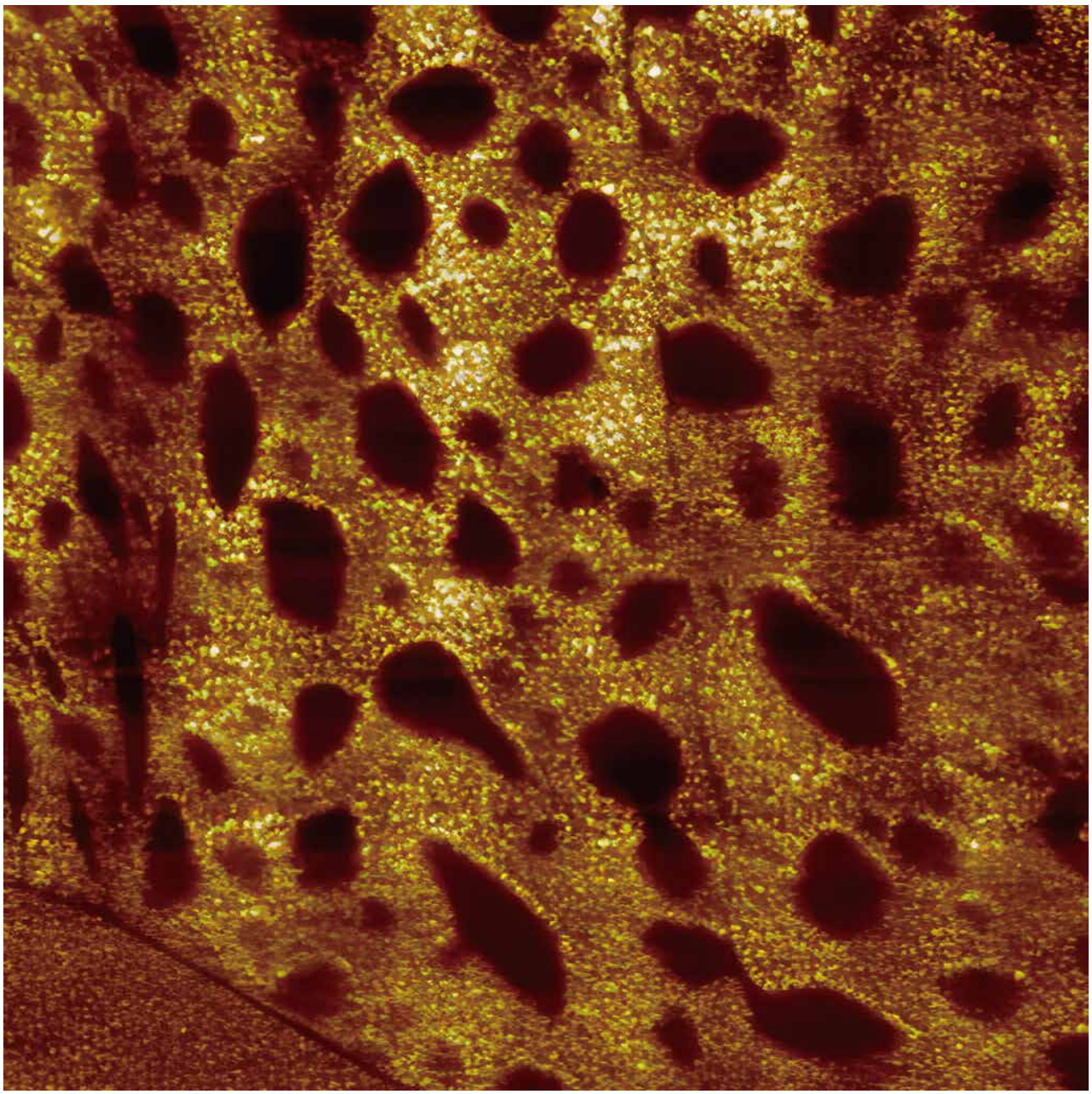
Enabling Nanoscale Advances

Park SYSTEMS

Park PinPoint™ mode

PinPoint your sample with AFM

Accurate nanomechanical and electrical imaging using PinPoint™ mode



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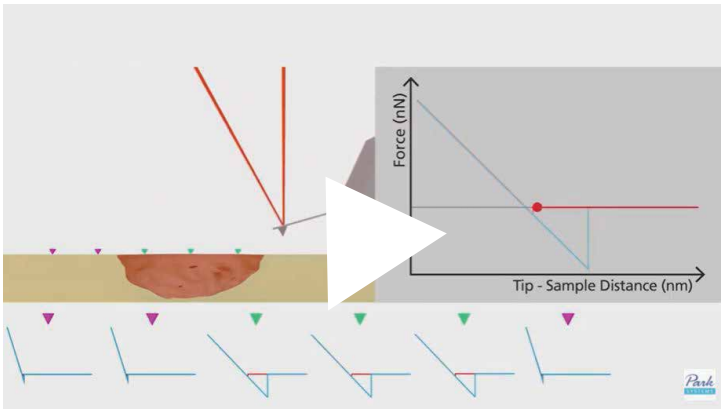
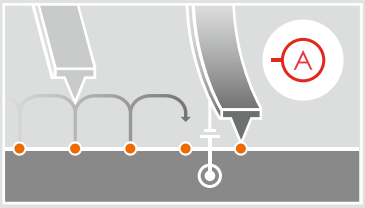


Scan QR code to watch an instructive video on Park PinPoint™ mode.

What is PinPoint™ mode



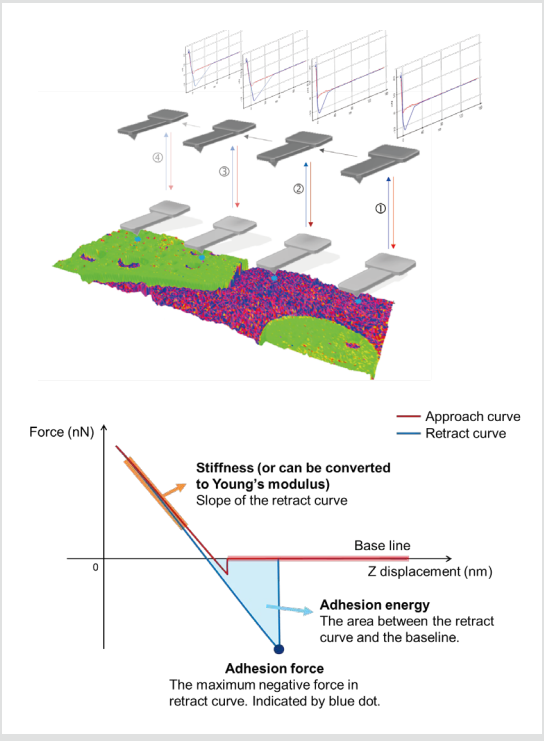
PinPoint is a proprietary operation mode of Park Systems AFMs that provides accurate and quantitative nanomechanical imaging via fast force spectroscopy mapping. Precise control of the contact force and movement speed of the cantilever allows the acquisition of nanomechanical properties such as adhesion force and elastic modulus. Moreover, an adjustable contact time enables the combination of PinPoint with several other electrical AFM modes like conductive AFM (C-AFM), Piezoresponse Force Microscopy (PFM), and Scanning Spreading Resistance Microscopy (SSRM). PinPoint therefore enables more accurate and less invasive characterization by integrating advanced AFM modes for the simultaneous measurement of mechanical and electrical properties.

How does PinPoint work?

In PinPoint mode, the XY scanner stops at each pixel, and the cantilever approaches and retracts to record high-speed force-distance curves with precise control of contact force and contact time between the tip and the sample. For example, an image with 256 x 256 pixels equates to 65,536 measurements, simultaneously acquiring 3D topography and nanomechanical information at each contact point.

PinPoint mode has the capability to simultaneously collect topography, stiffness, elastic modulus, and adhesion force in real-time. Since the cantilever is lifted between each force-distance curve, PinPoint ensures a frictionless operation that eliminates shear forces while enabling sub-nm contact forces, and therefore preserves tip and sample conditions.

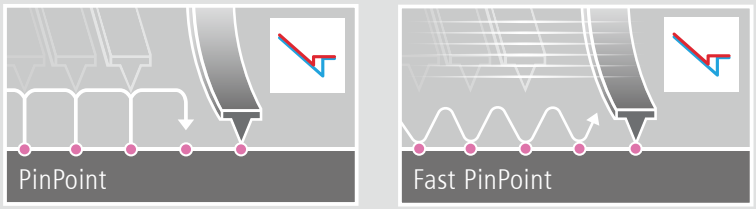
- PinPoint can be combined with various electrical and electromechanical measurement modes.
- PinPoint allows a non-invasive characterization of soft samples, that are sensitive to shear forces.
- It offers simultaneous acquisition of up to eight unique information channels.
- Users can fully customize acquisition channels to meet different experimental requirements.
- Precise control of the contact time at the setpoint (maximum loading force) optimizes tip–sample interaction.
- The stationary XY scanner during each force–distance cycle ensures highly accurate and reproducible measurements.



Working principle of PinPoint nanomechanical mode by Park Systems. the probe moves sequentially from point 1 to 4, and at each point force-distance curves are taken to calculate the nanomechanical properties.

Fast PinPoint™ mode

Fast PinPoint is an advanced mode that measures nanomechanical properties, such as modulus and adhesion, while simultaneously capturing high-resolution topography at high speed. It is ideal for structures that change over time as it allows for fast data acquisition.



Working principles

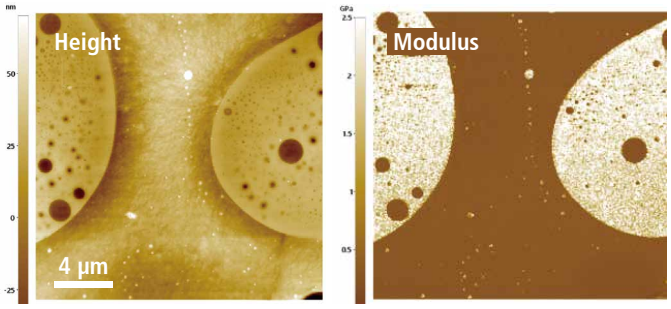
- Aquires sinusoidal F/d curves at each contact point during the imaging
- Precise force control with minimized lateral forces for accurate results
- Non-destructive measurement suitable for sensitive samples

Advantages:

Fast PinPoint operates at low modulation frequencies from 100 Hz to 2 kHz and recording images 8 times faster than the standard PinPoint mode (~2 min for 128 × 128 pixels). Such high scan speed is curical for mechanical characterization of soft materials like polymers, composites, and biological samples.

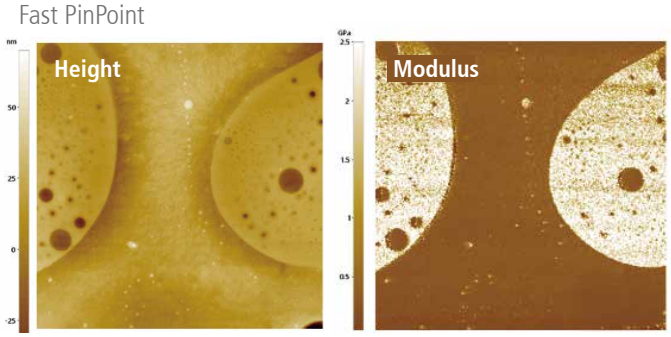
- **PS/LDPE**

PinPoint



Scan Rate:0.13 Hz
Imaging Time: ~33 min

Fast PinPoint



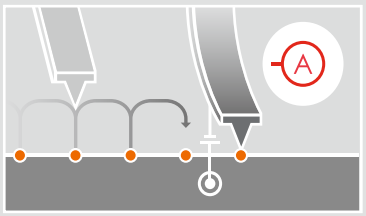
Scan Rate: 1 Hz
Imaging Time: ~4.3 min

Reference Modulus
PS: ~2.25 GP
LDPE: ~0.316 GPa

PinPoint C-AFM

PinPoint C-AFM for highly reproducible, non-invasive current imaging

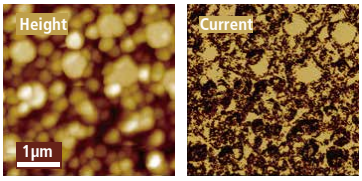
PinPoint C-AFM provides higher accuracy in both topography and current measurements compared to traditional C-AFM through:



- Reduced shear forces, preserving tip quality and extending tip lifetime
- Higher spatial resolution as a result of lower tip wear
- Controlled contact force and contact time for highly accurate current detection
- Preservation of sample integrity, particularly on soft, polymeric surfaces
- Simultaneous acquisition of conductive, topographical and nanomechanical information

ZnO Nanorods

PinPoint C-AFM

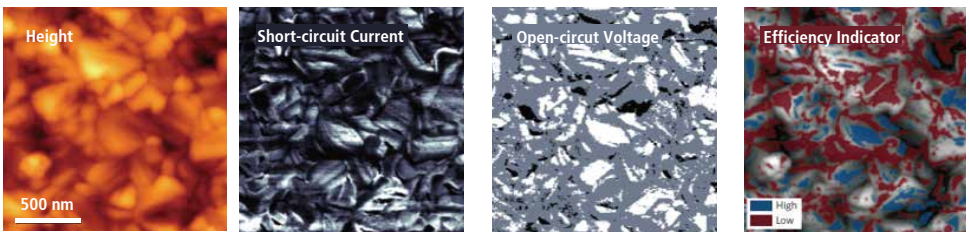


Topography and current images acquired using PinPoint C-AFM and conventional C-AFM.

Conventional C-AFM

PinPoint C-AFM provides stable and reproducible current imaging, while conventional C-AFM shows scan-direction-dependent contrast.

Hybrid Halide Perovskite Solar Cell



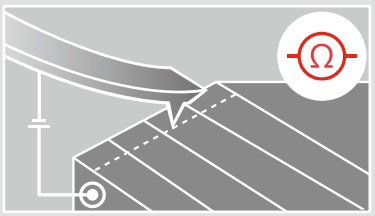
Spatial variations in short-circuit current (Isc) and open-circuit voltage (Voc) are observed within individual perovskite grains, distinguishing high- and low-efficiency regions.

Sibel Y. Leblebici et al. (2016). Facet-dependent photovoltaic efficiency variations in single grains of hybrid halide perovskite. Nature Energy 16093.

PinPoint SSRM

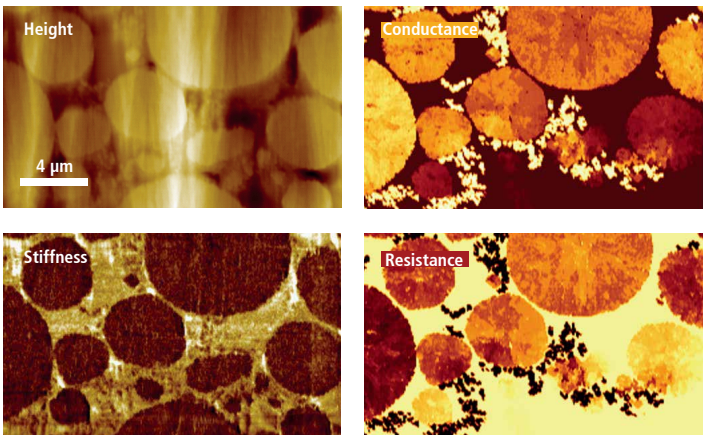
PinPoint SSRM for semiconductor and energy materials applications

PinPoint SSRM provides higher accuracy in electrical measurements compared to conventional SSRM through:



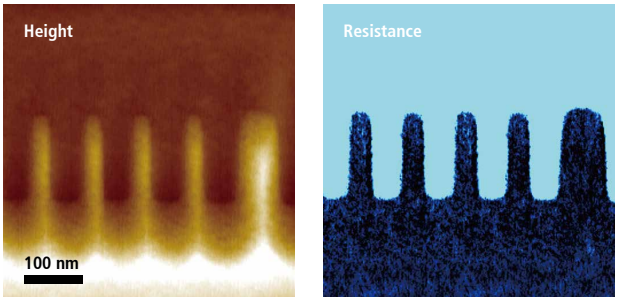
- Reduced shear forces for longer tip lifetime and less sample damage
- More accurate detection of electrical signals due to controlled contact force and contact time
- Simultaneous acquisition of current, conductance, resistance, topography, and nanomechanical properties

Li-ion Battery Electrode



Topography, conductance, resistance, and stiffness were simultaneously measured on Park NX-Hivac under vacuum condition.

Ge ALE on Patterned Wafer



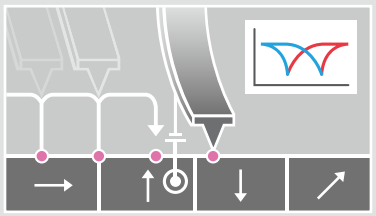
SSRM resistance imaging clearly resolves patterned Ge structures after ALE processing.

Electrical contrast reveals etch-dependent variations across the sidewalls and recessed regions.

PinPoint PFM

PinPoint PFM for enhanced piezoresponse characterization at the nanoscale

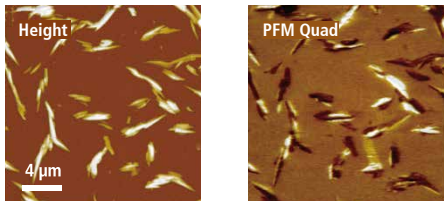
PinPoint PFM provides non-invasive piezoresponse measurements with improved accuracy compared to conventional PFM through:



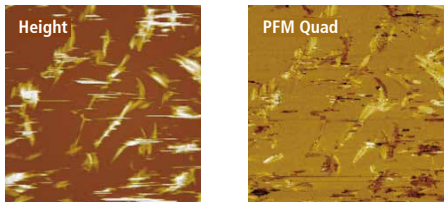
- Controlled contact force and contact time for repeatable and accurate piezoresponse measurements
- High spatial resolution due to reduced tip wear
- Non-invasive imaging particularly suitable for soft samples and samples weakly adhered to the substrate, enabled by reduced shear forces.
- Simultaneous acquisition of piezoresponse, topography and nanomechanical properties

Annealed Phenanthrene

PinPoint PFM



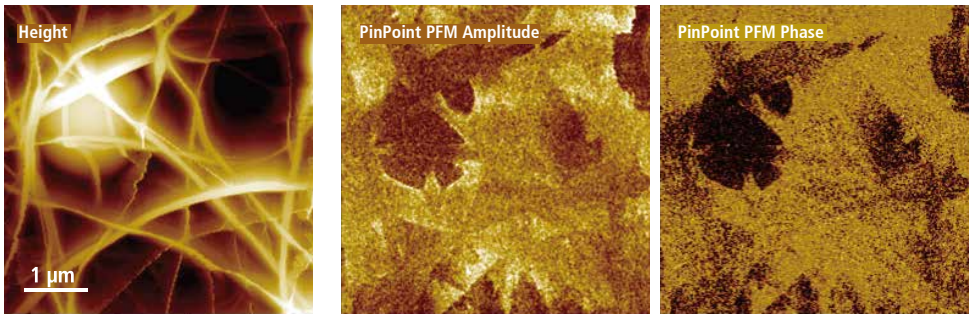
Conventional PFM



Height and PFM quad images of annealed phenanthrene reveal the piezoresponse distribution of the crystalline domains.

PinPoint PFM provides clearer and more stable contrast compared to conventional PFM due to reduced lateral forces.

PVDF Fibrous Membrane

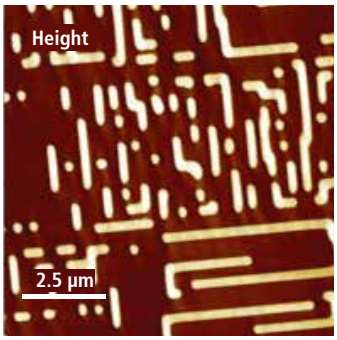


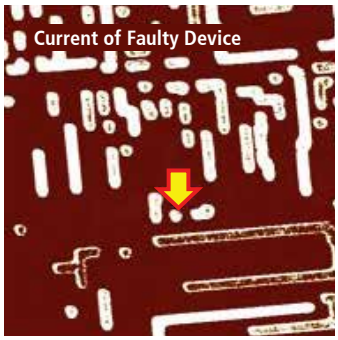
Height, PFM amplitude, and phase images reveal ferroelectric domain structures in the PVDF fibrous membrane.

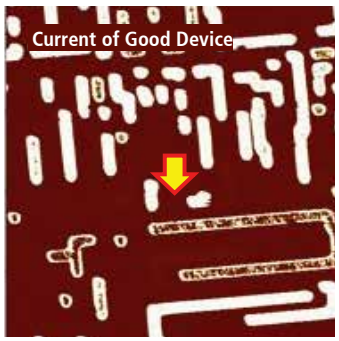
Sample courtesy: M. Suchea, IMT Bucharest, Romania P Pascariu, Petru Poni Institute, Romania

Application Examples - Electrical Characterization

▪ Failure Analysis of Semiconductor Devices using PinPoint C-AFM



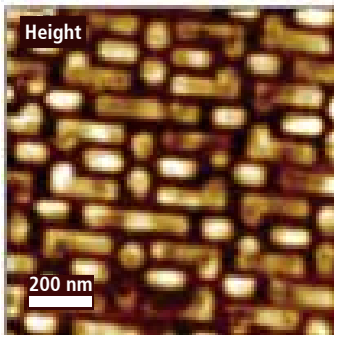


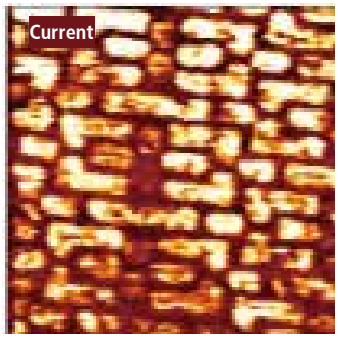


Localized current mapping enables failure analysis of semiconductor devices.
* The defect is clearly marked by the yellow arrow.

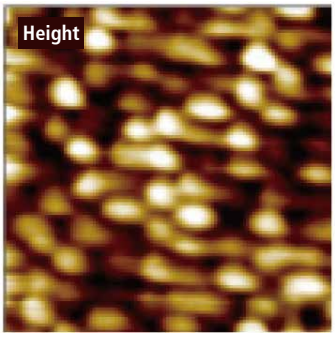
▪ Metallic Conduit Wiring Layer in a 6T SRAM (22 nm Node)

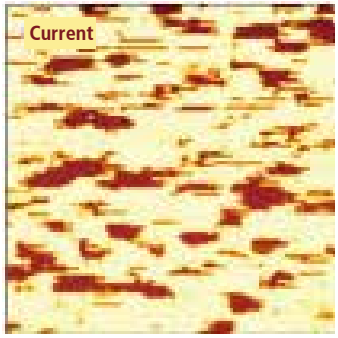
PinPoint C-AFM





Conventional C-AFM

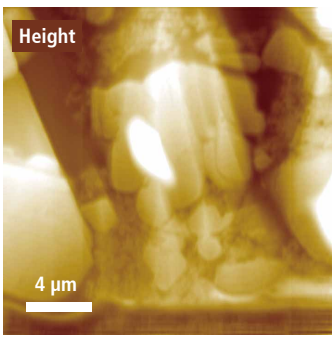


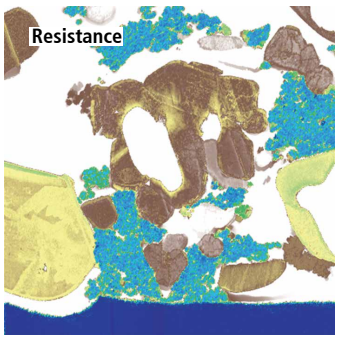


PinPoint C-AFM enables stable and high-resolution current imaging of nanoscale interconnect structures.

Compared with conventional C-AFM, improved electrical contrast allows clearer identification of conductive paths.

▪ Li-ion Battery on Si Substrate using PinPoint SSRM

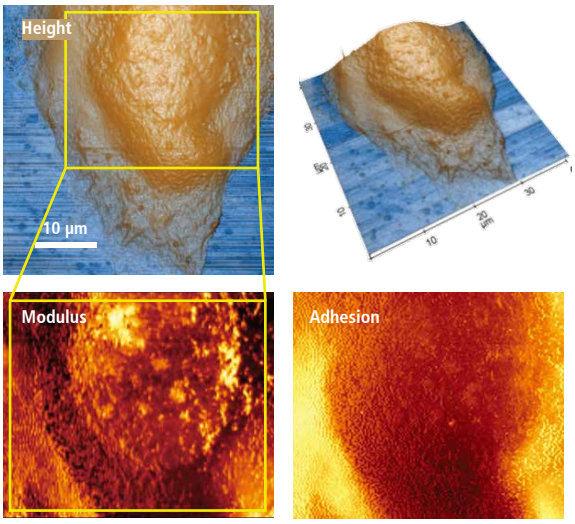




SSRM imaging reveals variations in local electrical resistance across the Li-ion battery electrode on a silicon substrate.

Application Examples - Nanomechanical Characterization

▪ MRC-5 Cell (Human Lung Fibroblast)

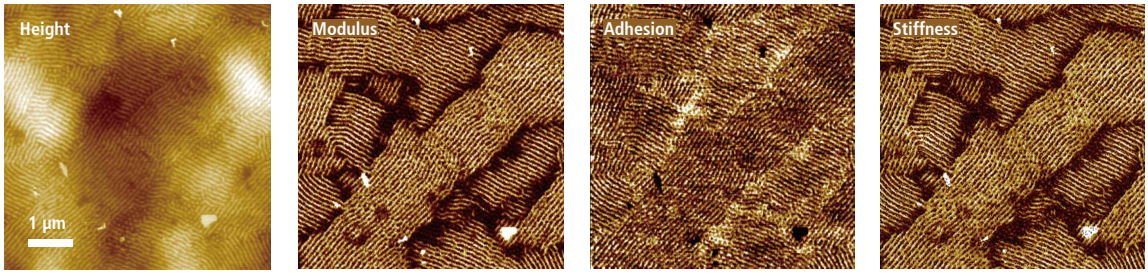


Nanomechanical imaging reveals local variations in stiffness and adhesion across the MRC-5 cell surface.

The stiffness and adhesion force ranges measured in PinPoint mode are approximately 90 kPa and 400 pN, respectively.

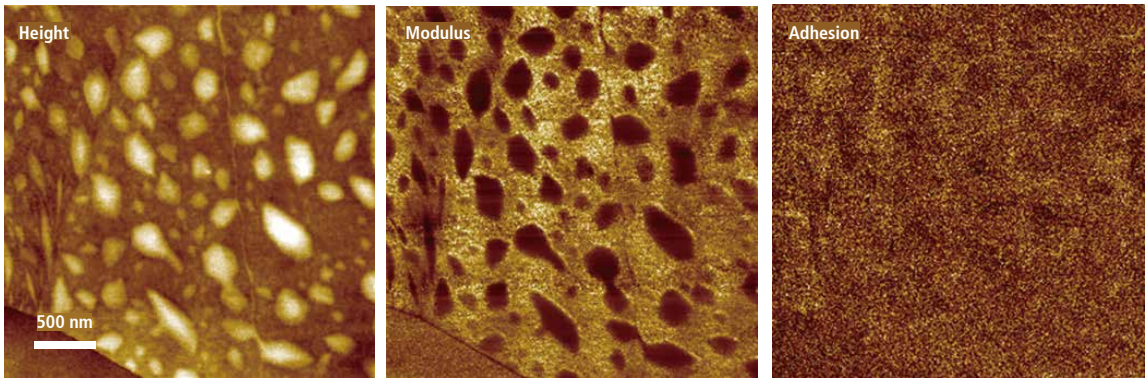
Simultaneous acquisition of topography and force-distance data minimizes positional errors and reduces sample damage, enabling reliable nanomechanical characterization of soft biological samples.

▪ PS-PMMA Block Copolymer



Nanomechanical contrast in modulus, adhesion, and stiffness clearly distinguishes polymer domains.

▪ MoS_2 Bubbles

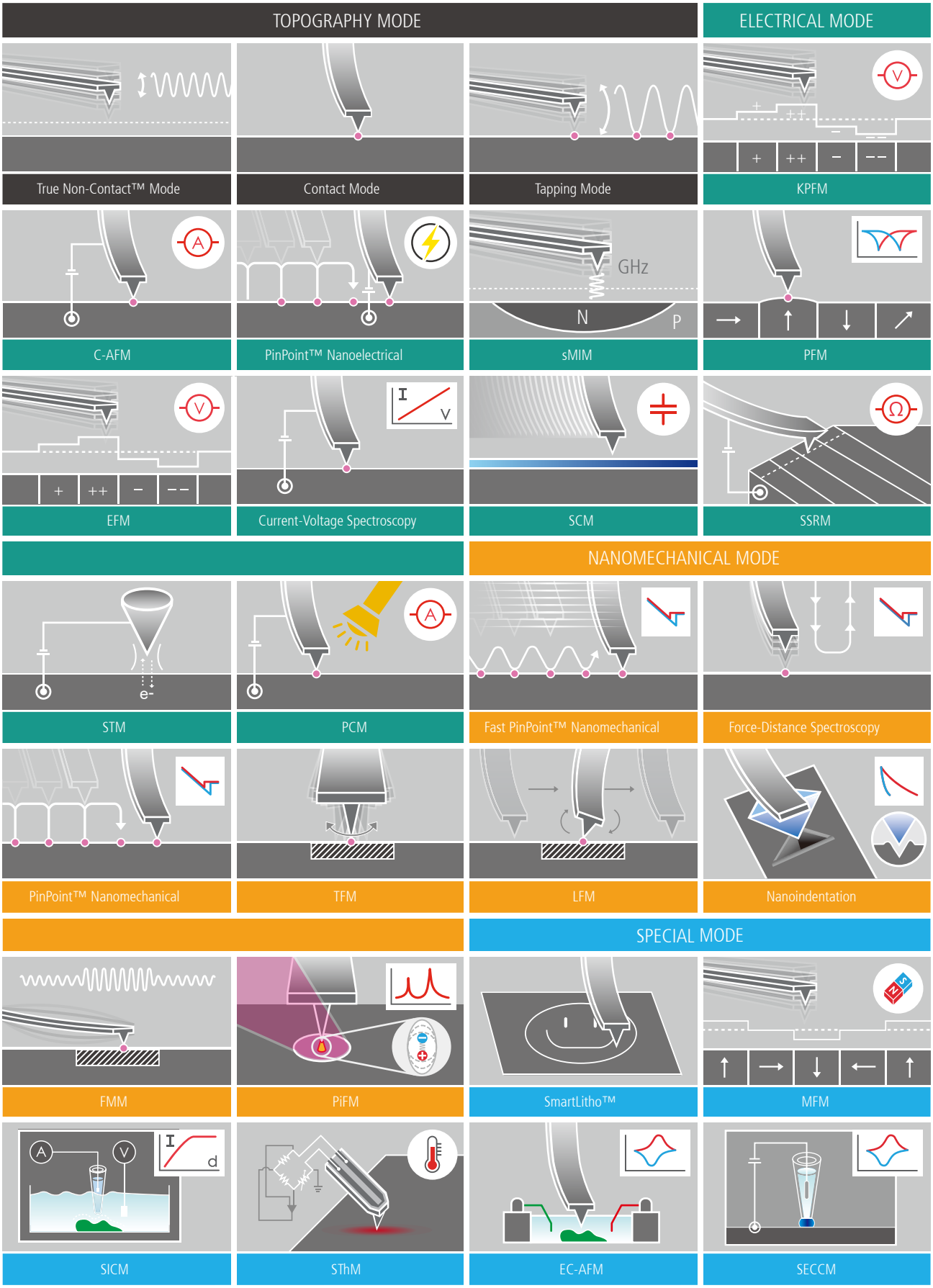


Modulus contrast clearly identifies bubble-like features and local mechanical variations in MoS_2.

Sample courtesy: Institut für Festkörperphysik, Universität Bremen, Germany

Park Atomic Force Microscopy Modes

Get the data you need with Park's selection of scanning modes



Park SYSTEMS

Enabling Nanoscale Advances

The Leading Innovator of **Nanometrology Solutions**

Park Systems is a leading manufacturer of AFMs and other nanoscale metrology instruments for both research and industrial applications.

AFM

Atomic Force Microscope
Ultimate Nano-Scale Metrology

Industrial Metrology

Manufacturing Process Control

WLI

White Light Interferometer
3D Optical Metrology

DHM

Digital Holographic Microscope
Real-Time 3D Optical Metrology

ISE

Imaging Spectroscopic Ellipsometer
Wide Field-of-View
Thin-Film Characterization

AVI

Active Vibration Isolation
Environmental Vibration Noise Isolation

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