Product Line
neaspec

attocube
WITTENSTEIN group

Applications Collection

nano-FTIR for Polymers

characterization of polymer nanostructures

NANOSCALE ANALYTICS
advanced imaging & spectroscopy

Recommended Product: *IR*-neaSCOPE

IR-neaSCOPE is designed for nanoscale analysis that only requires measurements of IR absorbtion. It detects laser-induced photothermal expansion in the sample using mechanical AFM-IR detection.

Requiring no IR detector and interferometry, IR-neaSCOPE provides a cost-efficient solution most suitable for samples with large thermal expansion coefficients (e.g. polymers, biomaterials, etc.). IR-neaSCOPE delivers IR absorption imaging, point-spectroscopy and hyperspectral imaging. It is fully upgradable to IR-neaSCOPE+s for advanced capabilities and access to a larger variety of sample material classes.

IR-neaSCOPE

- artefact-free absorption measurement
  → by decoupling efficiently optical from mechanical sample properties
- maximum performance without sample damage
  → by accurate focusing of all illumination power onto the tip
- high-quality results independent of user experience
  → using intuitive software with a guided user interface

Provides nanoscale infrared (IR) imaging and spectroscopy based on probing laser-induced photothermal expansion with an AFM tip.

Visit our webpage *IR*-neaSCOPE

Product Line
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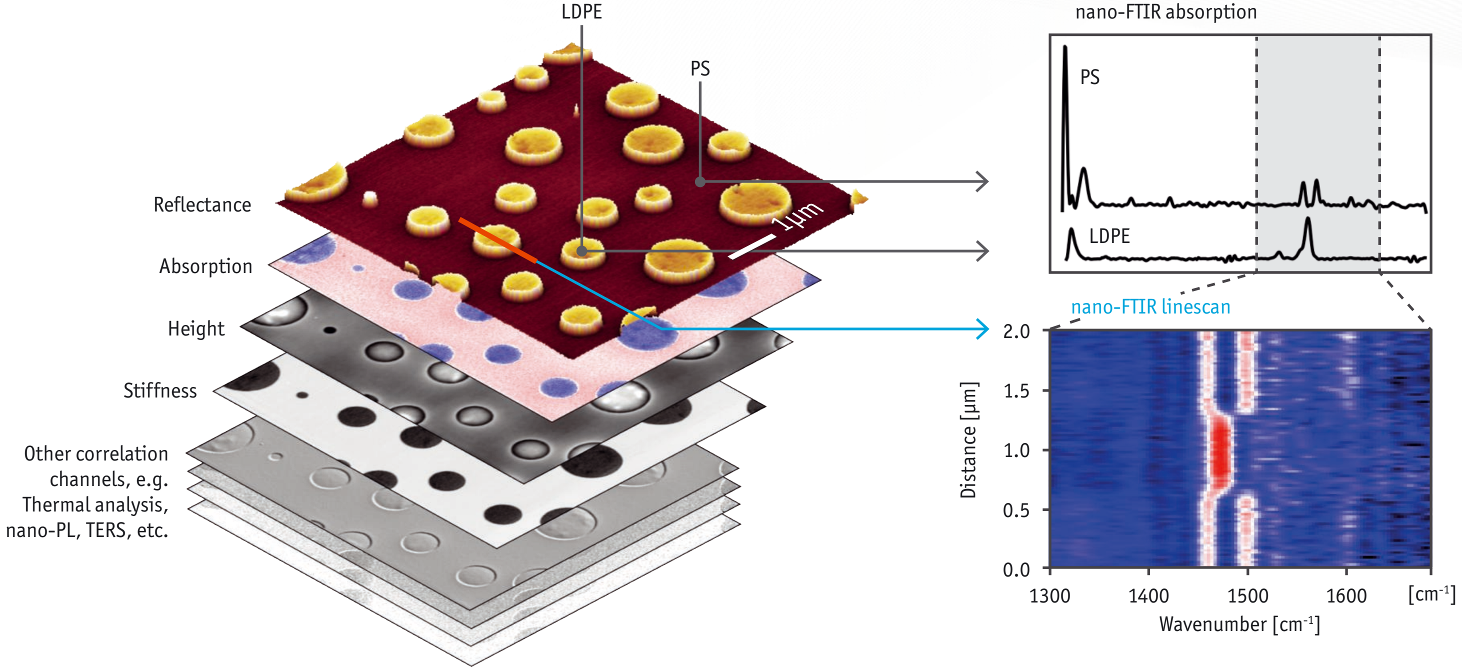
Correlative nanoscopy of polymer composites

neaSCOPE is the most versatile single instrument for correlative analysis of optical, mechanical and electrical properties of polymers at the nanoscale. It can seamlessly measure elastic light scattering (absorption & reflectivity at vis, NIR, MIR & THz), inelastic scattering (TERS, nano-PL), photocurrent, electrical properties (e.g. conductive AFM, KPFM, EFM) and mechanical stiffness, modulus, etc.



Correlation nanoscopy of a phase-separated polystyrene (PS) and low-density polyethylene (LDPE) thin film (ca. 30-50 nm thin) delivers, i.a. absorption and stiffness maps with 10 nm spatial resolution. nano-FTIR spectroscopy unambiguously identifies of LDPE islands in the PS matrix. A spectroscopic line scan across a 1 µm sized LDPE island (bottom right) demonstrates the outstanding data quality (no smoothing or filtering applied) even for rapid data aquisition (100 spectra in <15 min) and verifies that the polymers do not mix at the interface, shedding light onto nanoscale miscibility of the polymers.

neaSCOPE facilitates nanoscale composition and contamination analysis of polymer systems.

Analytical Methods — M. Meyns, et al., Analytical Methods 2023, 15, 606-617

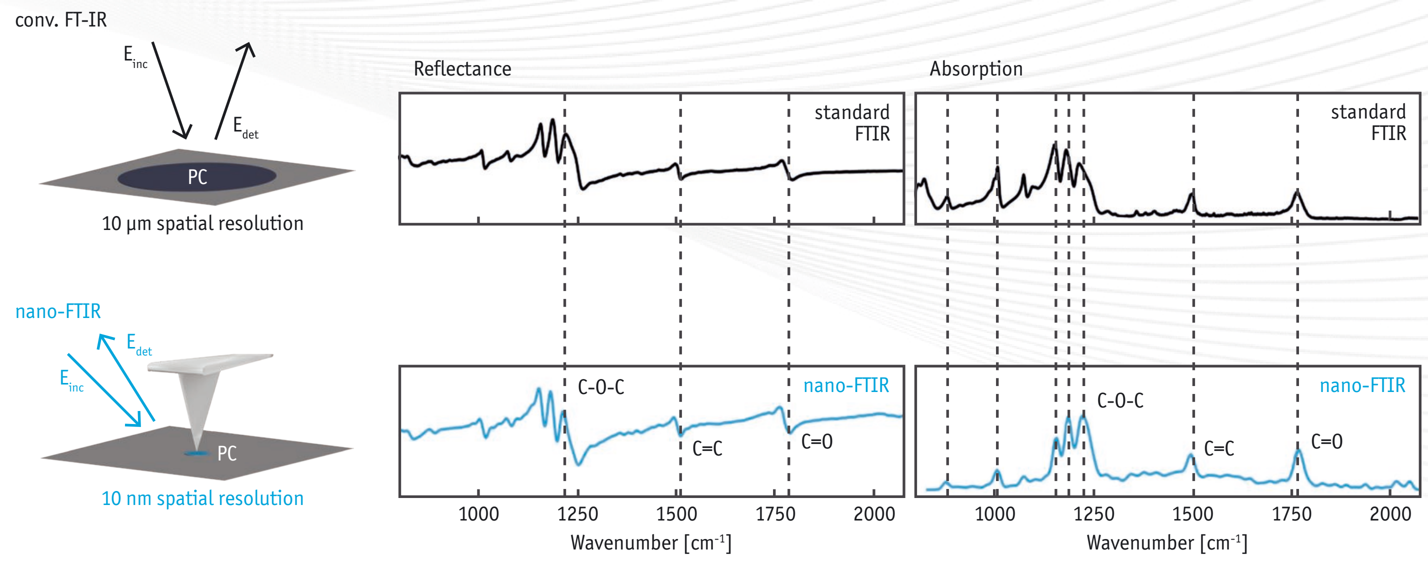
nature chemistry — L. Grossmann, et al., Nature Chemistry 2021, 13, 730

Analytical Methods — M. Meyns, et al., Analytical Methods 2019, 11, 5195

Spectrochimica Acta Part A — J. Kim et al., Spec. Acta Part A. 2022, 274, 1386

Nanoscale chemical identification using standard FTIR vibrational fingerprints

Patented nano-FTIR spectroscopy can simultaneously measure high-quality broadband IR absorption and reflectance spectra with unprecedented 10 nm spatial resolution, speed and sensitivity. nano-FTIR spectra are in excellent agreement with conventional IR spectra, allowing for a routine automated chemical identification according to standard databases.



nano-FTIR analyses chemical composition at 10 nm scale.

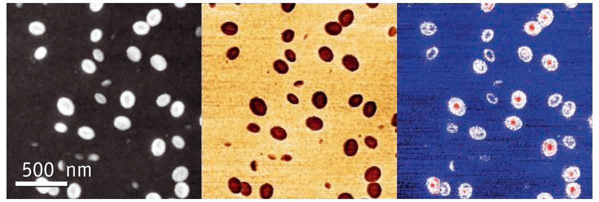
Carbohydrate Polymer — N. Kotov et al., Carbohydrate Polymers 2023, 302, 120320

npj materials degradation — A. Oancea et al., NPJ Mat Degrad. 2023, 7, 21

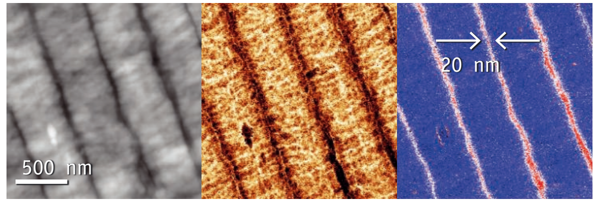
Nanoscale mapping of heterogeneity in polymer films and nanoparticles

Superior sensitivity allows neaSCOPE to use low illumination power (< 2 mW) for gentle, trully nondestructive IR nanoimaging ca pable of identifying even the most subtle sub-10 nm structures in any AFM ready sample from thick to ultra-thin heterogeneous polymer films & nanoparticles.

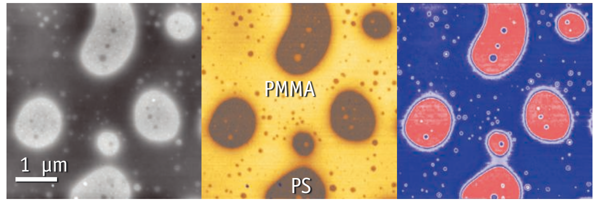
Janus particle phase separation



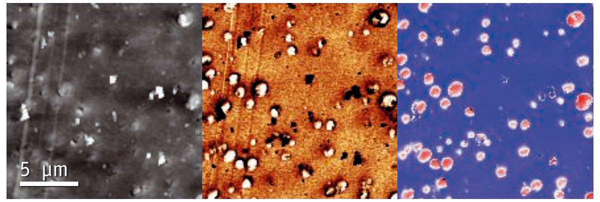
Polyamide adhesion layers



Polymer film heterogeneity



Teflon particle distribution in bulk matrix



neaSCOPE facilitates nanoscale composition and contamination analysis of polymer systems.

I. V. Minin et al., Appl. Phys. Lett. 2021, 118, 131107

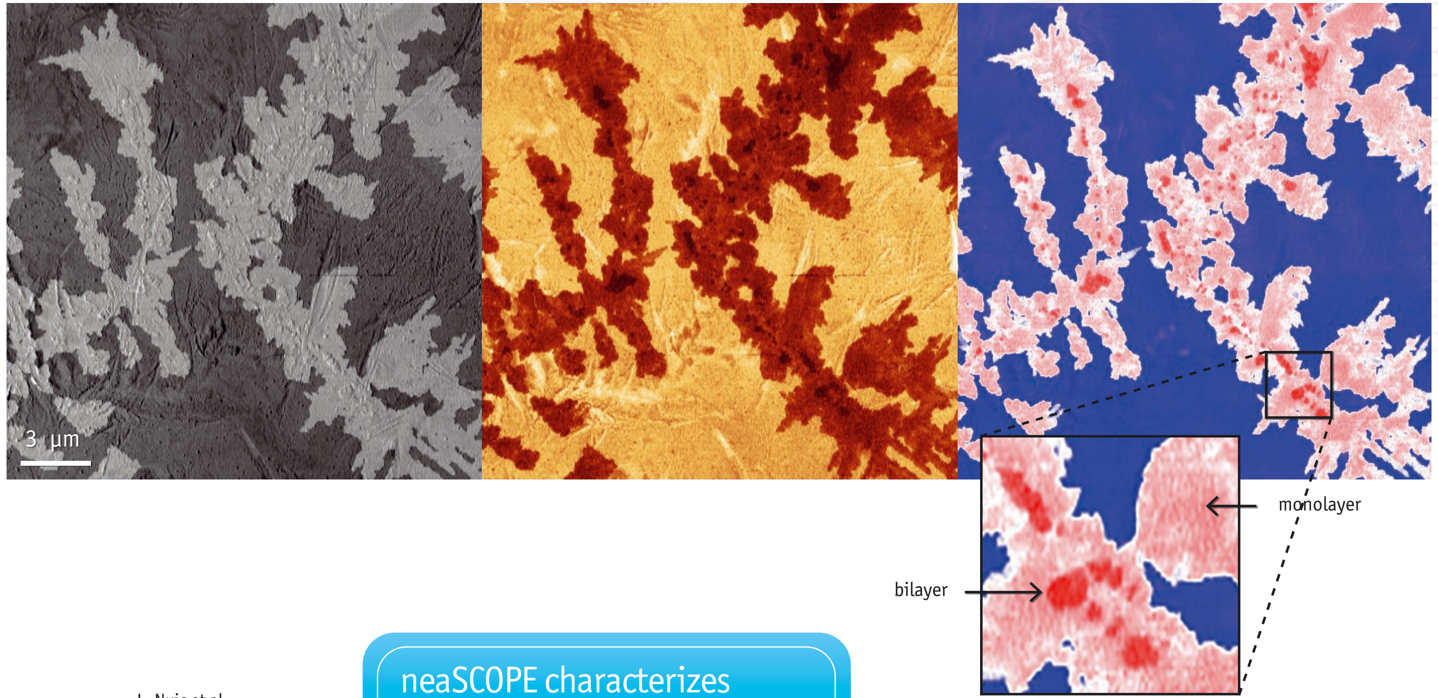
M. Eisele et al., Analytical Science 2018, 10, 2629

IR nanoimaging of self-assembled monolayers

neaSCOPE true background-free IR nanoimaging (proprietary neaspec technology) allows for ge-nuine nanoscale analysis of nanostructured polymers over ultra-large areas, avoiding misleading artifacts typical for other tip-enhanced IR techniques.

Imaging 20 µm x 20 µm area of a 10 nm thin self-assembled poly(ethylen oxide) monolayer at 1123 cm-1 (asymmetric C-O-C stretching) reveals fractal nature of the assembly process. Artifact-free detection delivers stable image contrast over the whole scan area, allowing for a reliable differentiation between mono and bilayer regions.

AFM phase | Reflectivity | Absorption



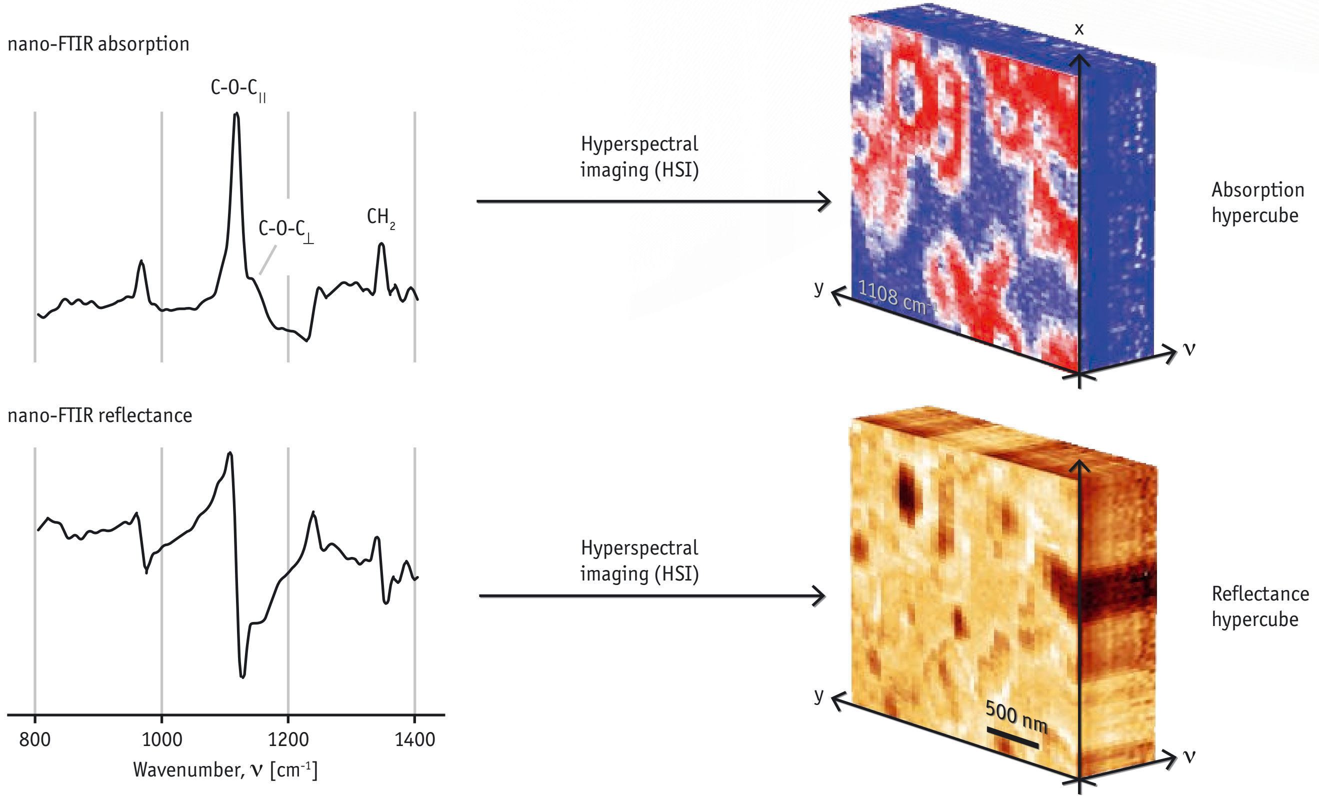
L. Nuic et al., Polymer 2023, 271,125795

A. Pereira et al., Anal. Chem. 2022, 92, 4716

neaSCOPE characterizes functional polymer structures at the nanoscale.

Nanoscale mapping of molecular conformation and orientation in an ultrathin polymer film

nano-FTIR is the only nanoscale hyperspectral imaging (HSI) technique that collects true broadband absorption and reflectivity spectra simultaneously at every pixel. Rapid spectra acquisition (>10 specta/sec) enables a complete chemical assessment of large sample areas with < 10 nm spatial resolution.



nano-FTIR HSI enables nanoscale control of biomaterial coatings.

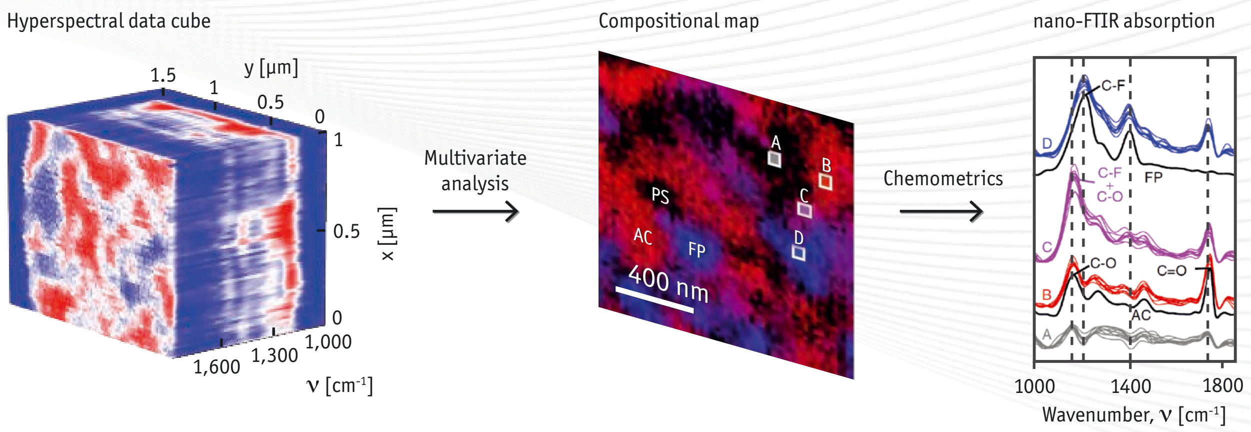
K. Walski et al., J of Col. & Interf. Sci. 2023, 634, 209

M. Kral et al., Colloids Surf. B 2023, 221, 112954

Analysis of C-O-C stretching and CH2 wagging bands in the hyperspectral data cubes (hypercubes) collected on a thin poly(ethylen oxide) film allowed for na- noscale mapping of domains with preferentially vertical (red areas) and horizontal (blue areas) orientation of molecular chains. Density function-al theory further identified the specific conformers in each do-main, explaining high performance of the film in preventing the non-specific deposition of biological materials.

Hyperspectral chemical analysis of a latex blend at the nanoscale

nano-FTIR hyperspectral imaging delivers high quality broadband spectra that allow for multivariate data analysis using standard routines for IR spectroscopy (e.g. principal component & cluster analysis, etc.) for ultimate chemometrics of complex polymer structures at the sub-10 nm scale.



Standard IR multivariate analysis applied to hyperspectral data cube (left) acquired by neaSCOPE on a 170-nm-thick film of latex tri-polymer yields a domain map (middle) that shows nanoscale coexistance of three expected blend components: fluoro-copolymer (FP), acrylic copolymer (AC) and polystyrene latex (PS).

Surprisingly, another domain type (purple) also ap- pears in the map. Analysis of the corresponding characteristic spectra (right) reveals chemical interaction between the fluoropolymer and the polyacrylate in these nanodomains, which is important for unders-tanding polymer mixing at the nanoscale.

I. Amenabar et al., Nature Comm. 2017, 8, 14402.

A. A. Govyadinov et al., J. Phys. Chem. Lett. 2013, 4, 1526

C. Westermeier et al., Nature Comm. 2014, 5, 4101

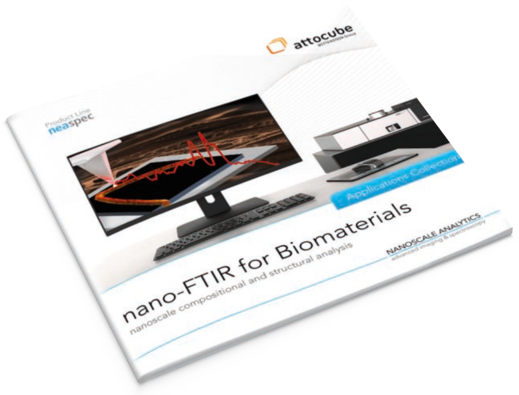
T. Taubner et al., Appl. Phys. Lett. 2004, 85, 5064

Hyperspectral imaging reveals chemical interaction of polymer blend compo- nents at the nanoscale.

Other Applications
realized with IR-neaSCOPE

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 bio-chemistry 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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