New Advances in Nanoscale IR Spectroscopy

Atomic Force Microscopy
3D Optical Microscopy
Fluorescence Microscopy
Tribology
Stylus Profilometry
Nanoindentation
New Advances in Nanoscale IR Spectroscopy

Dean Dawson
Senior Director, Business Manager – nanoIR
Bruker Nano (formerly Anasys Instruments)

- nanoIR3 New product Introduction

Dr Curt Marcott,
Senior Partner at Light Light Solutions,

- Tapping AFM-IR
- Latest nanoIR Applications

Bruker Confidential
Bruker Nano Acquires Anasys Instruments

Anasys joins Bruker Nano Surfaces Division

Strengthening the world of nanoanalysis and nanomechanical materials characterization- together

- Bruker Nano Surfaces Division acquired Anasys Instruments Corp on April 10th 2018
- All nanoIR products are now integrated into the Bruker Nano Product Support
The leader in nanoscale IR spectroscopy

- History of patented technology for nanoscale IR spectroscopy & materials property mapping
- Ernst Abbe award for Alex Dazzi - Inventor of AFM-IR

2010: nanoIR™ 1st Generation AFM-IR
2014: nanoIR2™ 2nd Generation AFM-IR Top Down Configuration & Resonance Enhanced
2015: nanoIR2-s™ Combined IR s-SNOM & AFM-IR
2016: nanoIR2-FS™ 3rd Generation FASTspectra
2017: Tapping AFM-IR HYPERspectra

2018: NEW nanoIR3™ Latest Generation nanoIR platform with Tapping AFM-IR
nanoscale infrared imaging & spectroscopy capabilities

Nanoscale IR chemical analysis

Chemical composition & nanoscale property mapping

Rich, interpretable spectra directly correlates to FTIR

Monolayer sensitivity & high spatial resolution
Broad range of nanoIR applications

Polymer blends & Block Copolymers

Multilayer films

Nanofibers

2D Materials/Graphene

Nano-Composites

Organic nano Contaminants

Life Science

Perovskites & Solar Cells
**NEW nanoIR3 platform configurations**

**nanoIR3™** - Latest Generation nanoIR platform with Tapping AFM-IR
- Highest performance nanoIR spectra with AFM-IR
- Sub-10nm resolution IR chemical imaging with Tapping AFM-IR
- Correlates to FTIR & industry databases
- Easy to use for fast, productive measurements

**nanoIR3-s™** High Performance IR nano-spectroscopy
- Complementary sSNOM & Tapping AFM-IR
- Highest Performance IR nano-spectroscopy
- Broadband Spectroscopy & Chemical Imaging
- Nanoscale property mapping
- Versatility & Easy to Use

**nanoIR3-s™ S-SNOM** - High Performance sSNOM Imaging
- IR s-SNOM platform for optical & chemical Imaging
- Supports multiple laser types, visible, nearIR
- Electrical nanoscale property mapping
- Upgradeable to nanoIR-spectroscopy
NEW Next Generation nanoIR3 with 2\textsuperscript{nd} Generation Tapping AFM-IR

- Unmatched sensitivity for nanoIR spectroscopy & chemical imaging
- 2\textsuperscript{nd} Generation Tapping AFM-IR with <10nm resolution chemical imaging
- New HYPERspectral IR laser with broader spectral range
- Point spectroscopy with single spectra in 1-2 secs
- Complementary material property mapping for electrical & mechanical property mapping
- Easy to use, high performance AFM imaging with improved noise and sensitivity
New nanoIR3
Improved Performance & Flexibility

Fully Purged System
from laser to sample

New Hyperspectral laser & multiple laser options to cover wide spectral range
<800cm\(^{-1}\) to >4,000cm\(^{-1}\)

2\(^{nd}\) Generation
Tapping AFM-IR
High resolution imaging and now spectroscopy

Supports AFM-IR & s-SNOM modes for experimental flexibility

New Optics train and improved beam pointing design

New AFM design with low noise and high stability
<50pm noise, new head & scanner design

Engineered for productivity with many unique, automated features and a robust, reliable design
Hyperspectral Imaging for fast identification of unknowns

5x5 µm, 50x50 spectrum array on PS/PMMA/epoxy blend

- Hyper spectral imaging provides point by point spectra over a large number of data points to provide an array of spectra and chemical images at specific wavenumbers

- Principle component analysis can be applied to identify specific chemical components and their spatial distribution
Sample Environmental Control

Humidity control & heater & cooler
- For control of humidity/gas & temperature for in-situ AFM-IR
- 4% to 95% non-condensing
- 4°C to 80°C heating and cooling

Sample transfer port for nanoIR3-s
- Protects sample in controlled gas environment from glove box to nanoIR system to protect
- includes integrated humidity sensor with optional high sensitivity humidity and oxygen sensors
IR Polarization Control & extended IR range

**Polarization control**
Allows users to study molecular orientation with nanoscale spatial resolution by changing the input polarization of the IR light while studying the associated changes in the nanoscale IR spectra and/or chemical maps at a certain wavenumber.

**Polarizer Option**
Optional & upgradeable

(L) AFM-IR spectra on electrospun PVDF fibers under two different IR polarizations (R) IR absorption image at 1404 cm⁻¹ of crossed PVDF fibers under polarized illumination. (polarization direction shown by arrow)

**FASTs spectra™ OPO mid-IR laser**
The new high pulse rate OPO laser extends the wavelength range of Resonance Enhanced AFM-IR to cover the 2700 to 3600cm⁻¹ wavenumbers, extending capability to important spectroscopic regions and addressing wider range of applications, while still providing direct correlation to FTIR at the nanoscale.

New extended resonance enhanced AFM-IR range

Previous resonance enhanced AFM-IR range

Nylon 12 nanoIR spectrum measured with both the new FASTs spectra OPO and FASTs spectra QCL lasers. Important C-H stretch, NH stretch and OH regions are now enabled with rich interpretable data.
nanoIR nanoscale property mapping modes

**Conducting AFM (CAFM):**
(Application Module)
Allows the user to obtain simultaneous height and current flow maps of the sample surface. Available on all Anasys systems.

**Kelvin Probe Force Microscopy (KPFM):**
(Application Module)
Allows the user to obtain surface potential measurements. Available on all Anasys systems.

**Lorentz Contact Resonance mode**
LCR composite image made by overlaying the LCR amplitudes collected at three different contact resonances. These resonances were selected to highlight the varying ratios of the lignin and cellulose which compose the sample.

**Nano thermal analysis**
Nanoscale thermal analysis of a PS-PMMA blend deposited on glass. A scan (left) shows indent in the surface caused by temperature ramps (right). The data from the PS (red) and PMMA (green) clearly differentiate the two materials. Also shown is data from a thin film of PS on PMMA (blue) showing the initial penetration of the PS followed by the melting of the PMMA.
NEW 2\textsuperscript{nd} Generation Tapping AFM-IR

- 2\textsuperscript{nd} Generation Tapping AFM-IR with
  - <10nm resolution chemical imaging
  - Enhanced spectroscopy capabilities
  - Improved surface sensitivity

- Improved performance achieved with a combination of:
  - Improved AFM design
  - Instrument optics design
  - New AFM probes

Measurement of graphene wedge on silicon with s-SNOM and Tapping AFM-IR show plasmonic effects at the edge.
Tapping AFM-IR: PEMA/PMMA Blend
Sample courtesy: University of Minnesota

Tapping AFM-IR Spectra and image clearly demonstrates the phase separation between polyethyl methacrylate (PEMA) matrix and polymethyl methacrylate (PMMA) domains based on characteristic IR absorption band of PEMA at 1026 cm⁻¹ (ambient condition).
Tapping AFM-IR: PEMA/PMMA Blend
Sample courtesy: University of Minnesota

3D image of tapping IR image at 1026 cm\(^{-1}\) overlaid on topography
Tapping AFM-IR: PS/PMMA Block Copolymer
Sample courtesy: CEA-Leti

Tapping AFM-IR image at 1730 cm\(^{-1}\) highlights PMMA spheres embedded in PS matrix in the PS/PMMA block copolymer sample.

Observed spatial resolution ~5 nm.
Applications – All from 2017-2018 Publications!

- **Life Science**
  - Recent paper in Cell – Simone Ruggeri, Tuomas Knowles (Cambridge)
  - AFM-IR in Fluid – Andrea Centrone (NIST)
  - Malaria Infected Red Blood Cells – Bayden Wood (Monash)
  - *In vivo* AFM-IR of Bacteria – Bayden Wood (Monash)

- **Materials Science**
  - Deuterium-labeled polyolefin copolymer blend – Dow
  - Core/Shell effect in electrospun PHB copolymer fibers – Delaware
  - Functionalized graphene – Manchester
  - h-BN – Photothermal AFM-IR of 2D Materials – Harvard
  - Geoscience – Schlumberger & USGS

- **Atmospheric Aerosols** – Mark Banaszak Holl (Michigan/Monash)

- **Polarized AFM-IR** – Karsten Hinrichs (ISAS)
Recent Paper in Cell:

Nanoscale Resolution Analysis of the Mechanical and Secondary and Quaternary Structural Properties of Individual FUS Condensates Reveal Substantial Differences between ADMA FUS versus HYPO FUS and Cation-p-Enhanced FUS Condensates
Determination of Polypeptide Conformation with Nanoscale Resolution in Water

Georg Ramer, Francesco Simone Ruggeri, Aviad Levin, Tuomas P.J. Knowles, and Andrea Centrone

ACS Nano, Just Accepted Manuscript • DOI: 10.1021/acsnano.8b01425 • Publication Date (Web): 22 Jun 2018

Figure 1. FTIR setup in water: a) FTIR measurement schematic. The sample is illuminated from below in TIR configuration. The AFM cantilever transduces the photo-induced thermal expansion of the sample as measured by the AFM detector. b) AFM cantilever contact resonant frequencies in air (orange) and water (blue).
Diphenylalanine, FF, is the core recognition module of the Alzheimer's disease β-amyloid polypeptide.

In H$_2$O!
Determination of Polypeptide Conformation with Nanoscale Resolution in Water

tert-butoxycarbonyl (Boc)-modified derivative (Boc-FF)
diphenylalanine (FF)

In D$_2$O
Multispectral Atomic Force Microscopy-Infrared Nano-Imaging of Malaria Infected Red Blood Cells

David Perez-Guaita, Kamila Kochan, Mitchell Batty, Christian Doering, Jose Garcia-Bustos, Shirly Espinoza, Don McNaughton, Phil Herald, and Bayden R. Wood

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Supporting Information

ABSTRACT: Atomic force microscopy-infrared (AFM-IR) spectroscopy is a powerful new technique that can be applied to study molecular composition of cells and tissues at the nanoscale. AFM-IR maps are acquired using a single wavenumber value; they show either the absorbance plotted against a single wavenumber value or a ratio of two absorbance values. Here, we implement multivariate image analysis to generate multivariate AFM-IR maps and use this approach to resolve subcellular structural information in red blood cells infected with Plasmodium falciparum at different stages of development. This was achieved by converting the discrete spectral points into a multispectral line spectrum prior to multivariate image reconstruction. The approach was used to generate compositional maps of subcellular structures in the parasites, including the food vacuole, lipid inclusions, and the nucleus, on the basis of the intensity of hemoglobin, lipid, and DNA IR marker bands, respectively. Confocal Raman spectroscopy was used to validate the presence of hemoglobin in the regions identified by the AFM-IR technique. The high spatial resolution of AFM-IR combined with hyperspectral modeling enables the direct detection of subcellular components, without the need for cell sectioning or immunological/biochemical staining. Multispectral-AFM-IR thus has the capacity to probe the phenotype of the malaria parasite during its intraerythrocytic development. This enables novel approaches to studying the mode of action of antimalarial drugs and the phenotypes of drug-resistant parasites, thus contributing to the development of diagnostic and control measures.
Figure 2. AFM-IR imaging of a *P. falciparum* trophozoite inside a red blood cell. (a) AFM topography. (b) AFM deflection map showing the location of the points where spectra were measured, inside (blue) and outside (red) of the protrusion. (c, d) Spectra measured from the signal of the IR intensity peak (V) showing different bands for the red and blue spots in the 1450–950 and 1800–1450 cm$^{-1}$ regions, respectively. (e, f) IR peak maps obtained at 1207 and 1660 cm$^{-1}$, respectively. (g, h) Score and loading plots from the PCA applied to the 3100–2800 cm$^{-1}$ region.
In vivo AFM-IR Spectroscopy of Bacteria

INTERFACE

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Research

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Subject Areas:
biochemistry, medical physics, nanotechnology

Keywords:
atomic force microscopy – infrared, in vivo, cell wall, Gram-positive bacteria, Gram-negative bacteria

A new experimental platform for probing nanoscale molecular changes in living bacteria using atomic force microscopy–infrared (AFM–IR) spectroscopy is demonstrated. This near-field technique is eminently suited to the study of single bacterial cells. Here, we report its application to monitor dynamical changes occurring in the cell wall during cell division in Staphylococcus aureus using AFM to demonstrate the division of the cell and AFM–IR to record spectra showing the thickening of the septum. This work was followed by an investigation into single cells, with particular emphasis on cell-wall signatures, in several bacterial species. Specifically, mainly cell wall components from S. aureus and Escherichia coli containing complex carbohydrate and phosphodiester groups, including peptidoglycans and teichoic acid, could be identified and mapped at nanometre spatial resolution. Principal component analysis of AFM–IR spectra of six living bacterial species enabled the discrimination of Gram-positive from Gram-negative bacteria based on spectral bands originating mainly from the cell wall components. The ability to monitor in vivo molecular changes during cellular processes in bacteria at the nanoscale opens a new platform to study environmental influences and other factors that affect bacterial chemistry.
In vivo AFM-IR Spectroscopy of Bacteria
Deuterium-labeled polyolefin copolymer blend
Deuterium-labeled polyolefin copolymer blend

IR Image at 1377 cm\(^{-1}\)

IR Image at 1473 cm\(^{-1}\)

Ratio Image: 1377 cm\(^{-1}\)/1473 cm\(^{-1}\)
Deuterium-labeled polyolefin copolymer blend

Fig. 4. (A) Bulk FTIR spectrum of the E/P/dEP copolymer blend compared to AFM-IR spectra collected in the (B) E phase and (C) P phase. (D) The AFM-IR image of the C-D stretch (2192 cm\(^{-1}\)) confirms that the dEP is dispersed in the E phase.
Electrospun PHB copolymer nanofibers

Macromolecules

Polymorphic Distribution in Individual Electrospun Poly[(R)-3-hydroxybutyrate-co-(R)-3-hydroxyhexanoate] (PHBHx) Nanofibers

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ABSTRACT: We have observed, for the first time, a heterogeneous spatial distribution of crystalline polymorphs in a single electrospun polymer nanofiber. Two crystalline polymorphs of PHBHx, the thermodynamically stable α-form consisting of chains with a 2_1 helical conformation and the metastable β-form consisting of chains with a planar zigzag conformation, are spatially distributed as a core–shell structure composed of an α-form-rich core and a β-form-rich shell. In addition, it was found that the thickness of the shell is independent of the fiber diameter. The characterization of crystalline polymorphic distribution in individual nanofibers has been made possible by utilizing a technique combining atomic force microscopy (AFM) and infrared spectroscopy (IR), which simultaneously provides the nanoscale spatial resolution and crystalline phase specificity. Based on the experimental results, a possible generation mechanism of this polymorphic heterogeneous core–shell structure is proposed. The implications of this core–shell model on fiber properties are also discussed.
Nanoscale infrared identification and mapping of chemical functional groups on graphene

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A B S T R A C T
Chemical functionalisation of graphene and other 2-dimensional materials is a key step in realizing their full potential in various applications. There is a need for non-destructive and unambiguous identification of chemical groups and mapping of their distribution on such materials with nanoscale spatial resolution and at monolayer thicknesses. In this work, AFM-coupled infrared spectroscopy is used to analyse single layer reduced graphene oxide flakes that have been non-covalently functionalized with sulfonated pyrenes. We show this technique to be capable of distinguishing between the different pyrene moieties and mapping the sulfonate groups on a 1.7 nm functionalised monolayer of reduced graphene oxide with 32 nm spatial resolution. This technique is also shown to be sensitive to small changes in the sulfonate absorption spectra arising from chemical and surface effects, enough to distinguish between different functionalizing molecules even on materials with anisotropic thermal conductivity.

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Functionalized Graphene

Fig. 1. (a) Reaction scheme for the production of i) PBS, ii) PCN/PBS functionalised flakes and U-rGO. (b, c, d) AFM micrographs and corresponding height profiles of U-rGO, PBS-rGO and PCNBS-rGO respectively (1 μm scales). (A colour version of this figure can be viewed online.)
Functionalized Graphene
Functionalized Graphene

SEM Images

AFM Topography

IR Images at 1030 cm$^{-1}$

IR Images at 1084 cm$^{-1}$

IR Images at 1230 cm$^{-1}$
Large Photothermal Effect in Sub-40 nm h-BN Nanostructures Patterned Via High-Resolution Ion Beam

Josué J. López, * Antonio Ambrosio, Siyuan Dai, Chuong Huynh, David C. Bell, Xiao Lin, Nicholas Rivera, Shengxi Huang, Qiong Ma, Soeren Eyhusen, Ido E. Kaminer, Kenji Watanabe, Takashi Taniguchi, Jing Kong, Dimitri N. Basov, Pablo Jarillo-Herrero, and Marin Soljačić

1. Introduction

The controlled nanoscale patterning of 2D materials is a promising approach for engineering the optoelectronic, thermal, and mechanical properties of these materials to achieve novel functionalities and devices. Herein, high-resolution patterning of hexagonal boron nitride (h-BN) is demonstrated via both helium and neon ion beams and an optimal dosage range for both ions that serve as a baseline for insulating 2D materials is identified. Through this nanofabrication approach, a grating with a 33 nm pitch, individual structure sizes down to 20 nm, and additional nanostructures created by patterning crystal step edges are demonstrated. Raman spectroscopy is used to study the defects induced by the ion beam patterning and is correlated to scanning probe microscopy. Photothermal and scanning near-field optical microscopy measure the resulting near-field absorption and scattering of the nanostructures. These measurements reveal a large photothermal expansion of nanostructured h-BN that is dependent on the height to width aspect ratio of the nanostructures. This effect is attributed to the large anisotropy of the thermal expansion coefficients of h-BN and the nanostructuring implemented. The photothermal expansion should be present in other van der Waals materials with large anisotropy and can lead to applications such as nanomechanical switches driven by light.
Photothermal Spectroscopy and Imaging of an h-BN 2D Material
Nanoscale geochemical and geomechanical characterization of organic matter in shale

Jing Yang¹, Javin Hatcherian², Paul C. Hackley² & Andrew E. Pomerantz¹

Solid organic matter (OM) plays an essential role in the generation, migration, storage, and production of hydrocarbons from economically important shale rock formations. Electron microscopy images have documented spatial heterogeneity in the porosity of OM at nanoscale, and bulk spectroscopy measurements have documented large variation in the chemical composition of OM during petroleum generation. However, information regarding the heterogeneity of OM chemical composition at the nanoscale has been lacking. Here we demonstrate the first application of atomic force microscopy-based infrared spectroscopy (AFM-IR) to measure the chemical and mechanical heterogeneity of OM in shale at the nanoscale, orders of magnitude finer than achievable by traditional chemical imaging tools such as infrared microscopy. We present a combination of optical microscopy and AFM-IR imaging to characterize OM heterogeneity in an artificially matured series of New Albany Shales. The results document the evolution of individual organic macerals with maturation, providing a microscopic picture of the heterogeneous process of petroleum generation.
Geoscience Application of AFM-IR

[Images of AFM-IR applications in geoscience, including optical microscopy, topography, and stiffness mapping with corresponding spectral data.]
Atmospheric Aerosols


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Supporting Information

ABSTRACT: Chemical analysis of atmospheric aerosols is an analytical challenge, as aerosol particles are complex chemical mixtures that can contain hundreds to thousands of species in attoliter volumes at the most abundant sizes in the atmosphere (~100 nm). These particles have global impacts on climate and health, but there are few methods available that combine imaging and the detailed molecular information from vibrational spectroscopy for individual particles <500 nm. Herein, we show the first application of atomic force microscopy with infrared spectroscopy (AFM-IR) to detect trace organic and inorganic species and probe intraparticle chemical variation in individual particles down to 150 nm. By detecting photothermal expansion at frequencies where particle species absorb IR photons from a tunable laser, AFM-IR can study particles smaller than the optical diffraction limit. Combining strengths of AFM (ambient pressure, height, morphology, and phase measurements) with photothermal IR spectroscopy, the potential of AFM-IR is shown for a diverse set of single-component particles, liquid-liquid phase separated particles (core-shell morphology), and ambient atmospheric particles. The spectra from atmospheric model systems (ammonium sulfate, sodium nitrate, succinic acid, and sucrose) had clearly identifiable features that correlate with absorption frequencies for infrared-active modes. Additionally, molecular information was obtained with <100 nm spatial resolution for phase separated particles with a ~150 nm shell and 300 nm core. The subdiffraction limit capability of AFM-IR has the potential to advance understanding of particle impacts on climate and health by improving analytical capabilities to study water uptake, heterogeneous reactivity, and viscosity.
Atmospheric Aerosols

![Image showing AFM height and deflection images, and IR spectra of single-component particles: (a) (NH₄)₂SO₄, (b) NaNO₃, (c) succinic acid, and (d) sucrose. D_{ve} of analyzed particle from each standard: 346, 303, 335, and 202 nm, respectively (further info in Table S1).]

DOI: 10.1021/ac501568g
Polarization-Dependent Atomic Force Microscopy–Infrared Spectroscopy (AFM-IR): Infrared Nanopolarimetric Analysis of Structure and Anisotropy of Thin Films and Surfaces

Karsten Hinrichs and Timur Shaykhutdinov

Abstract
Infrared techniques enable nondestructive and label-free studies of thin films with high chemical and structural contrast. In this work, we review recent progress and perspectives in the nanoscale analysis of anisotropic materials using an extended version of the atomic force microscopy–infrared (AFM-IR) technique. This advanced photothermal technique, includes polarization control of the incoming light and bridges the gap in IR spectroscopic analysis of local anisotropic material properties. Such local anisotropy occurs in a wide range of materials during molecular nucleation, aggregation, and crystallization processes. However, analysis of the anisotropy in morphology and structure can be experimentally and theoretically demanding as it is related to order and disorder processes in ranges from nanoscopic to macroscopic length scales, depending on preparation and environmental conditions. In this context, IR techniques can significantly assist as IR spectra can be interpreted in the framework of optical models and numerical calculations with respect to both, the present chemical conditions as well as the micro- and nanostructure. With these extraordinary analytic possibilities, the advanced AFM-IR approach is an essential puzzle piece in direction to connect nanoscale and macroscale anisotropic thin film properties experimentally. In this review, we highlight the analytic possibilities of AFM-IR for studies on nanoscale anisotropy with a set of examples for polymer, plasmonic, and polaritonic films, as well as aggregates of large molecules and proteins.

Keywords
Atomic force microscopy–infrared spectroscopy, AFM-IR, thin film, nanopolarimetry, polymer, protein, aggregate, anisotropy, polaritons, molecular orientation, amyloid, polarization, plasmons
Figure 2. Schematic of AFM-IR measurement on an anisotropic sample in reflection geometry with polarization control for p- and s-polarized conditions. Modified with permission from reference 52. Copyright 2018 Elsevier.
Figure 6. Infrared nanopolarimetry on H- and J-type ZnTPP aggregates. (a) Artistic illustration of oriented attachment growth of the H-type network with measurements performed on the H-type nanorod. (b) Representative cascaded and normalized spectra showing anisotropy found in H- (top) and J-type aggregates (bottom). (c) Corresponding vibrational mode characteristics. (d, e) Infrared nanopolarimetric images of two perpendicularly oriented H-nanorods. (f) Infrared image of the J-type dendrite. Modified from reference 36 with permission from American Chemical Society.
SciX Conference in Atlanta
October 21-26, 2018

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Marriott Marquis (until
the block is sold out).
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Advance Registration

Atlanta Marriott Marquis
Atlanta, GA
October 21 - 26

POSTER SUBMISSION DEADLINE JULY 31
Speakers using Bruker/Anasys AFM-IR Instrumentation

- Andrea Centrone - Determination of Polypeptides Conformation in Water with Infrared Nano-Spectroscopy
- Simone Ruggeri - Infrared nanospectroscopy identification and structural characterisation of amyloidogenic inclusions in C. Elegance models of neurodegeneration
- Karsten Hinrichs - Infrared nanopolarimetric analysis of structure and anisotropy of thin films
- Mark Rickard - AFM-IR Provides New Insights into Flexible Packaging Films
- Karin Weiland - Accessing drug encapsulation in liposomal nanocarriers with nanoscale lateral resolution through hyphenation of nES-GEMMA and PTIR spectroscopy
- Jérémie Mathurin - PTIR nanospectroscopy of organic matter in an Antarctic micrometeorite
Speakers using Bruker/Anasys AFM-IR Instrumentation

- Ariane Deniset-Besseau - Advanced Infrared Nanospectroscopy using photothermal induced resonance technique
- Mark Banaszak Holl - Uptake and Retention of Nanoplastics in Quagga Mussels
3rd Annual European Forum on Nanoscale IR Spectroscopy
September 12-13, 2018

- Co-Hosting with National Physical Laboratory, Teddington, London UK
- Discover and share cutting edge research and ideas in nanoscale IR research!
- Poster submissions still available

register at: Bruker.com/events/2018/efns
Invited Speakers

- **Dr Francesco Simone Ruggeri** – University of Cambridge
- **Dr Suzanne Morsch** – University of Manchester
- **Dr Tom Hauffman** – The Vrije Universiteit Brussel
- **Dr Valeria Giliberti** – Italian Institute of Technology
- **Dr Kwiatek Wojciech M.** – Polish Academy of Sciences
- **Dr Heinz Sturm** – Federal Institute of Material Research and Testing
- **Dr Curtis Marcott** – Light Light Solutions
- **Prof Alex Dazzi** – University of Paris-Sud
- **Miriam Unger** – Bruker-Anasys

Join Bruker-Anasys Instrument for the 3rd annual European Forum on Nanoscale IR Spectroscopy to discover and share cutting edge research and ideas in nanoscale IR research!

Titles of the talks

- **Dr Francesco Simone Ruggeri**
  - Work on fluid AFM-IR & cells

- **Dr Suzanne Morsch**
  - AFM-IR Analysis of Solid Insulation Degradation

- **Dr Tom Hauffman**
  - Nano-scale hybrid structure molecular analysis

- **Dr Kwiatek Wojciech M.**
  - Beyond classical insight into nanoworld spectroscopy with nanolIR2

- **Dr Valeria Giliberti**
  - Light-induced functional conformational changes of protein receptors probes by mid-IR nanospectroscopy

- **Dr Miriam Unger**
  - Latest Advancements in nanoscale IR Spectroscopy

Conference location:
National Physical Laboratory
Hampton Road
Teddington, TW11 0LW, United Kingdom

Contact us for more information:
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Summary

• nanoIR spectroscopy and imaging performance improvements have improved continually to enable access to a broader range of applications

• The examples in this webinar show that nanoIR spectroscopy provides unique datasets and new research insights not achievable with other techniques

• nanoIR technology continues to grow to improve spectroscopy S/N and chemical spatial resolution while improving surface sensitivity becoming a broadly adoptable technique.
New Advances in Nanoscale IR Spectroscopy