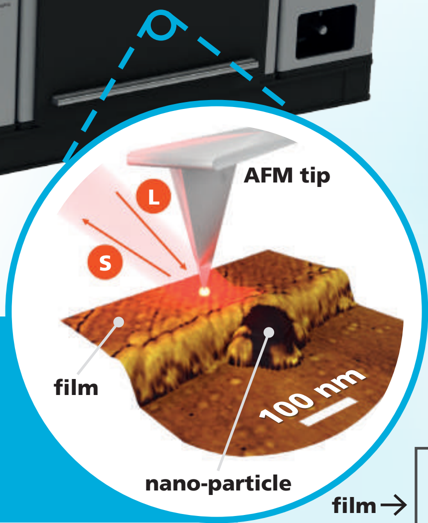
# E-Book

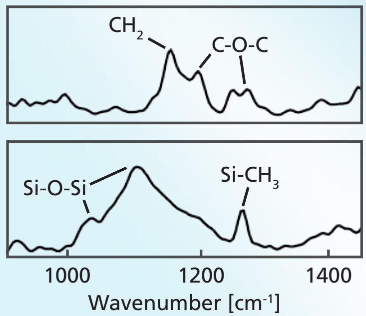
## characterization of polymer nanostructures

nano-FTIR spectroscopy is a modern technique developed by neaspec that combines the analytical power of FT-IR spectroscopy with the nanoscale spatial resolution of AFM


neaspec
see the nanoworld

Chemical identification
at 10 nm spatial resolution




NANO LETTERS — *F. Huth et al., Nano Lett. 2012, 12, 3973.*

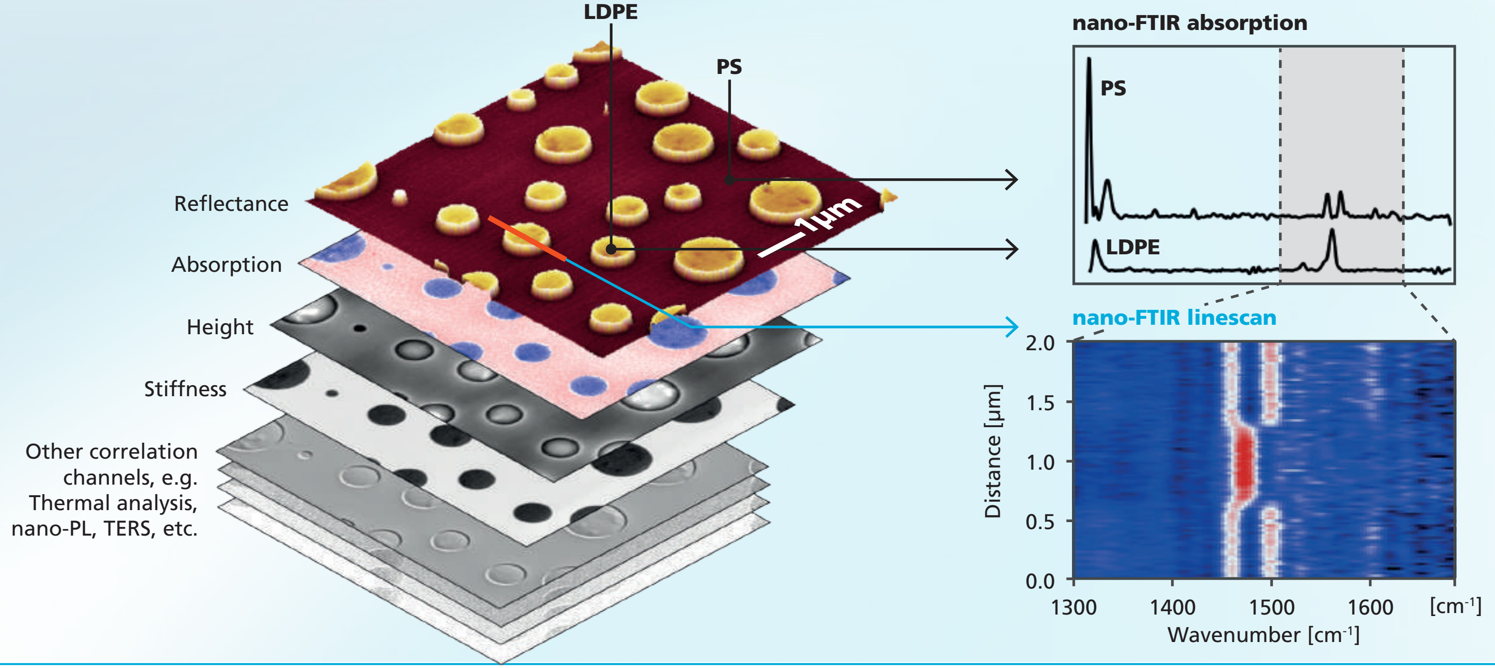
nature materials — *F. Huth et al., Nature Mater. 2011, 10, 352.*

# Correlative nanoscopy of polymer composites

**neaSNOM 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.**

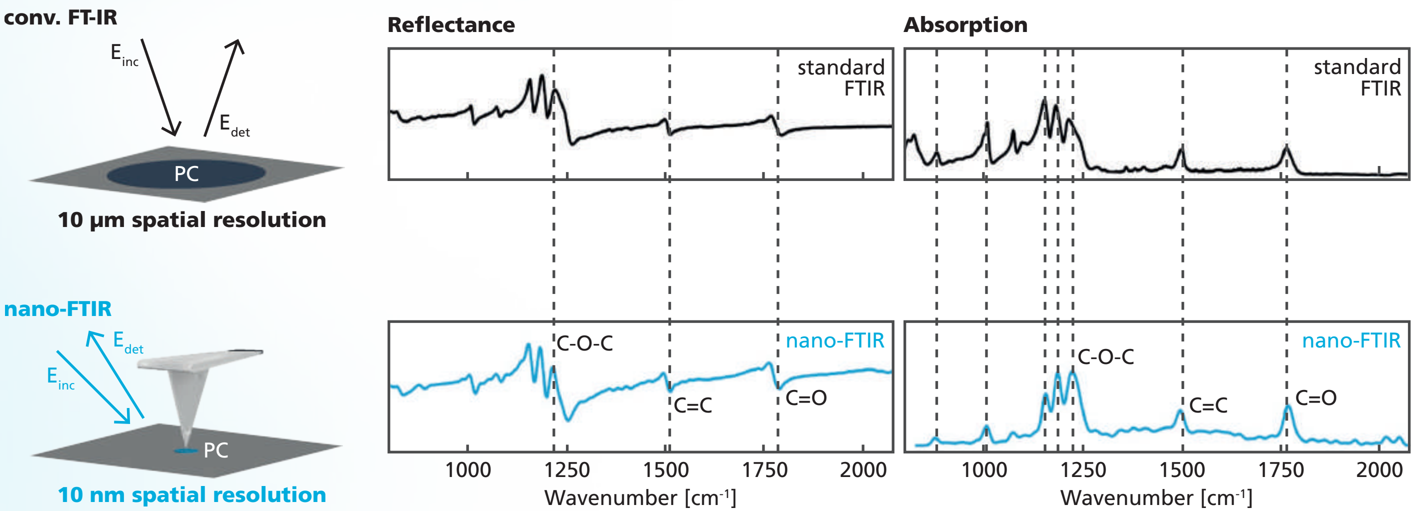
Correlation nanoscopy of a phase-separated polystyrene (PS) and low-density polyethylene (LDPE) thin film (ca. 30-50 nm thin) delivers, i.a. absorption and stiffness maps with 10 nm spatial resolution. nano-FTIR spectroscopy unambiguously identifies of LDPE islands in the PS matrix. A spectroscopic line 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 mixability of the polymers. *In collaboration with M. Meyns, AWI (Germany).*

neaSNOM provides all-around nanoscale characterization of polymer blends & nanostructures



# 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.



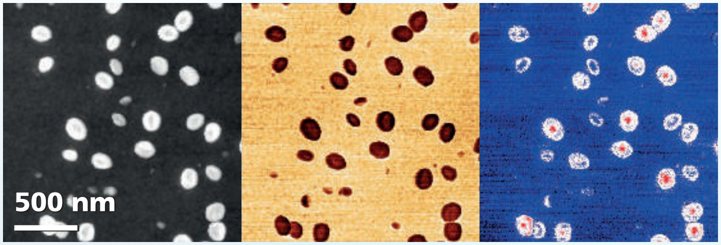



Conventional FTIR (top) and nano-FTIR (bottom) absorption and reflectance spectra of a thick polycarbonate (PC) sample demonstrate an excellent match in terms of peak frequencies, magnitudes and line shapes throughout the whole mid-IR fingerprint region, allowing for an unambigous identification of even the weakest vibrations and bringing quantitative chemical analysis to the nanoscale.

**nano-FTIR analyses chemical composition at 10 nm scale**

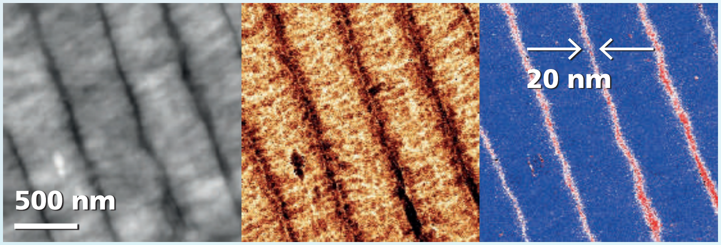
# Nanoscale mapping of heterogenuity in polymer films and nanoparticles

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



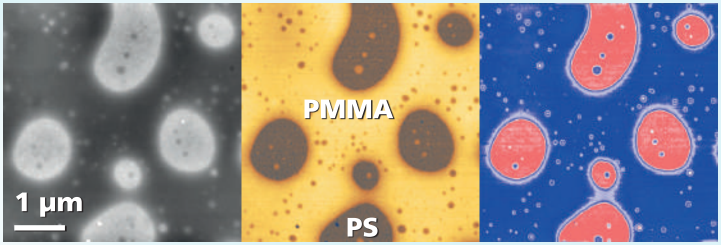

Janus particle phase separation

*In collaboration with BASF*

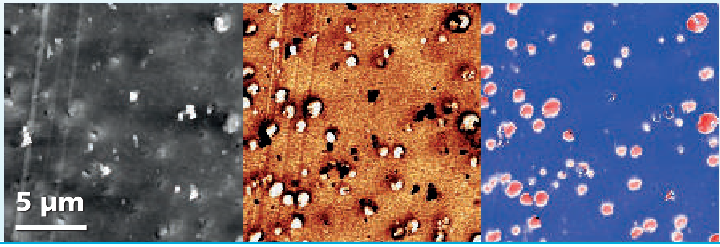



Polyamide adhesion layers

*Sample kindly provided by Royal DSM*




Polymer film heterogeneity




Teflon particle distribution in bulk matrix

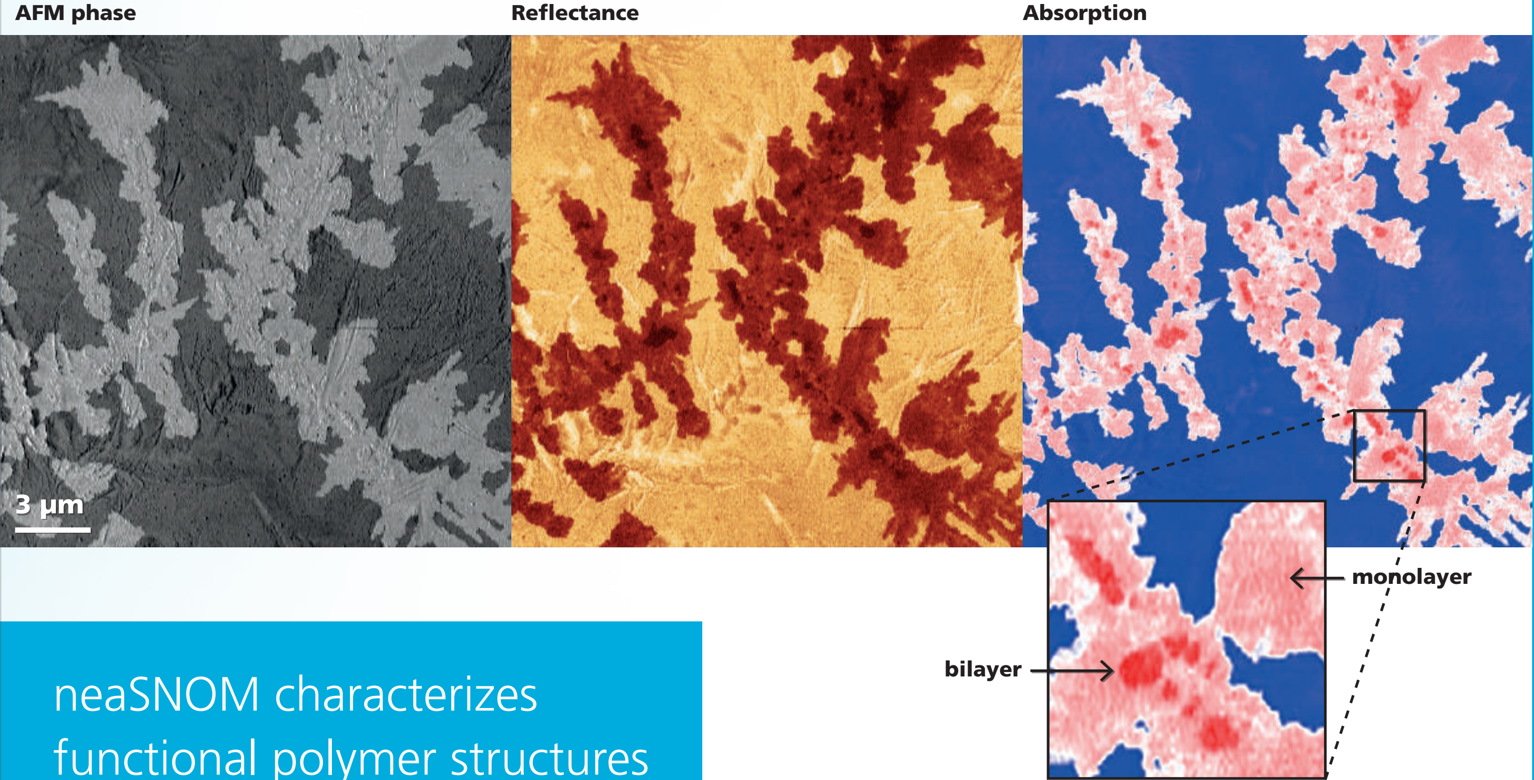
*Sample kindly provided by Royal DSM*

neaSNOM facilitates nanoscale composition and contamination analysis of polymer systems

# IR nanoimaging of self-asembled monolayers

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

Imaging 20 um x 20 um 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. (*in collaboration with Dr. Ognen Pop-Georgievski, Academy of Sciences, Czech Republic*)

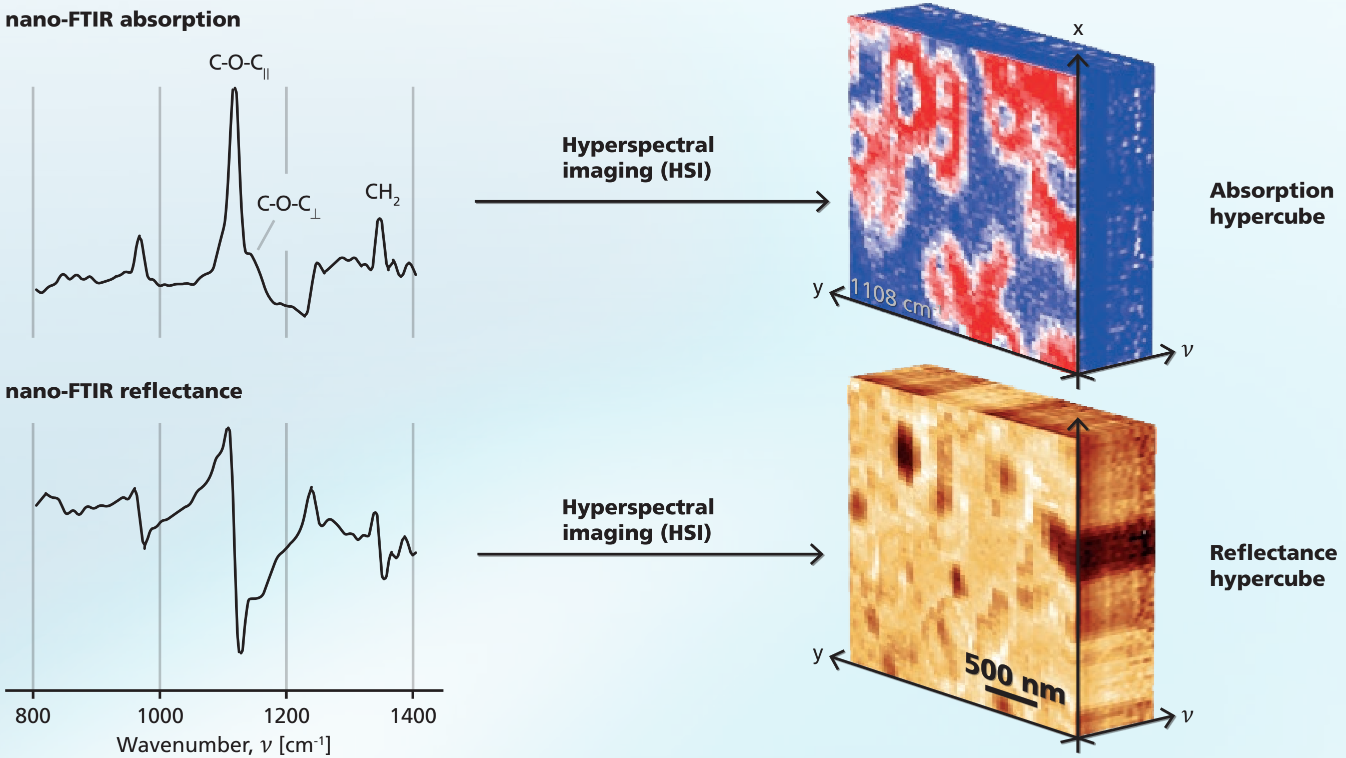





neaSNOM characterizes functional polymer structures at the nanoscale

# 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 spectra/sec) enables a complete chemical assesment of large sample areas with < 10 nm spatial resolution.




## nano-FTIR HSI enables nanoscale control of biomaterial coatings

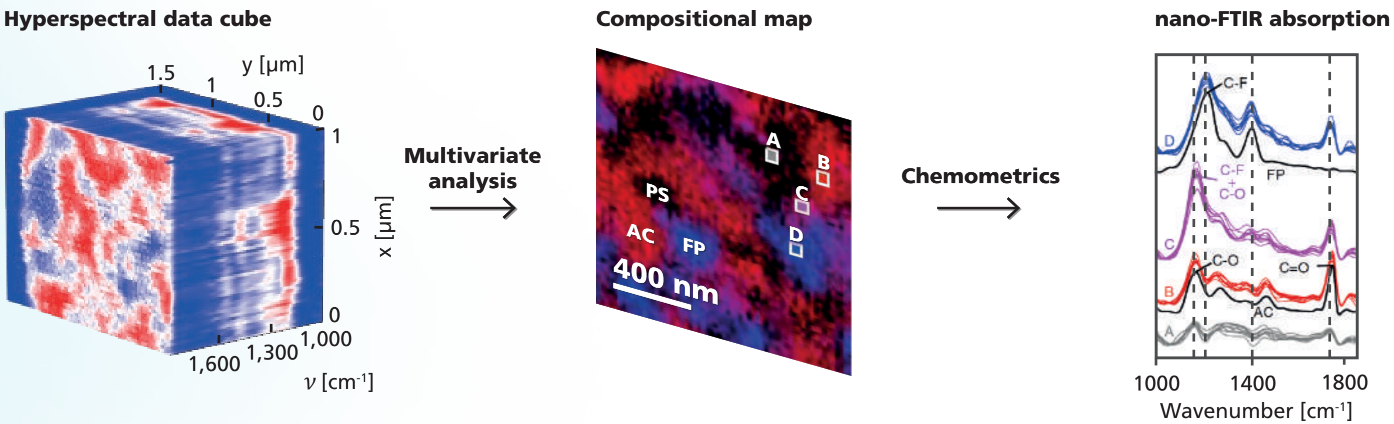
Analysis of C-O-C stretching and $CH_2$ wagging bands in the hyperspectral data cubes (hypercubes) collected on a thin poly(ethylen oxide) film allowed for nanoscale mapping of domains with preferentially vertical (red areas) and horizontal (blue areas) orientation of molecular chains. Density functional theory further identified the specific conformers in each domain, explaining high performance of the film in preventing the non-specific deposition of biological materials.

# Hyperspectral chemical nanoanalysis of a latex polymer blend

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

## Hyperspectral imaging reveals chemical interaction of polymer blend components at the nanoscale






Standard IR multivariate analysis applied to hyperspectral data cube (left) acquired by neaSNOM 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 appears 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 understanding polymer mixing at the nanoscale.


nature COMMUNICATIONS

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

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

nature COMMUNICATIONS

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

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

# Revolutionizing nanoscale analytics

neaspec designs, manufactures and distributes advanced nanoscale optical imaging & spectroscopy microscopes.

The company was founded with the ultimate goal to enable technological & scientific progress in every lab around the world.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