PeakForce Tapping

How AFM Should Be

Innovation with Integrity
PeakForce Tapping
How AFM Should Be

Bruker’s exclusive PeakForce Tapping® is the most significant scientific breakthrough in atomic force microscope (AFM) technology since the introduction of TappingMode™. It provides unprecedented high resolution imaging, extends AFM measurements into a range of samples not previously accessed and uniquely enables simultaneous nanoscale property mapping.

Highest resolution imaging
PeakForce Tapping enables the researcher to precisely control probe-to-sample interaction enabling the lowest available imaging forces. This superior force control results in the most consistent, highest resolution AFM imaging for the widest range of sample types, from the softest biological samples to very hard materials.

Unique, quantitative results, whatever you measure
PeakForce Tapping’s piconewton (pN) force sensitivity simultaneously and uniquely combines the highest resolution AFM imaging with quantitative, nanoscale electrical, mechanical, biological, and chemical property mapping, enabling researchers of all experience levels to make new discoveries.

Easy to use, making every user an AFM expert
PeakForce Tapping’s superior force control provides the user with unmatched AFM ease of use with ScanAsyst® image optimization software, and the low forces preserve the probe shape for longer life and more consistent imaging.

Multimodal graphene characterization with PeakForce Tapping, PeakForce KPFM, PeakForce QNM and PeakForce IR. Image size: 15 μm top left and right; 5 μm bottom left and right.

“PeakForce Tapping provided my lab with the force control and resolution necessary to produce ground-breaking ligand-receptor interaction maps using functionalized probes on live cells in a very time efficient and controlled way.”

– Daniel Müller, ETH Zürich, Switzerland
Enabling New Discoveries

In PeakForce Tapping, the probe periodically taps the sample and the pN-level interaction force is measured directly by the deflection of the cantilever. Through superior force control, the feedback loop keeps the peak force constant, down to 10 pN, in both air and fluid, which is significantly lower than is typically used with other modes, such as TappingMode (~1 nN).

In addition to material research, PeakForce Tapping is ideal for measurement of biological samples due its unprecedented low imaging forces. It overcomes the many limitations of TappingMode operation in fluid such as the need to constantly tune the cantilever. Routine measurements of live-cell mechanical properties are now available with PeakForce Tapping technology.

The superior force control maintains tip shape and sample integrity, leading to consistently accurate and high-resolution measurements of even the smallest biological structures, such as double helix DNA.

The greatest power of PeakForce Tapping technology, however, comes from its ability to simultaneously enable and enhance other correlative and quantitative mapping techniques, delivering new possibilities in an ever-expanding set of topographical, mechanical, biological, electrical and chemical applications at the nanoscale.

Bruker continues to demonstrate its leadership in AFM technology development with PeakForce Tapping, built on the foundation of five separate patents. This has led to over 1,000 peer-reviewed publications in the first five years since its release, generating nearly 3000 citations. This adoption rate has surpassed even that of TappingMode.

“Thanks to PeakForce QNM, we were able to rapidly obtain pertinent information on the mechanical properties of very soft and sticky polymer materials, such as bioadhesives or adaptive hydrogels, that other classical SPM techniques were not able to provide.”

– Philipe Leclère et al, University of Mons (UMONS) Belgium

Submolecular resolution of the major and minor grooves of the DNA double helix. Image obtained with BioScope Resolve on an inverted microscope. Image size 15 nm x 43 nm.
PeakForce QNM for Materials
Quantitative Nanoscale Mechanical Characterization

Utilizing PeakForce Tapping technology, PeakForce QNM® maps and distinguishes between nanomechanical properties—including modulus, adhesion, dissipation, and deformation—while simultaneously imaging sample topography at atomic scale resolution. It is non-destructive to both tip and sample since it directly controls the peak normal force and minimizes the lateral force on the probe. Since force distance data is analyzed directly, there is no ambiguity regarding the source of image contrast, as often occurs in other techniques. The quantitative data produced can help researchers answer the critical question of what materials they are seeing in their topographic images. Additionally, it is now possible to study the variation and position of mechanical properties across a surface with ease, and at previously unattainable resolution.

PeakForce QNM provides:
- Highest resolution mapping of nanomechanical properties
- High-speed, most quantitative nanomechanical mapping
- Widest operating range for samples, from extremely soft materials (~1 kPa) to hard metals (100 GPa)

PeakForce QNM for Life Sciences
Submolecular, Quantitative Mapping of Biological Interactions

PeakForce QNM allows bio-researchers, for the first time, to correlate submolecular AFM imaging with quantitative mapping of mechanical, chemical and biological interactions, including recognition imaging through the adhesion channel, with high resolution and low force control.

Additionally, it provides simultaneous, high-resolution imaging and mechanical property mapping of live cells, viruses and tissues. This opens up new areas of investigation into the role of mechanics in biological structures and processes. PeakForce QNM overcomes the numerous limitations of other modes for cell imaging, acquiring images at regular AFM imaging rates. Furthermore, its force-ramp rates uniquely enable visco-elastic property measurements over the widest available frequency range.

PeakForce QNM enables:
- Submolecular resolution mapping of mechanical, chemical and biological interactions
- High-speed, quantitative mechanical property and adhesion mapping of live cells
- Easiest to use, making every user an AFM expert
PeakForce TUNA
Highest Resolution Current Mapping on the Most Fragile Samples

PeakForce TUNA™ is an ideal method for probing conductivity of fragile samples such as organic photovoltaics, conductive nanotubes, and nanoparticles. It overcomes the limitations of traditional contact-mode-based conductive AFM techniques, which are severely restricted by sample damage or probe tip contamination from CAFM lateral forces. PeakForce TUNA provides direct, precise force control and eliminates lateral forces. This enables routine high-sensitivity and high-resolution current imaging.

Now users can benefit from the full fA to μA current range, directly correlated quantitative nanomechanical property imaging with PeakForce QNM, and the ease-of-use of ScanAsyst, all with one module. PeakForce TUNA can also be integrated with environmental control to regulate oxygen and water levels down to ppm to accommodate the most sensitive samples.

**PeakForce TUNA offers:**
- Highest resolution current mapping on the most fragile samples
- Unmatched repeatability and consistency in nanoelectrical measurements
- Correlated nanomechanical and nanoelectrical properties

PeakForce KPFM
Industry-Leading Spatial Resolution and Artifact-Free Potential Contrast

PeakForce KPFM™ improves measurement performance over traditional KPFM techniques by providing the highest spatial resolution and most accurate measurements of surface potential. These improvements have been achieved with the combination of new PeakForce Tapping mode, scan algorithms and Bruker’s unique in-house probe developments.

Uniquely, PeakForce KPFM provides the most accurate probe-to-probe surface potential measurements, enabling consistent measurements across different material types. It can be used with PeakForce Tapping QNM to deliver simultaneous, highly correlated nanoscale topography, electrical and mechanical property mapping on a wide range of samples. PeakForce KPFM also has overcome the significant ease-of-use issues of traditional KPFM techniques by operating in ScanAsyst mode, enabling the acquisition of expert-quality data by users of all experience levels.

**PeakForce KPFM delivers:**
- Most accurate, repeatable, and sensitive work function measurements
- Leading-edge spatial resolution combined with artifact-free potential contrast
- Correlated quantitative nanomechanical property mapping
PeakForce IR
Unprecedented Quantitative Nanochemical Characterization

PeakForce IR™ extends nanoscale mapping beyond the range of conventional AFM, sSNOM, or photothermal techniques to provide not just more information but also to probe previously inaccessible samples. The mode interleaves sSNOM signal acquisition with PeakForce Tapping feedback to provide a full, combined set of information. Nanoscale chemical maps with 10 nm spatial resolution and monolayer sensitivity are directly correlated with quantitative nanomechanical information such as modulus, adhesion, and deformation.

With PeakForce IR there is no requirement to microtome a thin slice or mount the sample onto a hydrophobic support. Addressable samples include those that are not Raman active, not reflective or transparent, or are not conducive to contact or TappingMode feedback. PeakForce IR can identify material types and detect film thickness variations with molecular monolayer sensitivity. It delivers scanning probe IR reflection and absorption imaging with all the advantages of scattering SNOM for chemical, materials, and plasmon imaging at the highest spatial resolution possible.

PeakForce IR expands nanoscale characterization to:

- Powders and polymer brushes where neither contact nor TappingMode succeed
- Rubbery components, metals, semiconductors, ceramics, and other samples not conducive to photothermal approaches
- Unique correlation of plasmonics and electronic structures of graphene and other 2D materials

PeakForce Capture
High-Sensitivity Nanomechanical Data at Every Pixel

Where PeakForce QNM analyzes each force curve in PeakForce Tapping in real-time to generate material property maps, PeakForce Capture™ goes beyond the image to provide the actual force curves at every pixel in addition to the calculated property channels. When enabled, force curves from the PeakForce QNM image are saved alongside the standard image file in a proprietary 3D data cube file format. This allows direct calculations with the NanoScope® analysis functions, as well as simple export to other systems or programs for additional analysis. When paired with PeakForce QNM, it provides the highest resolution mechanical mapping capabilities and analysis that can be used with standard models for biomechanics.

PeakForce Capture provides:

- Highest resolution force mapping
- Sensitivity to discover unexpected events not captured with other techniques
- User-specific models through data export features
**ScanAsyst**  
**Self-Optimizing AFM for High-Resolution Imaging**

ScanAsyst is a PeakForce Tapping based image optimization technique that enables every user to create the highest resolution AFM images using single-touch scanning.

ScanAsyst eliminates the need to navigate complicated AFM interfaces and parameter settings, automating PeakForce Tapping so that extremely high-quality images can be produced by any user, regardless of experience level. “Intelligent” algorithms automatically and continuously monitor image quality and make appropriate parameter adjustments. The user simply selects a scan area and scan size for a sample, in air or fluid, essentially enabling a turnkey solution for AFM imaging. ScanAsyst uniquely enables easy imaging of live cells while simultaneously providing high-resolution cellular detail.

**ScanAsyst enables:**
- Easiest, consistent measurement of a wide range of samples for material research
- Single-button, repeatable roughness measurements for wafer applications
- Easiest, most stable high-resolution imaging of cells and molecules

“It was previously impossible to resolve the finest structures of a live cell like microvilli, but now with the improved PeakForce Tapping on BioScope Resolve I can image them easily.”

– Hermann Schillers,  
University of Münster, Germany
# PeakForce Tapping Applications

<table>
<thead>
<tr>
<th>Characterization of novel, nanostructured, and 2D materials</th>
<th>ScanAsyst</th>
<th>PeakForce QNM</th>
<th>PeakForce TUNA</th>
<th>PeakForce KPFM</th>
<th>PeakForce IR</th>
<th>PeakForce Capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials research for energy and devices, including lithium ion batteries, fuel cells, organic photovoltaics</td>
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<td>Composition mapping and nanomechanics of multiphase polymeric and composite materials</td>
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<td>Semiconductor device characterization and failure analysis</td>
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<td>In situ lithium ion battery anode, cathode, and SEI layer studies</td>
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<td>Molecular bio-imaging, including DNA, proteins, and membranes in liquid</td>
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<td>In situ live and fixed cell imaging, including recognition mapping and cell mechanics as function of disease states</td>
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<td>Analysis and classification of defects on industrial samples</td>
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<td>Roughness measurements</td>
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# Featured on Bruker AFMs

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<thead>
<tr>
<th>Dimension FastScan®</th>
<th>ScanAsyst</th>
<th>PeakForce QNM</th>
<th>PeakForce TUNA</th>
<th>PeakForce KPFM</th>
<th>PeakForce IR</th>
<th>PeakForce Capture</th>
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<td>Dimension FastScan Bio™</td>
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## See the Difference Peakforce Tapping Can Make

We welcome you to visit one of our many application labs worldwide to see for yourself how PeakForce Tapping modes work on your samples. Our application scientists will be pleased to work with you to define how best to solve your scientific and applications challenges.

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