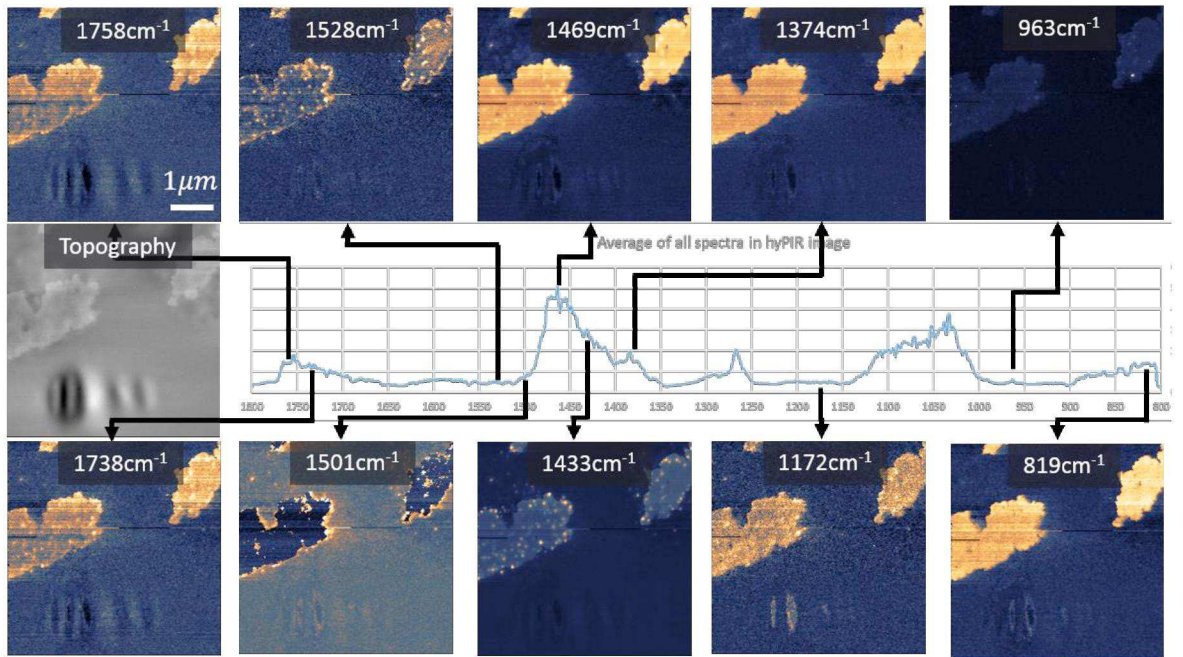


Excitation laser set to 652 nm
PiFM & s-SNOM imaging simultaneously
Longitudinal field of PiFM is not polarization dependent
Horizontal field of PiFM is polarization dependent

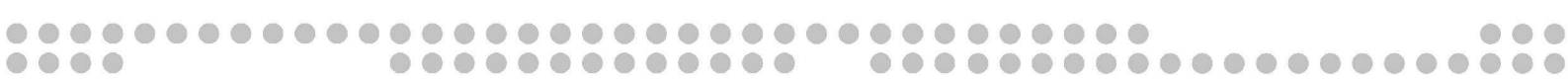
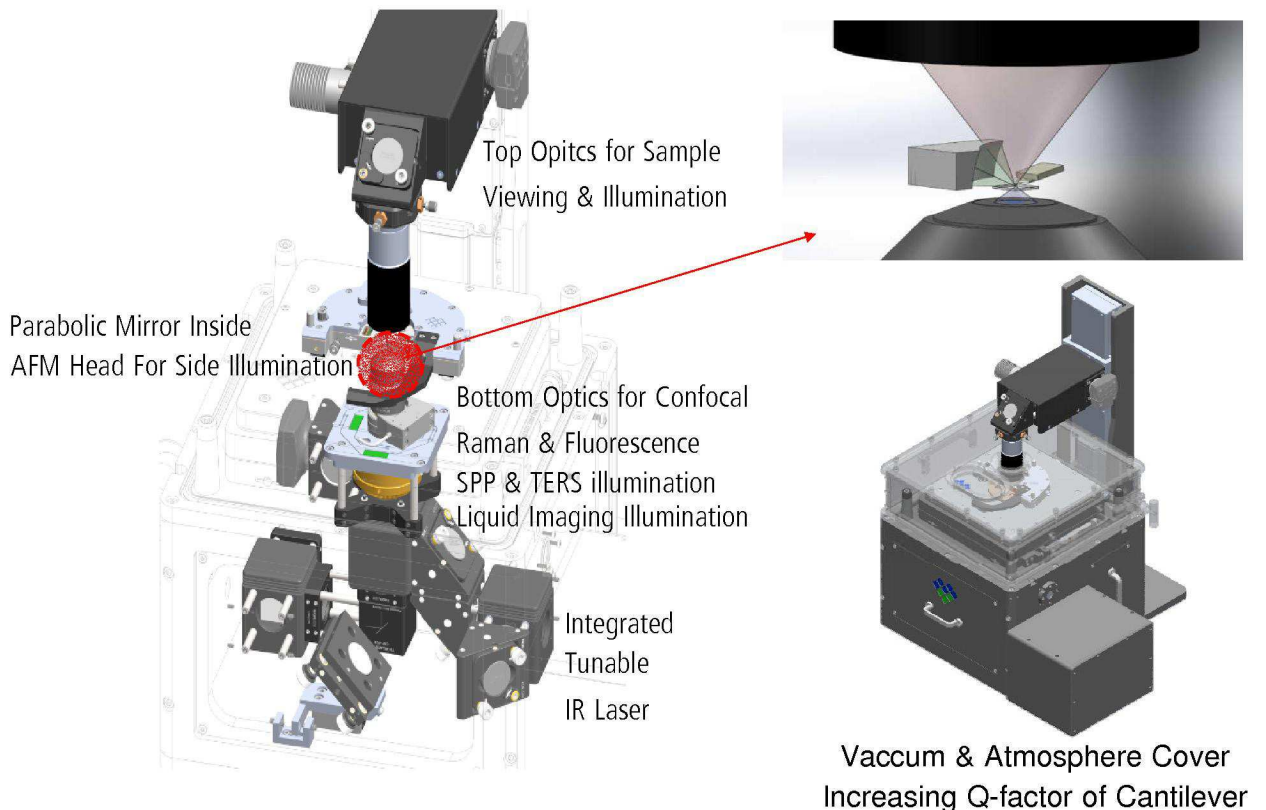
hyPIR™ Imaging - A spectrum at every pixel !

IR Hyperspectral Imaging of Asphalt Binder

Each of the intensity maps above is generated from the same hyPIR image. This single hyPIR image allows us to observe all the relevant chemical signatures of a sample, an asphalt binder in this example.



Full Optical Access (Top, Side, Bottom), Vacuum, Atmosphere, Liquid





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