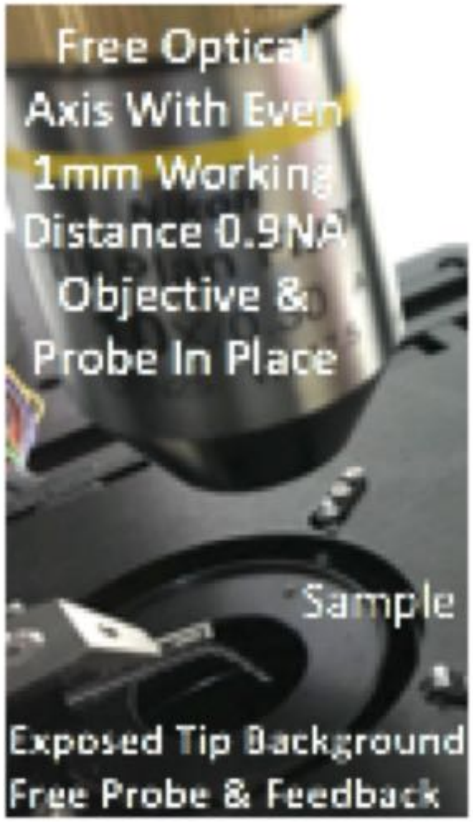
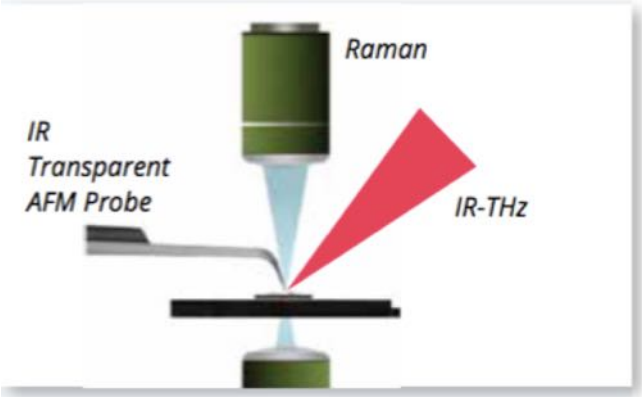
# The Multiprobe IR Apertureless Advantage

# Multiprobe Apertureless NSOM Key Features

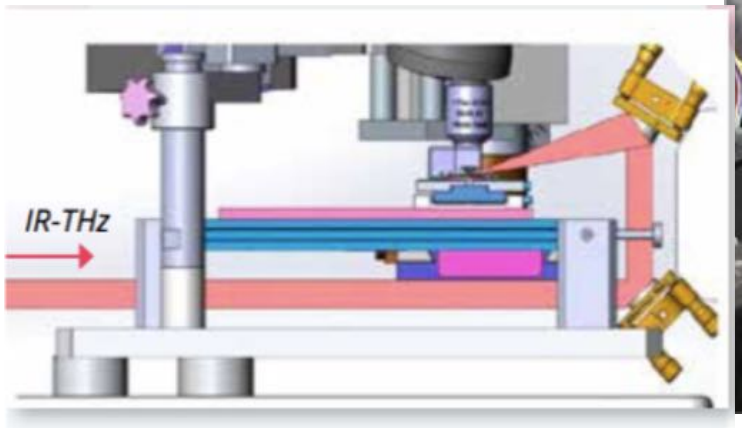
- *Instrument and Probes* allowing aperturless IR NSOM with on-line Raman vibrational spectroscopic comparison at ambient and controlled environment conditions
- *Probes produced in-house with singular characteristics*
  - Can be made of a variety of materials to optimize scattering only from the probe tip and not the shaft or cantilever
  - Multiple probes can be brought into contact
- *Controlled environment & low temperature* 10oK operation with similar characteristics
- *Feedback With tuning fork independently shown to be superior*
  - Superior for apertureless imaging
  - With ten times higher force sensitivity of any AFM feedback method
- *Variable Magnetic Field Readily Integrated*
- *MultiProbe Transport Measurements*

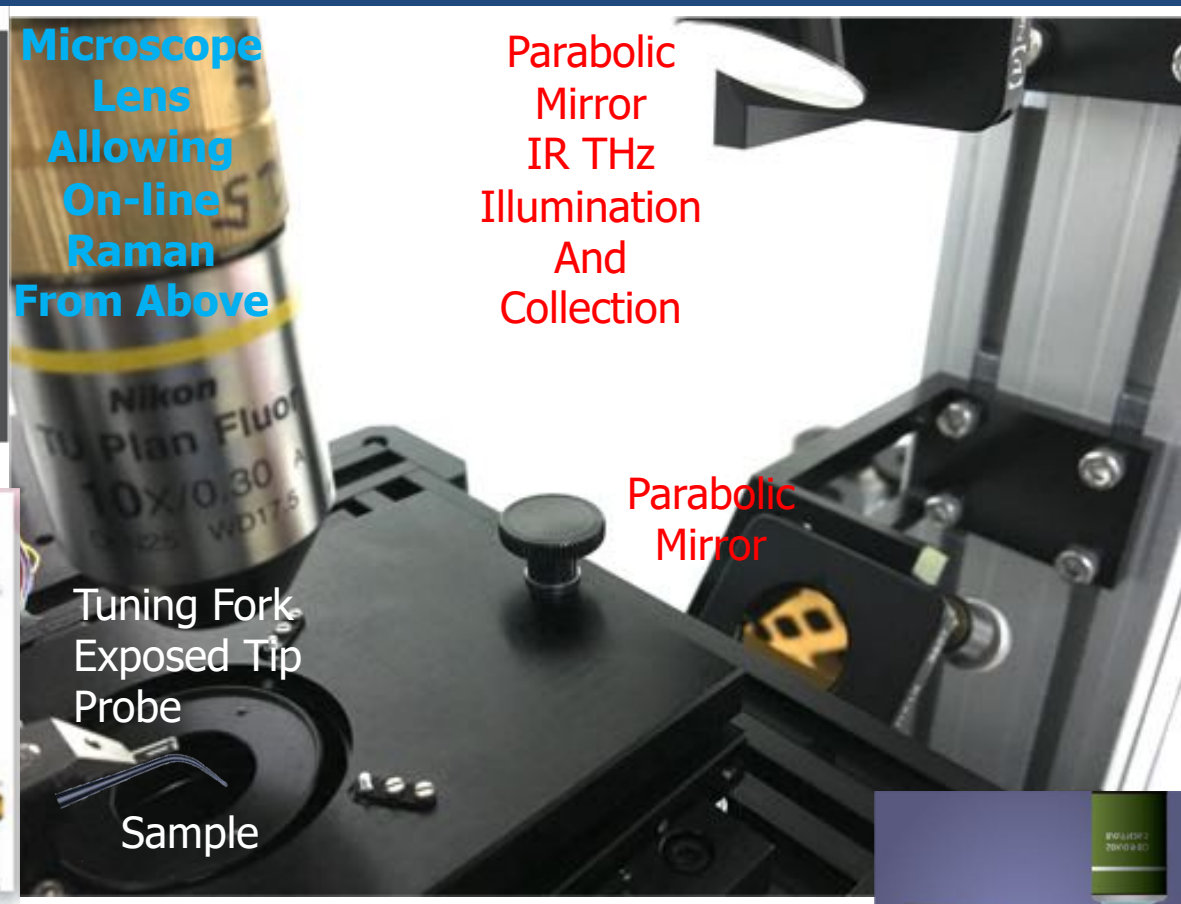
# Illumination from top bottom and 360° all around

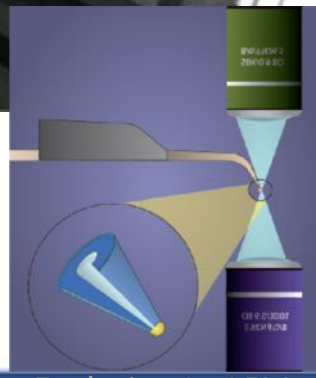



# Side Illumination Apertureless IR With Simultaneous Raman Excitation and Collection

Probes With Transparent IR Shafts & Scattering Tips That Do Not Block Any Ray of the Raman Lens

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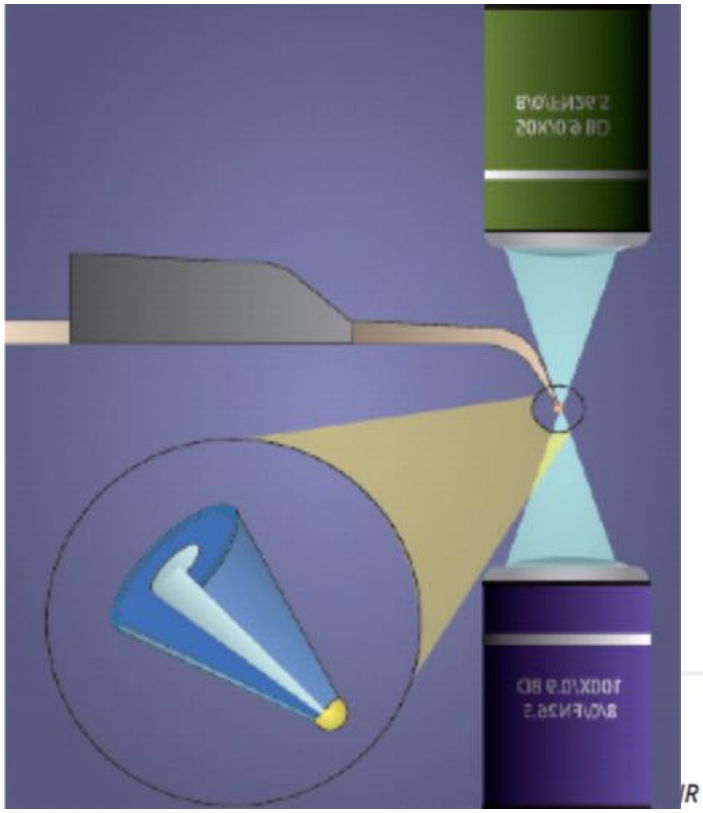
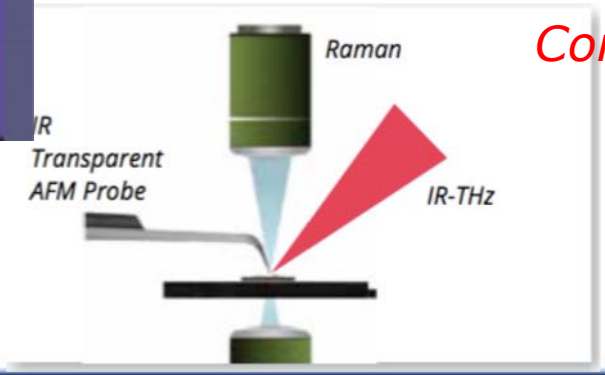
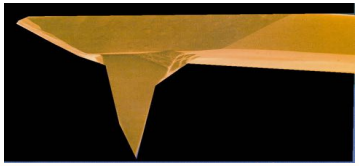


**What customers publish: "…In our experimental configuration, the tip apex is not shadowed, as the laser beam is a focused beam with a converging angle of 26.7°, while the half angle of the tip is only about 4° . "** [Sun and Shen, Apertureless near-field scanning Raman microscopy using reflection scattering geometry, Ultramicroscopy 94, 237 (2003)]




*Conventional Probes Block The Optical Axis*



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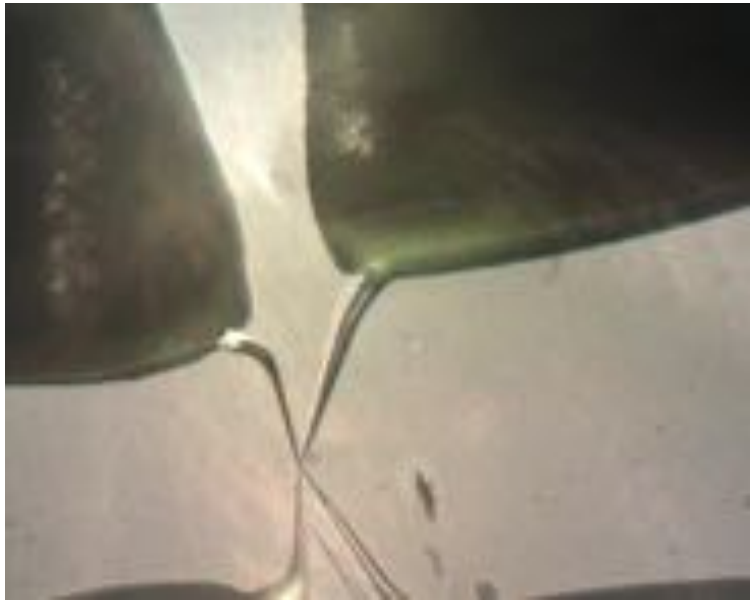
# Probes Can Be Brought Into Contact & Separated With Nanometric Precision For Investigating Nanotransport of Conductivity, Optical & Thermal Phenomena



**What customers publish:** ” Collisions between both tips were effectively prevented by a proximity detection mechanism based on mechanical interaction between both tips. The minimum distance between both tips is reached when both tip coatings touch..” Klein et al, NanoLett. 14, 5010 (2014)

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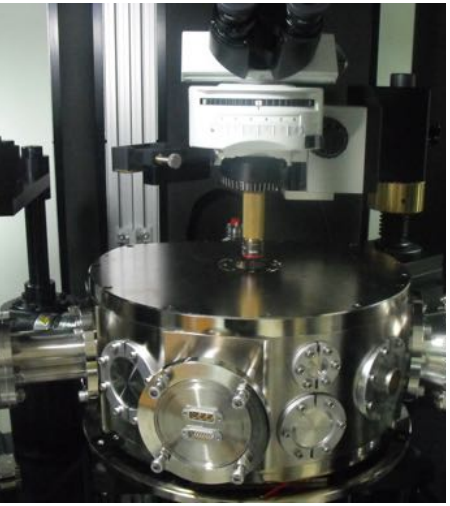
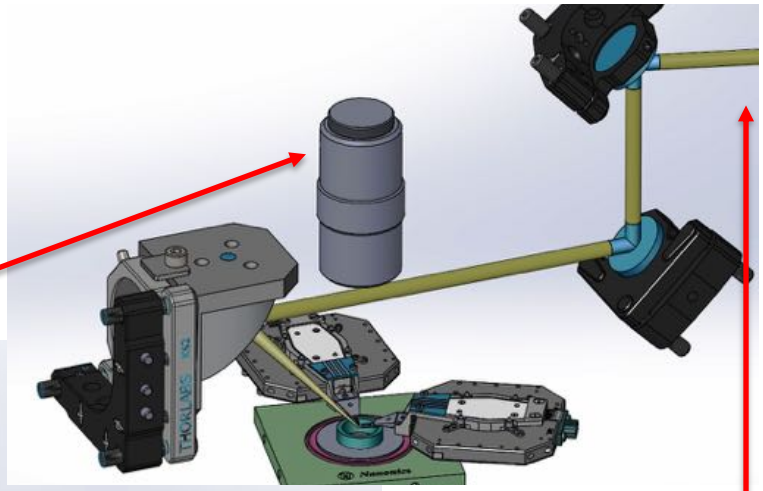
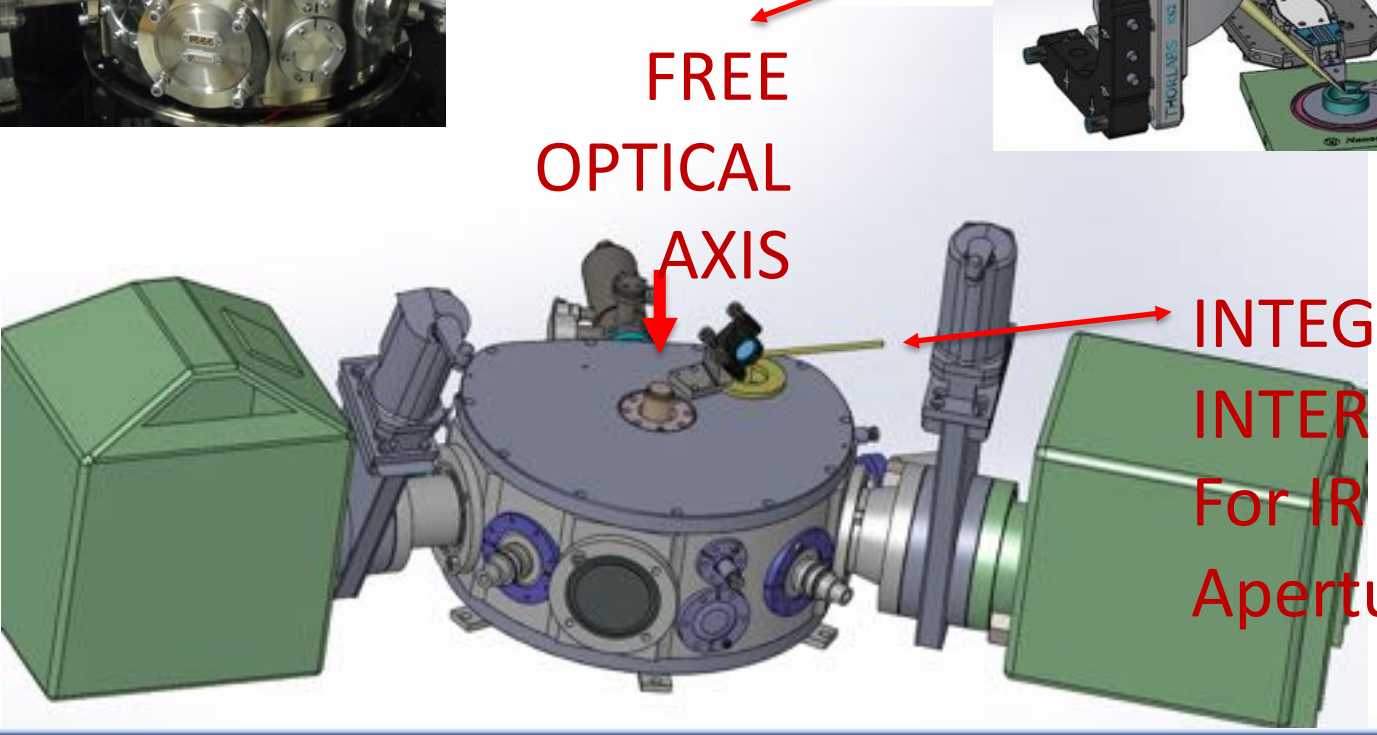
# Fully Integrated Controlled Environment and 10°K Conditions Multiprobe Apertureless





FREE OPTICAL AXIS



INTEGRATED INTERFEROMETER For IR and Visible Apertureless NSOM

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# Superiority of Tuning Fork For Scattering NSOM Independently Demonstrated

## Terahertz Nanoscopy of Plasmonic Resonances with a Quantum Cascade Laser

Riccardo Degl'Innocenti,[*,†,⊥] Robert Wallis,[†,⊥] Binbin Wei,[†] Long Xiao,[†,‡] Stephen J. Kindness,[†] Oleg Mitrofanov,[§] Philipp Braeuninger-Weimer,[‡] Stephan Hofmann,[‡] Harvey E. Beere,[†] and David A. Ritchie[†]

[†]Cavendish Laboratory, University of Cambridge, J. J. Thomson Avenue, CB3 OHE Cambridge, United Kingdom

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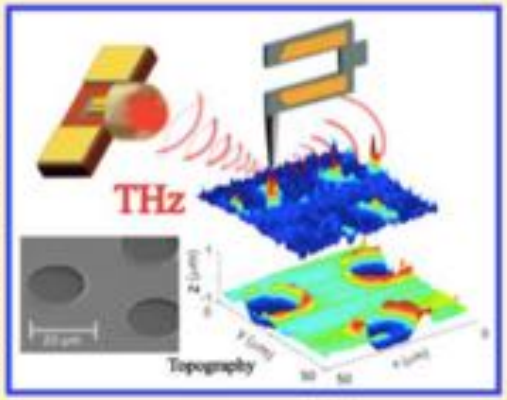
[§]Department of Electronic and Electrical Engineering, University College London, Torrington Place, WC1E 7JE London, United Kingdom

*Supporting Information*

**ABSTRACT:** We present a terahertz (THz) scattering near-field optical microscope (s-SNOM) based on a quantum cascade laser implemented as both source and detector in a self-mixing scheme utilizing resonant quartz tuning forks as a sensitive nanopositioning element. The homemade s-SNOM, based on a resonant tuning fork and metallic tip, operates in tapping mode with a spatial resolution of ~78 nm. The quantum cascade laser is realized from a bound-to-continuum active region design with a central emission of ~2.85 THz, which has been lens-coupled in order to maximize the feedback into the laser cavity. Accordingly, the spatial resolution corresponds to >$\lambda/1000$. The s-SNOM has been used to investigate a bidimensional plasmonic photonic crystal and to observe the optical resonant modes supported by coupled plasmonic planar antennas, showing remarkable agreement with the theoretical predictions. The compactness, unique sensitivity, and fast acquisition capability of this approach make the proposed s-SNOM a unique tool for solid-state investigations and biomedical imaging.




**KEYWORDS:** *near-field microscopy, terahertz, plasmonics, photonic crystals, quantum cascade laser, self-mixing detection*

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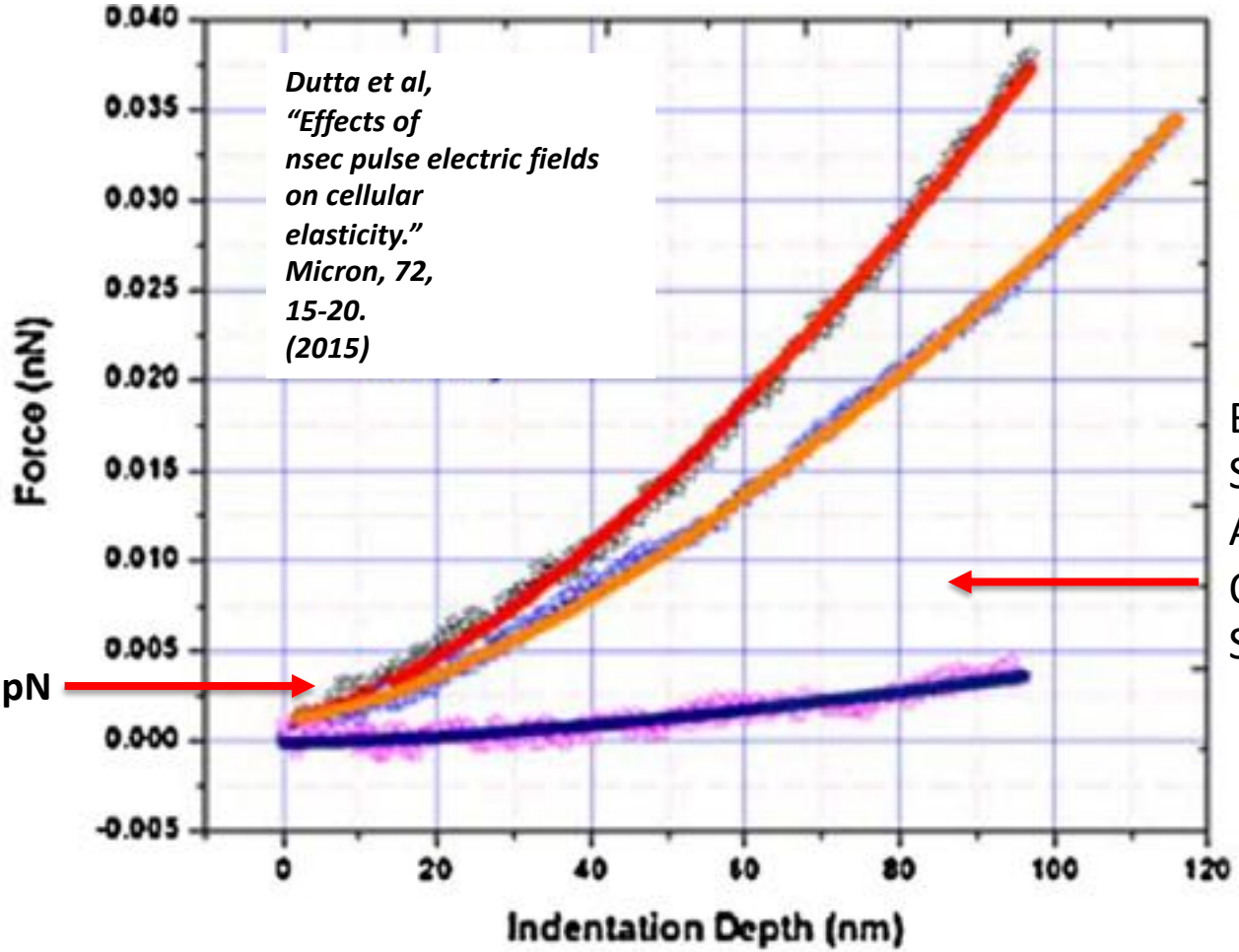
# Published Characteristics of Nanonics Systems & Probes

## *Highest Force Sensitivity*




Force Sensitivity Significantly Improved Over Conventional AFM

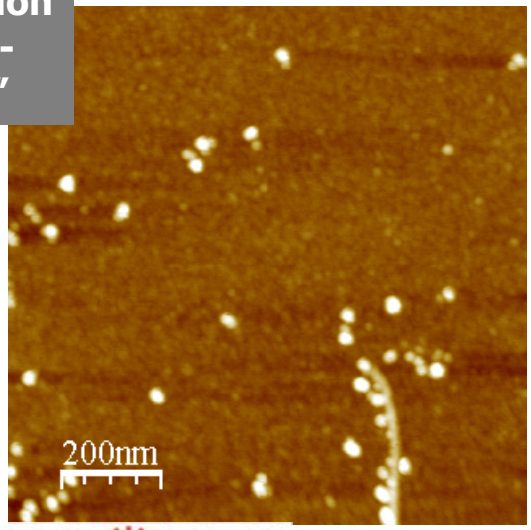
**<5 pN**

Best Force Sensitivity Achievable In Other AFM Systems

# Published Characteristics of Nanonics Systems *Excellence in AFM Morphology*

**What customers publish:**
**"…high sensitivity in amplitude and phase, as well as high mechanical quality factor…. it provides conclusive information about the morphology of one-dimensional nanostructures."**

Materials Letters 165 (2016) 67–70




## Quantum Dot Decorated DNA

SCIENTIFIC REPORTS

OPEN

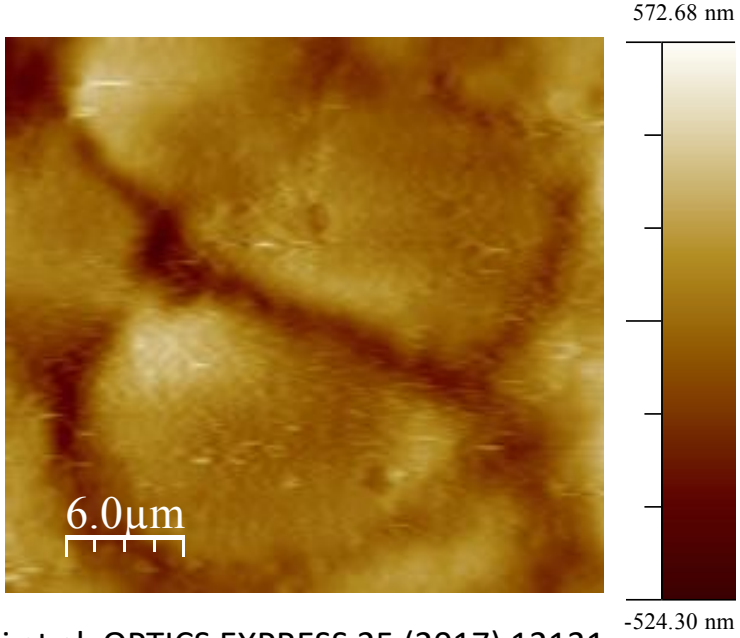
**Reduction in Step Height Variation and Correcting Contrast Inversion in Dynamic AFM of $WS_2$ Monolayers**

Kyle Godin, Christian Cupo & Eui-Hyeok Yang

A model has been developed to account for and prevent the anomalies encountered in topographic images of transition metal dichalcogenide monolayers using dynamic atomic force microscopy (dAFM).

Received: 29 August 2017
Accepted: 5 December 2017
Published online: 19 December 2017

## Microvilli on the Surface of Live MDCK Cells




Brahami et al, OPTICS EXPRESS 25 (2017) 12131

# Excellent XY Morphological Fidelity Even Compared To FESEM As Described in the literature

Materials Letters 165 (2016) 67–70

Contents lists available at ScienceDirect

Materials Letters

journal homepage: www.elsevier.com/locate/matlet

## Atomic force microscopy (AFM) and 3D confocal microscopy as alternative techniques for the morphological characterization of anodic $TiO_2$ nanoporous layers

Diego P. Oyarzún [a,*], Omar E. Linarez Pérez [b], Manuel López Teijelo [b], César Zúñiga [a], Eduardo Jeraldo [a], Daniela A. Geraldo [a,c], Ramiro Arratia-Perez [a,c]

[a] Centro de Nanociencias Aplicadas (CENAP), Facultad de Ciencias Exactas, Universidad Andrés Bello, Chile, Avenida República 275, Santiag
[b] Instituto de Investigaciones en Fisicoquímica de Córdoba (INFIQC), Facultad de Ciencias Químicas, Universidad Nacional de Córdoba, Hay Medina Allende, 5000 Córdoba, Argentina
[c] Núcleo Milenio de Ingeniería Molecular para Catálisis y Biosensores, ICM, Chile

### 4. Conclusions

The characterization of the surface morphology by FESEM and TEM was compared with the results obtained by both AFM and 3D confocal microscopy. Characterization of porous oxide layers by AFM shows that the microscope with tuning fork configuration (intermittent mode) presents advantages over the beam bounce configuration (contact mode) namely high sensitivity in amplitude and phase, as well as high mechanical quality factor. This, in turn, allows the acquisition of real images of high resolution of the organized nanostructures. Additionally, the average radius values obtained from the AFM experiments are very similar to those obtained from FESEM images, which reflects that the morphological information obtained by atomic force microscopy for $TiO_2$ nanotubes is reliable and representative of the properties of the system. In brief, the intermittent AFM mode using tuning fork configuration is a powerful tool for characterizing highly ordered porous nanostructures as it provides conclusive information about the morphology of this one-dimensional nanostructures. On the

The Tuning Fork Uniquely Provides A High Quality Factor, Q, For Ultra Sensitivity In AFM And In AFM Morphology. This Is Not Available With Any Beam Bounce Feedback AFM (see green highlighted customer description). Also True Non-contact Is Achieved With The Nanonics Tuning Fork Systems. Thus, Nanonics Provides The Only AFM Systems That Allow For Switching Between AFM And STM Feedback With The Same Probe. Proving Non-contact AFM Operation

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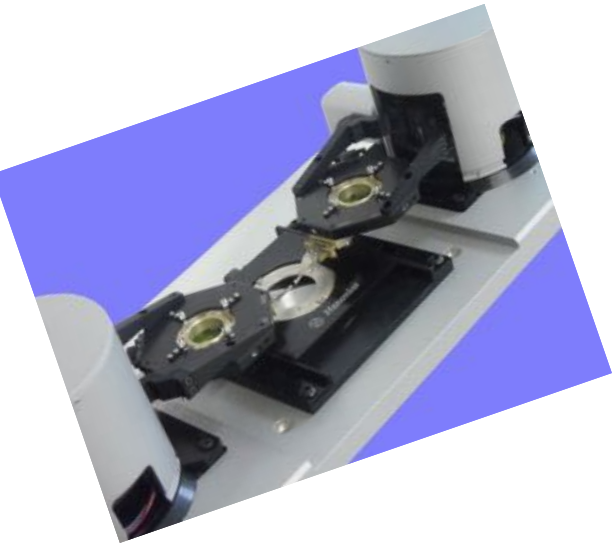
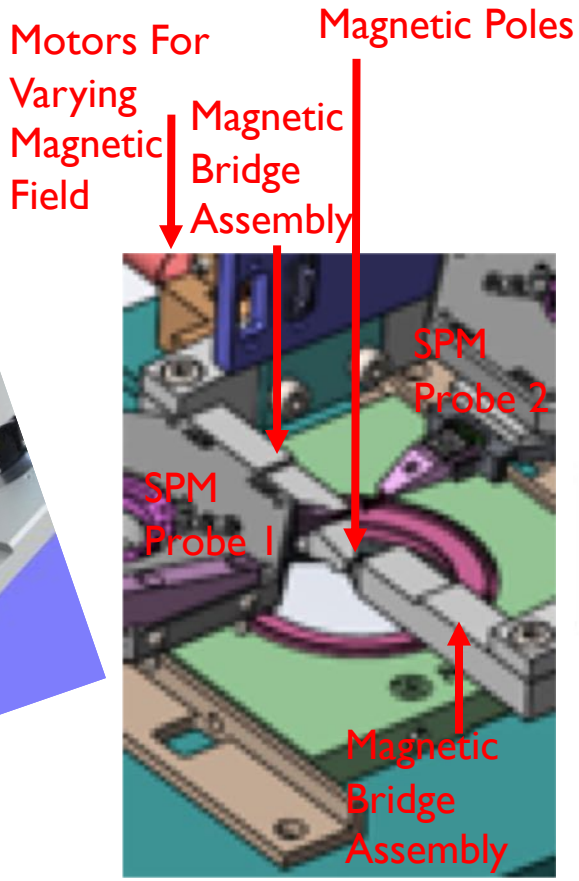
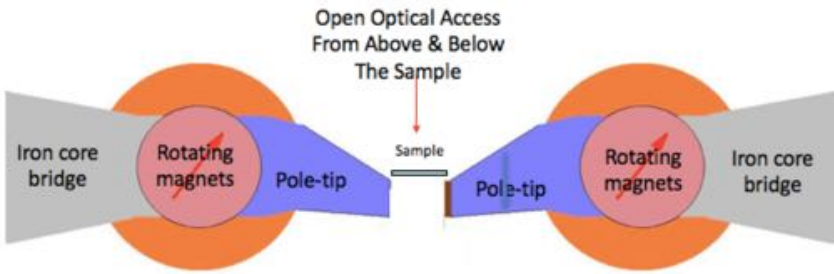
# Variable Magnetic Fields Above or Below Sample





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# Collage Produced By Combining Apertureless Images of Amplitude & Phase of Plasmonic Transport