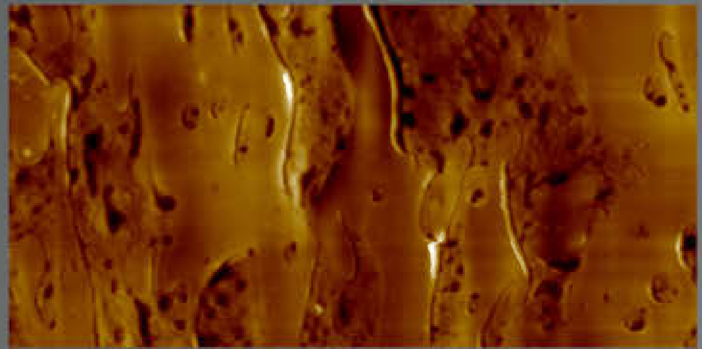
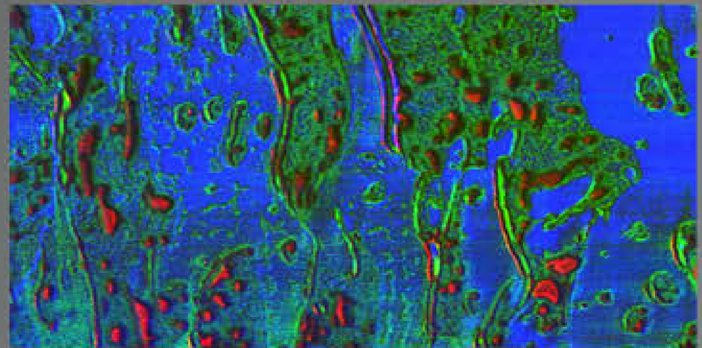
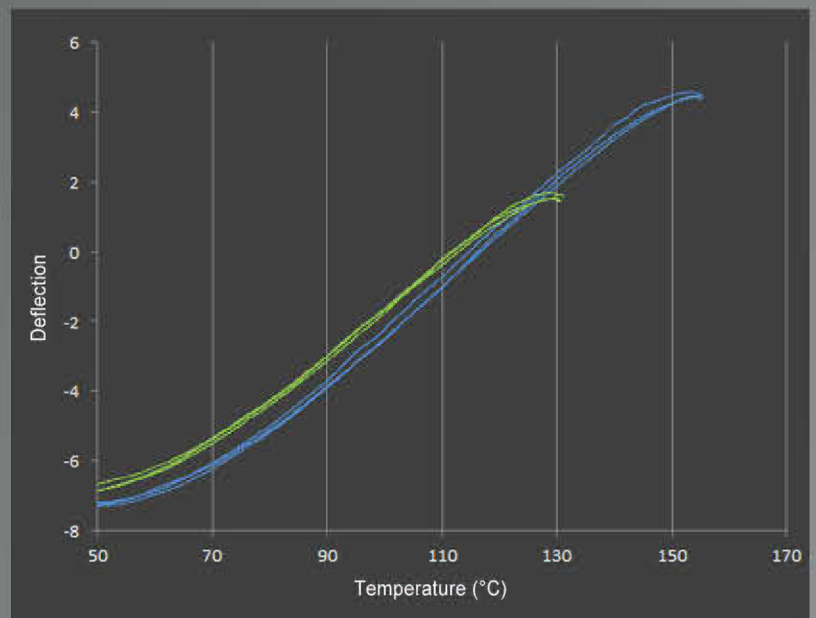
afm+

Don't just image your sample, understand it!





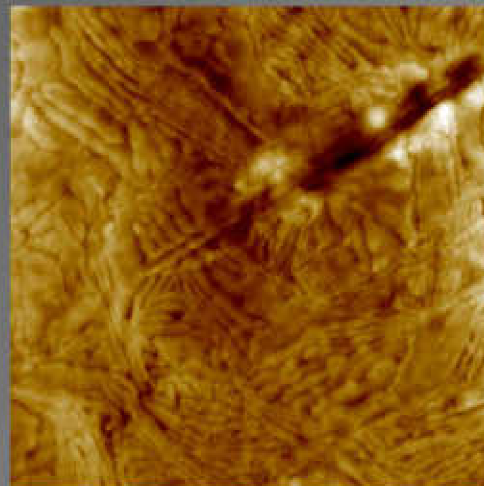


ANASYS INSTRUMENTS

The nanoscale analysis company

Atomic force microscopy (AFM) is a powerful tool for nanoscale research. Over the past several years, Anasys Instruments has expanded the reach of AFM to provide widely applicable analytical capabilities, enabling researchers to make new discoveries and solve real-world problems.

*The **afm+** delivers high-quality AFM performance with a closed-loop 80µm x 80µm XY scan stage and a motorized XY stage to accurately position the probe.*

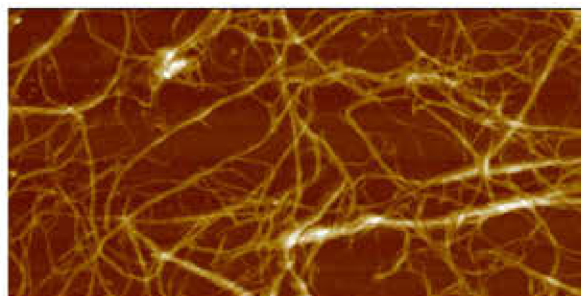


2 x 2 µm tapping mode scan of high density polyethylene showing the lamellar structure of the semicrystalline polymer.

The Anasys **afm+**® offers a full featured AFM with powerful analytical capabilities that make it much more than just an imaging tool. Some of the key aspects are:

Full featured AFM
- All common imaging modes
- High resolution closed loop imaging with excellent noise performance

Easy to setup and operate
- The **afm+** is built for maximum ease of use; premounted cantilevers allow fast and easy alignment
- Motorized sample stage and high quality optics allow rapid location of the analysis area
- Decades of AFM expertise distilled into instrument design means faster time to results, even for novice users



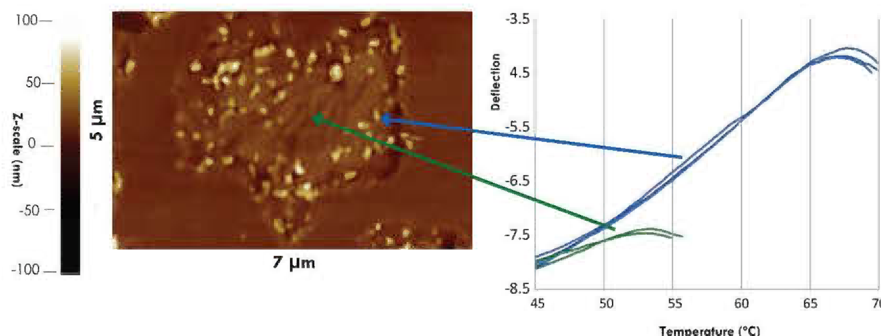
A tapping image of a cellulose nanofibril sample which has undergone a mechanical fibrillation process. The 5 x 2 micron scan shows the morphology of entangled nanofibrils with high lateral resolution.

Powerful localized nanoscale analytical techniques pioneered by Anasys world leading scientific team
- **Thermal:** nanoscale thermal analysis with our patented ThermaLever™ probes
- **Mechanical:** wideband nanomechanical analysis with our Lorentz Contact Resonance mode
- **Chemistry:** upgradeable to add nanoscale IR Spectroscopy for localized chemical composition

AFM + Thermal Analysis

Nanoscale Thermal Analysis (nano-TA)

Based on our proprietary thermal probe technology, the **afm+** allows you to obtain transition temperatures on any local feature of your sample or to obtain a transition temperature map.



An AFM image with nano-TA data of a toner particle. The particle was embedded in epoxy and microtomed. The topography of the sample shows variations in structure, which can then be analyzed using nano-TA. Toner particles include a number of components (wax, resin, dye, etc.) that exhibit different transition temperatures.

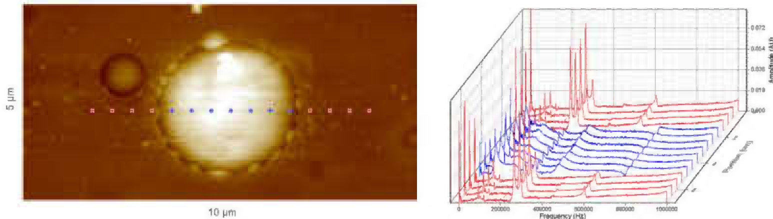
AFM + Mechanical Analysis

Lorentz Contact Resonance (LCR)

The Lorentz Contact Resonance (LCR) imaging mode further enhances the capabilities of the **afm+** and **nanoIR** systems. LCR allows rapid broadband nanomechanical measurements over a range of temperatures. LCR imaging differentiates between multiple components of a sample and allows precise location of the probe for subsequent chemical or thermal analysis with nanoscale resolution.

Nanomechanical spectroscopy

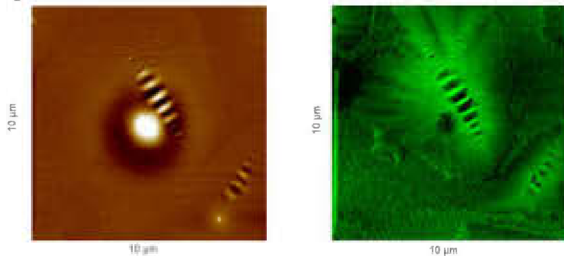
LCR can discriminate different materials based on wideband contact resonance spectra.



AFM topography measurement (L) and a series of Lorentz Contact Resonance mechanical spectra (R) on a blend of polystyrene (PS) and low density polyethylene (LDPE). LCR spectra clearly distinguish the PS and LDPE by the positions and amplitudes of the resonant peaks.

Compositional Mapping

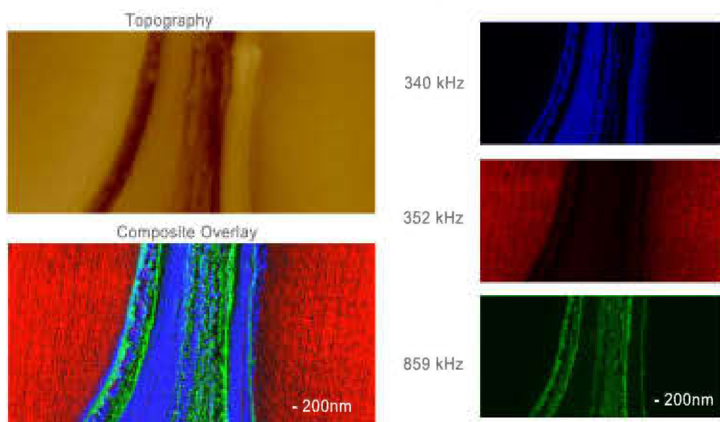
LCR provides high resolution maps of material components in heterogeneous materials.



Topography (left) and Lorentz Contact Resonance amplitude (right) images on a composite material. The LCR amplitude and phase images clearly distinguish different components in the composite as well as highlighting surface stress features in the LCR amplitude image.

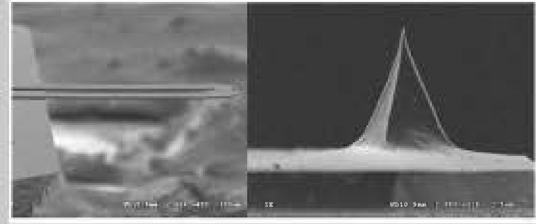
Multi-component Composite Overlay

Multi-component samples can be imaged at multiple frequencies, identifying and imaging each component individually. Our software can then be used to create an RGB overlay image



Three color mechanical map of wood cells. This composite image was made by overlying 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.

The Science Behind the Solution



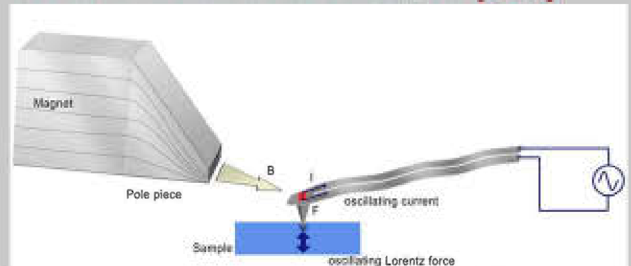
ThermaLever Probe

Developed by Anasys, ThermaLever probes are unique micromachined Si probes that are similar in geometry to standard Si AFM probes but incorporate a resistive heater at the end of the cantilever. They can image the sample surface with lateral resolution similar to a standard AFM probe and be used to selectively heat the sample to perform localized thermal analysis. In addition, these probes allow rapid dynamic thermomechanical measurements using Lorentz contact resonance.

Nano-Thermal Analysis (nano-TA)

Nano-TA allows measurements of local thermal properties with nanoscale resolution. This is accomplished by using the ThermaLever probe to locally heat the sample. While heating, the deflection of the cantilever is monitored. At the point of phase transition, the material beneath the tip softens and the probe penetrates into the sample. This provides the nanoscale equivalent of a bulk thermo-mechanical analysis experiment.

Lorentz Contact Resonance (LCR)



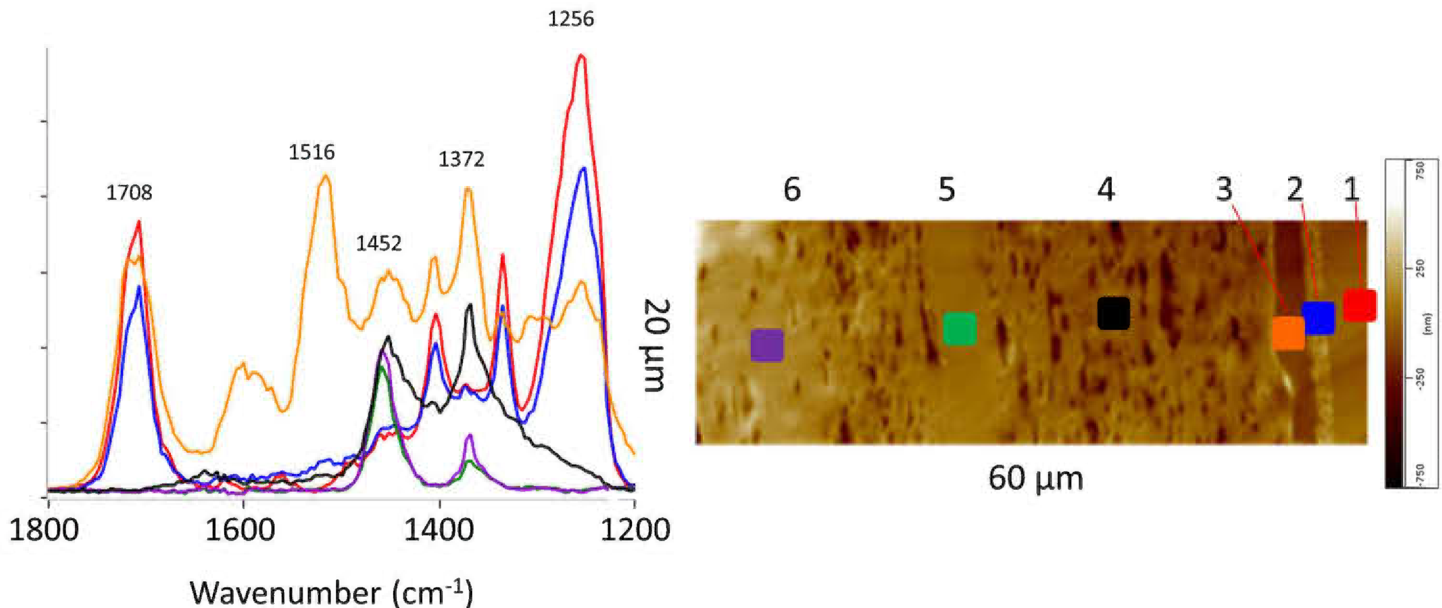
Lorentz Contact Resonance (LCR) is a significant improvement for AFM based Contact Resonance measurements which enable localized mechanical property analysis. The LCR cantilever actuation scheme is based on the Lorentz force generated by the interaction of a focused magnetic field and an AC current flowing through the ThermaLever probe. Due to the geometry of the probe and the magnetic field, as shown in the figure, the Lorentz force is concentrated at the end of the probe. This elegant actuation scheme involves no moving parts, and therefore does not suffer from parasitic resonances typical of standard contact resonance systems. As a result, the LCR technique has the benefit of addressing wideband mechanical response on a range of materials (from a few kHz to a few MHz). Finally, because the same cantilever can be heated up to 400C, the system can provide rapid frequency and temperature dependent measurements of materials at the nanoscale.

Upgradeable Analytical Capabilities

AFM + IR Spectroscopy nanoIR

The new **afm+** is fully upgradeable to our nanoIR™ system, a probe-based measurement tool that utilizes infrared spectroscopy to reveal chemical composition at the nanoscale. The nanoIR also provides high-resolution characterization of local topographic, mechanical, and thermal properties. Potential application areas span the realms of polymer science, materials science, and life science, including detailed studies of structure-property correlations.

- Point-and-click nanoscale IR spectroscopy
- IR spectra that correlate to FTIR libraries
- Chemical imaging



Distinctive chemical information, in the form of AFM-IR spectra, are captured from each layer of a multilayer film. The locations of each collected spectra is linked to the AFM image. For instance, the as-obtained spectra of the 1.2 µm PET/pigment layer (Layer 2) is cleanly separated from the neighboring 4.5 compliant polyurethane layer (Layer 3).

About Anasys Instruments

Anasys Instruments designs breakthrough, award-winning products that provide nanoscale probe based analytical techniques while providing high quality AFM imaging. We introduced the nano-TA in 2006 which launched the field of nanoscale thermal property measurement. In 2010, Anasys introduced the nanoIR Platform which pioneered the field of nanoscale IR measurement. In 2012, Anasys is proud to introduce Lorentz Contact Resonance which developed the field of wideband nanoscale dynamic mechanical spectroscopy.
For further details, please visit www.anasysinstruments.com

Front cover:

AFM Topography (top), Lorentz Contact Resonance image (middle) and nano-TA curves (bottom) of a multi-component polymer blend. The middle image was created by combining LCR amplitude images at three different contact resonances to highlight the distribution of the blend components. The nano-TA curves allow measurement of two of the thermoplastic materials which complement the mechanical information and allow identification of these components.

The afm+ system is covered by US and foreign patents:
www.anasysinstruments.com/company/patents

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