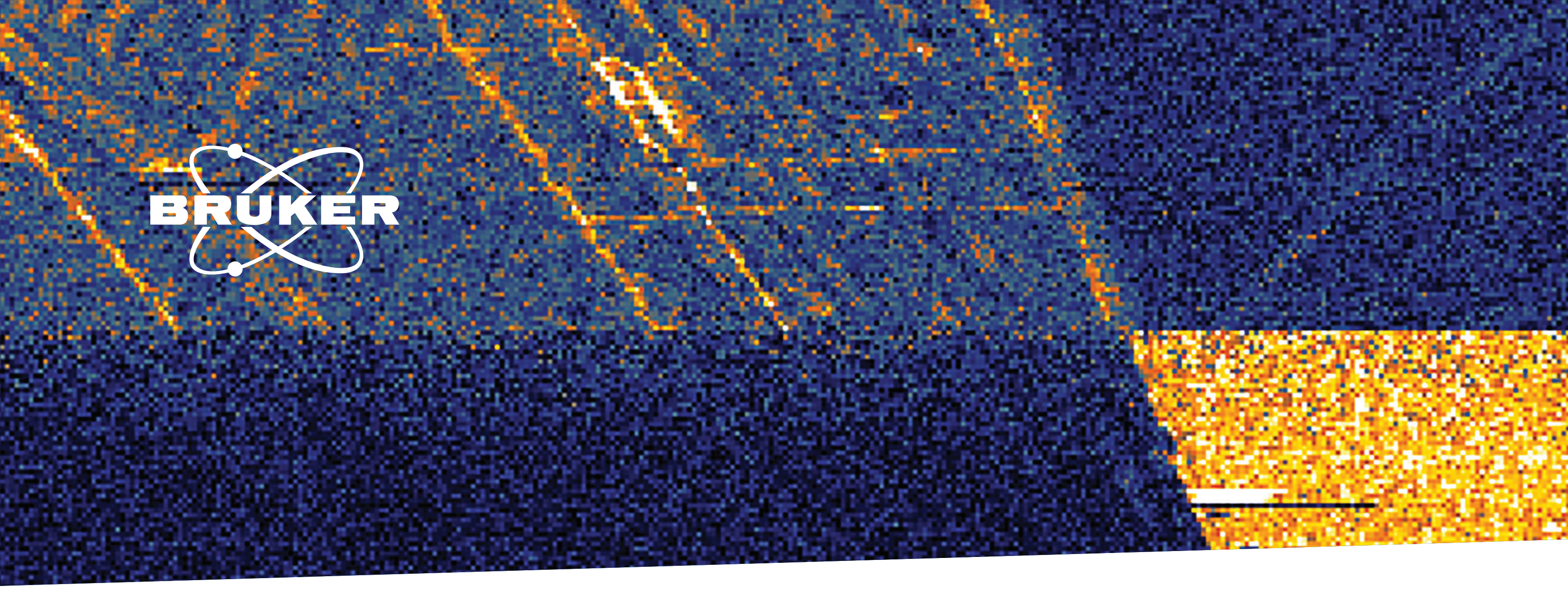


Surface Sensitive AFM-IR Mode

Selective Chemical Probing of Top Surface Layer

Bruker's new patented Surface Sensitive AFM-IR decreases chemical probing depth from greater than 500 nanometers to tens of nanometers, enabling selective characterization of a sample's top surface layer only. This photothermal-based, non-destructive technique significantly improves user productivity by eliminating the need for cross-sectioning and additionally removes spectral saturation that can often occur when examining thick strong IR absorbing samples. The technique provides a unique combination of high spatial resolution and high surface sensitivity for nanochemical ID, complementing traditional analytical techniques (FTIR, XPS, TOF-SIMS). With these combined capabilities, Surface Sensitive AFM-IR mode significantly increases the productivity of Bruker's nanoscale IR spectroscopy systems and opens a wide range of new applications for thin films, life sciences, geosciences, and many more.

Surface Sensitive AFM-IR:

- Improves AFM-IR probing depth from >500 nm to <10 nm
- Combines high spatial resolution and high surface sensitivity
- Eliminates the need for cross-sectioning
- Removes spectral saturation and correlates to FTIR

How It Works

Surface Sensitive AFM-IR was developed by Professor Alexandre Dazzi, University, Paris de Saclay, France with subsequent enhancements by scientists and engineers at Bruker, and the new mode is patented and jointly owned by Bruker and the French National Center for Scientific Research (CNRS). The method illuminates the sample with a beam of pulsed infrared radiation and measures the cantilever response at one of the contact resonance frequencies to acquire a depth-controlled spectrum of the surface layer. The surface sensitivity is achieved as a result of two factors: by limiting the thermal diffusion length at a high modulation frequency of the infrared radiation source (>1 MHz); and by exploiting the non-linear frequency mixing of the photothermal expansion force and an external acoustic excitation at the tip-sample interaction region. Operating the IR laser at higher pulse repetition rates limits the thermal diffusion length in both the lateral (X,Y) and axial (Z) directions. At the same time, the sample is excited by an external acoustic source, resulting in a non-linear frequency mixing between the photothermal expansion and acoustic excitation force that is confined strictly at the tip-sample interaction volume.

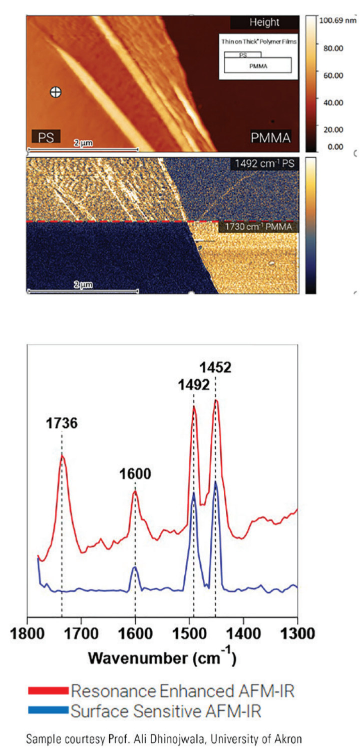


FIGURE 1

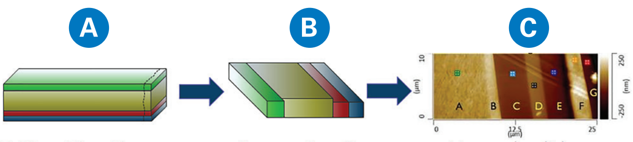
30-nm-thick polystyrene (PS) film on a 100-nm-thick poly(methylmethacrylate) (PMMA) substrate. The red spectra recorded using Resonance-Enhanced AFM-IR indicates the presence of both the PS top layer (1452 and 1492 cm^{-1}) and the PMMA substrate (1736 cm^{-1}). The blue spectra shows the Surface Sensitive AFM-IR measurement with the PMMA substrate removed.

Significantly Reduce Time to Data

Traditionally for multifilm layers, many samples had to be microtomed to enable measurement of the individual layers. Surface Sensitive AFM-IR mode significantly reduces sample preparation time by reducing the need for cross-sectioning, enabling clean measurement of the top layer in non-cross-sectioned samples.

FIGURE 2

A) Multilayer Film with cross-section at the end, B) Cross-sectioned layer presented face up, C) Measured multi-layer cross-section.



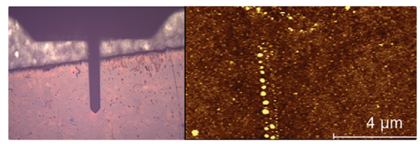
Eliminate Spectral Saturation

Spectral saturation is a major problem for thick, strong IR-absorbing samples measured by traditional transmission FT-IR spectroscopy. Such samples typically need microtoming to produce undistorted spectra. Attenuated total reflection (ATR) IR measurements can be made on the top 1-3 millimeters of a thick sample, but the technique requires the sample to be in contact with a high refractive index internal reflection element. In addition, ATR spectral intensities increase at longer IR wavelengths accompanied by peak shifts and band shape dispersions for the strongest IR absorbing bands. Surface Sensitive AFM-IR can eliminate the spectral saturation and band distortions that are prevalent when using Resonance Enhanced AFM-IR and other conventional IR techniques.

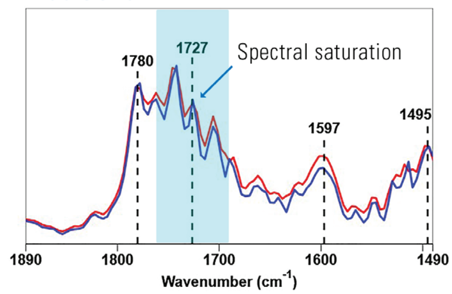
Seamlessly Configure Your NanoIR System

Surface Sensitive AFM-IR mode is an available option for the Dimension IconIR, the nanoIR3/3-s/3-s Broadband systems, and can be utilized on the latest Bruker HYPERspectra QCL lasers (Daylight) and the nanoIR Broadband Spectroscopy laser (APE GmbH). Installed systems can be upgraded in the field with appropriate compatibility upgrades. Compatibility on the nanoIR2 and nanoIR2s systems is expected in the future. Please contact Bruker for more information.

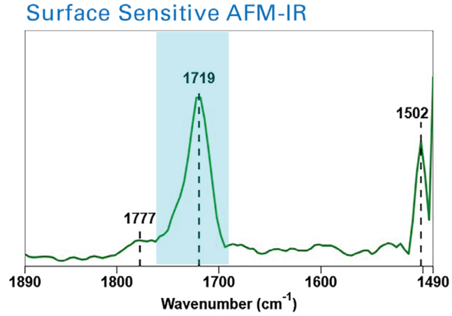
75 µm thick Kapton Tape (Polyimide)



Traditional AFM-IR



Surface Sensitive AFM-IR



Surface Sensitive AFM-IR vs. FTIR

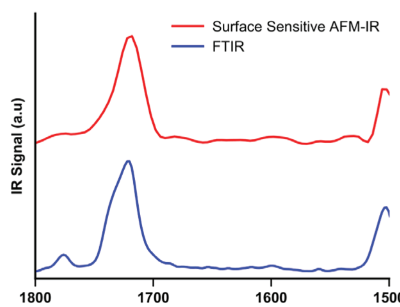


FIGURE 3

Surface Sensitive AFM-IR mode avoids or significantly reduces saturation artifacts without microtoming, which saves time and improves productivity.

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