Product Line
neaspec

attocube
WITTENSTEIN group

Applications Collection

Nanoanalysis of 2D Materials

discover exotic phenomena in low-dimensional structures

NANOSCALE ANALYTICS
advanced imaging & spectroscopy

Recommended Product: *IR*-neaSCOPE+TERs

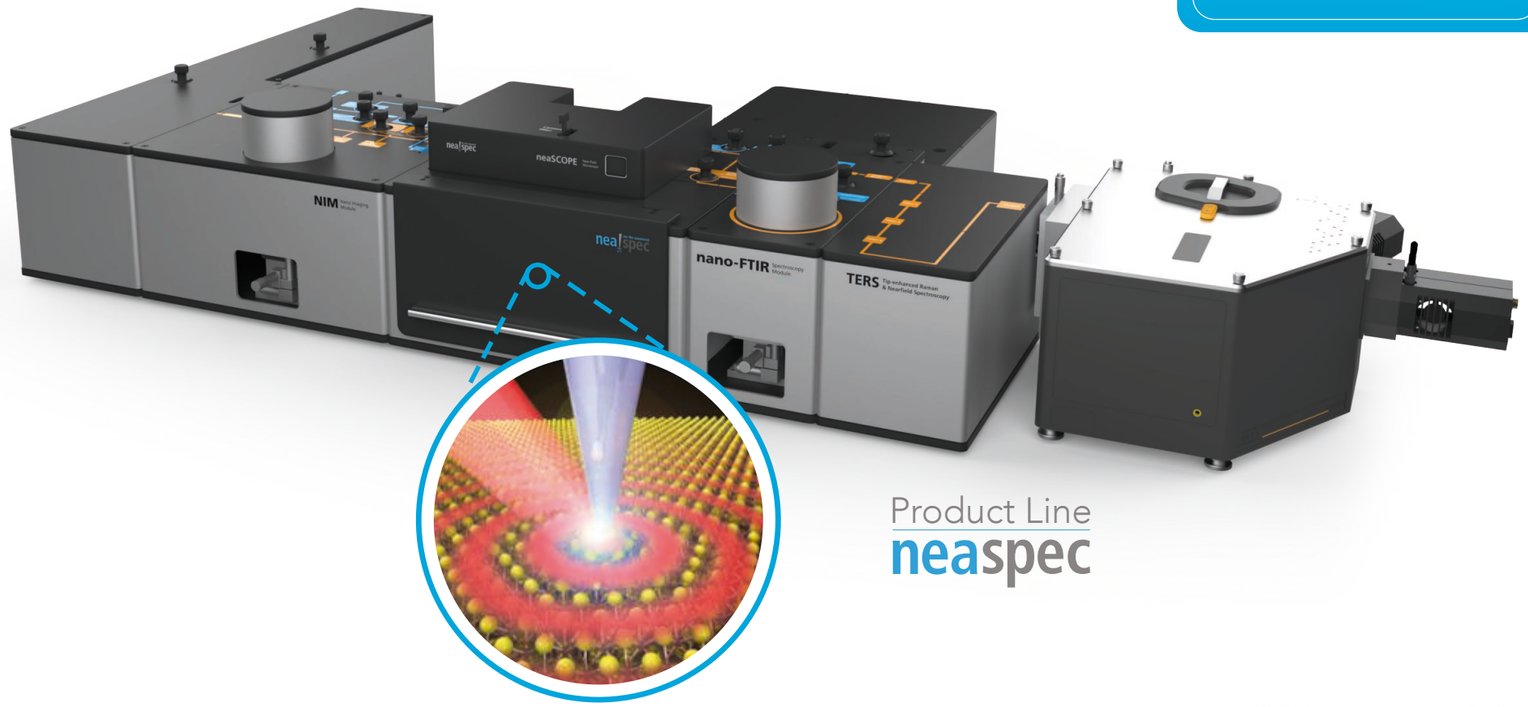
IR-neaSCOPE+TERs combines AFM & nano-IR with Raman and Photoluminescence (PL) spectroscopy for an ultimate tip-enhanced (TE) characterization using elastic and inelastic light scattering from the same microscope. It allows for simple alignment procedure using complementary IR or visible scattering, which delivers robust nanoscale resolved Raman and PL spectroscopy performance.

Visit
our webpage
IR-neaSCOPE+TERs

IR-neaSCOPE+TERs

- same spot for nano-IR and nano-Raman/PL spectroscopy
  → using a single ultrabroadband high-NA parabolic mirror for on-tip focusing
- maximum inelastic light scattering signal from the tip
  → using strong near-field scattering for perfect focusing
- single user interface for correlative measurements
  → optimized for storing and organizing multidimensional correlative data

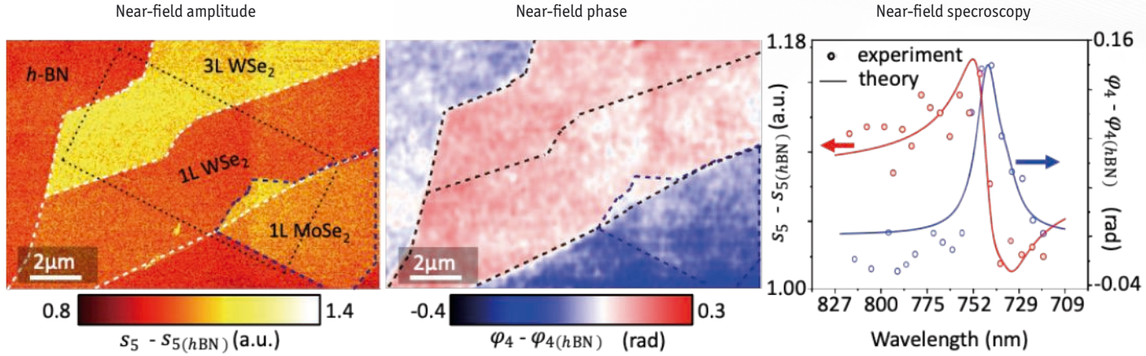
enables nano-IR, Raman, and photoluminescence spectroscopy in a single microscope



Product Line
neaspec

Exciton nanospectroscopy in atomically thin $MoSe_2$ and WSe_2

neaSCOPE*s equipped with s-SNOM measures near-field amplitude and phase simultaneously, probing sample reflectivity and absorption with spatial resolution at the 10 nm scale. Tunable visible illumination enables nano-spectroscopy of excitons even in monolayer TMDs.



neaSCOPE quantification of exciton-polariton spectra extracted from amplitude- and phase-resolved single frequency images of TMD nanostructures allowed for the extraction of complex dielectric functions in monolayer, bilayer, and trilayer WSe_2. Comparison of measured spectra with theoretical modelling of exciton resonance energy affected by dielectric screening, interlayer hybridization, and layer thickness provides novel insights into optical properties of atomically thin TMD sample structures.

neaSCOPE advances exciton-based photonic & semiconductor devices

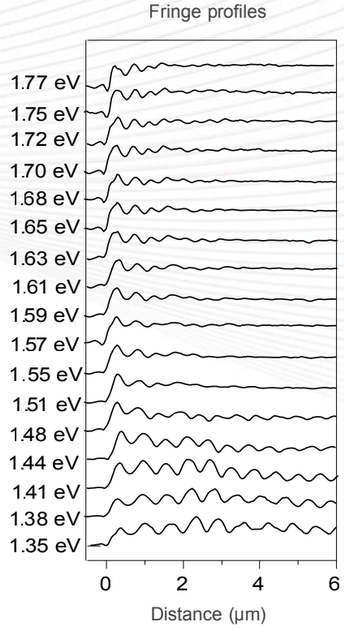
nature COMMUNICATIONS — S. Zhang et al., Nat. Commun. 13, 542 (2022)

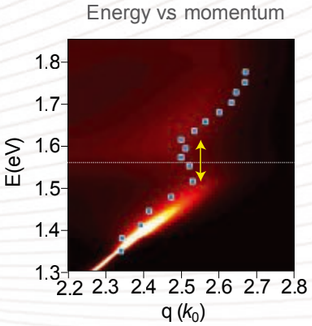
Exciton-polariton transport in $MoSe_2$ waveguides

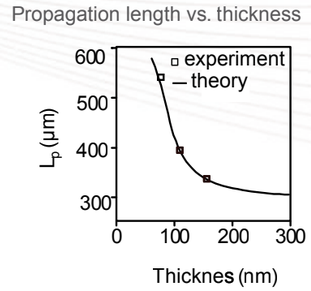
Dispersion-free optics of neaspec instruments enables nanoscale resolved measurements completely independent of frequency of light. Using tunable visible laser light for investigating exciton-polaritons in 2D material waveguides allows for quantification of polariton dispersion.

Exciton-polariton (EP) interference patterns mapped by neaspec s-SNOM under different illumination energy enabled analysis of EPs dispersion and propagation length in $MoSe_2$. Propagation lengths exceeding 12 µm and an intriguing dispersion back-bending near the exciton resonance were found in addition to the remarkable tunability of the EP propagation length from 300 nm to 600 nm by adjusting the waveguide thickness. Quantitative data quality allowed for matching experiment with theoretical predictions, positioning neaspec's s-SNOM technology as a pivotal method for detailed analysis of nanophotonic circuits made of van der Waals materials.

neaSCOPE enables complete analysis of nanophotonic devices







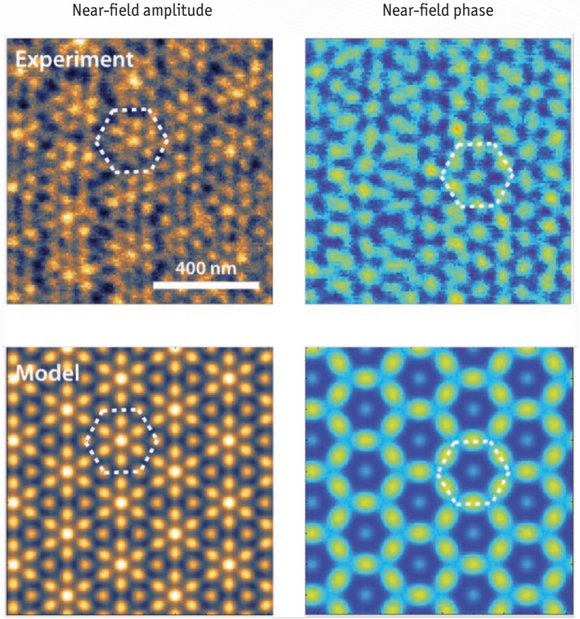
nature photonics — Hu et al., Nature Photonics 11, 356 (2017)

Quantum control of nano-light using solitonic photonic crystals in twisted bilayer graphene

neaSCOPE is the only instrument that achieves complete background suppression in the interferometric near-field measurements, which enables quantitative comparison with simulations that is pivotal for a detailed analysis of electronic properties of 2D materials.

High sensitivity to charge carriers allows neaSCOPE*S to directly visualize Moire pattern of the solitonic superlattice in twisted Graphene bilayer. It results from topological changes in electronic structure and transforms twisted Graphene into a natural photonic crystal for surface plasmons. The measured Moire interference patterns matched perfectly with that from superposition models, demonstrating the analytical quality of neaspec near-field data. Tunability of plasmonic band gaps was demonstrated by adjusting the polariton wavelength (λ_p) via gate voltage (V_G)

s-SNOM investigates electronic phenomena in twisted bilayer graphene

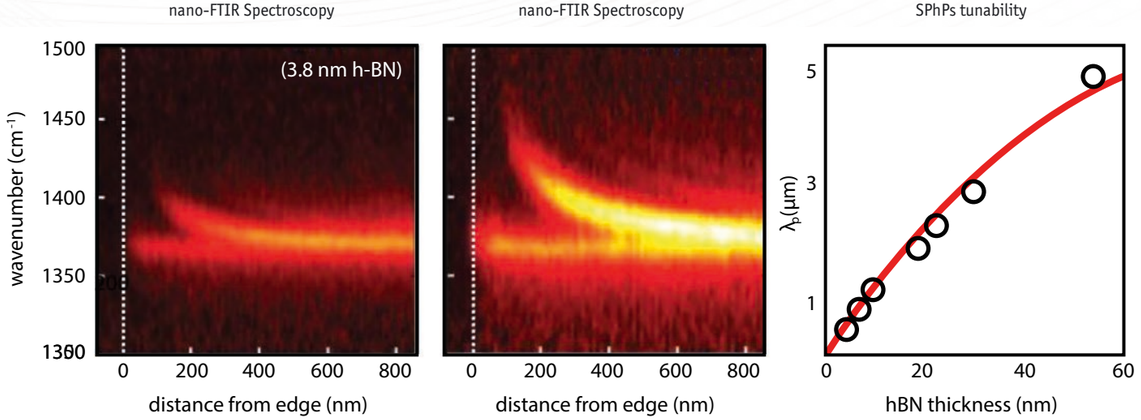


$V_G = +80V \quad \omega = 940\ cm^{-1} \quad \lambda_p = 135\ nm$

Science S. Sunku et al., Science 362 1153 (2018)

Tunable phonon polaritons in atomically thin hexagonal boron nitride (hBN)

neaSCOPE equipped with nano-FTIR provides reliable highest quality nanospectroscopy for detailed analysis of Surface Phonon-Porlariton (SPhP) wavelength, confinement, dispersion and other optical properties of van der Waals materials.



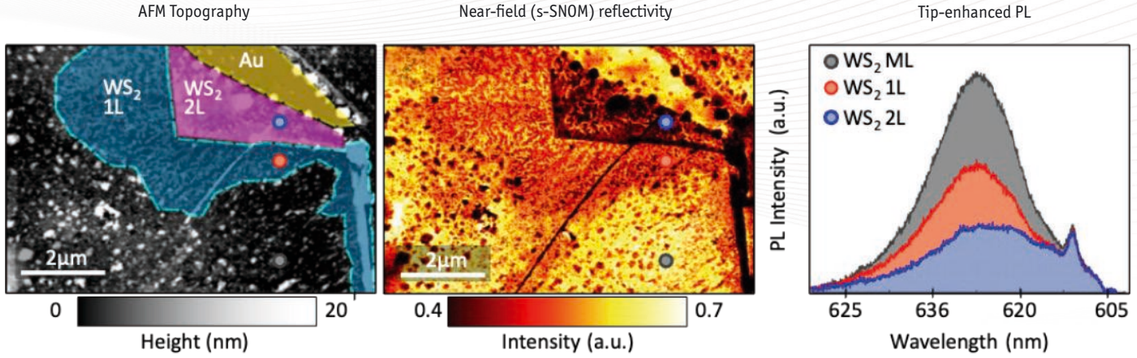
Line profiles across flake edges of hexagonal boron nitride (hBN) measured by nano-FTIR spectroscopic imaging elucidate characteristic polariton dispersion, which depends on the number of material layers. The unique thickness-dependent tunability of SPhPs (λp), combined with the ability of polaritons to travel over distances up to 10 μm with minimal energy loss, positions hBN as an excellent candidate for developing waveguides in infrared nanophotonics.

nano-FTIR allows for hyperspectral imaging of even ultrathin vdW materials

Science S. Dai et al., Science 343, 1127 (2014)

Correlating charge transfer & local dielectric variations in WS_2

neaSCOPE+TERs combines multiple measurement modes including s-SNOM, Photoluminescence (PL), and Atomic Force Microscopy (AFM), enabling comprehensive correlative nano-analysis of 2D materials in a single instrument



s-SNOM sensitivity to the sample dielectric environment allowed for differentiating between surface-adhered and non-adhered regions of WS_2 that are virtually indistinguishable in the AFM topography. A blue-shift and decrease of the exciton peak in tip-enhanced PL spectra indicated partial quenching due to stronger charge transfer between WS_2 and gold substrate in the surface-adhered areas, confirmed by KPFM measurement of the surface work function.

Correlative near-field + PL nanoscopy enables full characterization of interlayer excitons in low-D materials

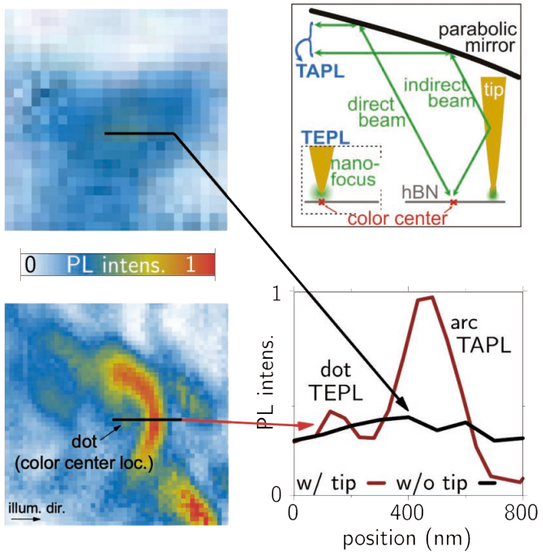
Applied Surface Science — O. Garrity et al., Appl. Surf. Sci. 574, 151672 (2022)

APPLIED materialstoday — X. Chen et al., Applied Materials Today 15 145–152(2019)

Probing Single Quantum Emitters using Nanoscale Photoluminescence

Ultrahigh-NA side-illumination objective provide maximum collection efficiency without restricting optical access to the tip, which is ideal for tip-enhanced techniques such nano-Raman, nano-PL and nano-FTIR.

neaSCOPE+TERs maps photoluminescence (PL) from color centers in MOVPE-grown hexagonal boron nitride (hBN) achieving nanoscale resolution below 30 nm. The point defects act as single quantum emitters exhibiting two distinct phenomena: tip-enhanced PL (TEPL) from direct near-field excitation, and tip-assisted PL (TAPL) due to constructive interference of the direct and tip-scattered beams. TAPL appears as a prominent arc structure, further revealing the in-plane dipole orientations of the color centers. This provides invaluable insights into correlation of dipolar emission and crystallographic axes of a material for control of quantum excitations in semiconductors.



neaSCOPE resolves PL from individual quantum emitters

NANOPHOTONICS — Niehues et al., Nanophotonics Nanophot. 14, 335-342 (2025)

Other Applications realized with *IR*-neaSCOPE+TERs

nano-FTIR for Polymers

chemical characterization at the nanoscale

Nanocomposite polymers, multilayer thin films, nanofibers and other polymer nano-forms often offer new properties or enhanced performance compared to bulk materials, demanding tools for chemical analysis with nanoscale spatial resolution for their investigations. nano-FTIR and s-SNOM are two leading techniques for nanoscale chemical mapping and identification.

Inorganic Materials

spectroscopic chemical analysis at the nanoscale

nano-FTIR spectroscopy and imaging have been successfully applied for material identification & mapping with nanometer precision using material-specific infrared spectroscopic signatures. This applications collection focuses on nanoscale investigation of inorganic materials in energy-storage, mineralogy, archaeology and corrosion sciences.

nano-FTIR for Biomaterials

nanoscale compositional and structural analysis

nano-FTIR can perform in-situ study of melanine in human hair for cosmetics treatment analysis, shed light on biochemistry of cell membranes & improve efficiency of drug delivery, analyze protein secondary structure in amyloid fibrils, and elucidate the nuclear organization of white-blood cells.

Additional Services

demo LAB

Evaluate the capabilities of our technology & products.

Successful test results could significantly increase the approval chance of your grant application.

Monthly reviews of neaspec publications.

Keep you up to date in the field of nanoscale analytics and help you discover new neaSCOPE applications.

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