



# Small Things, Big Differences: Bruker Nano Atomic Force Microscopes

# Welcome

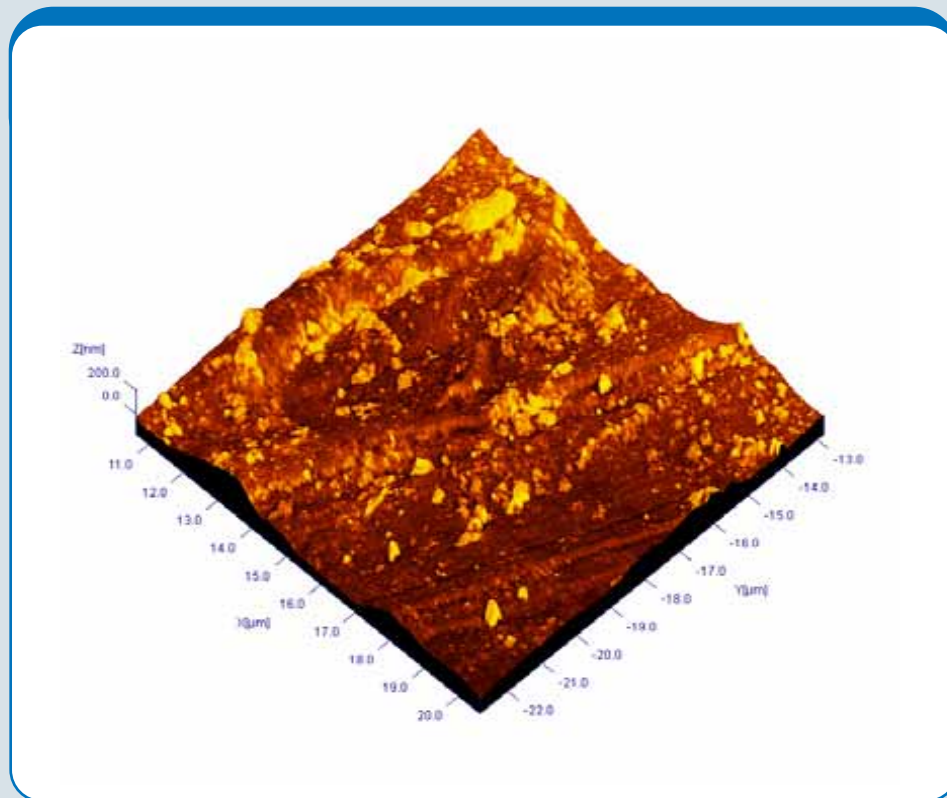


## David Sampson

Product Manager  
Bruker AXS Inc.  
Madison, WI, USA

### Today's Topics:

- The Bruker Difference
- Nanos in Action
- What's new



# NANOS – the Simple Add-On for Optical Microscopy

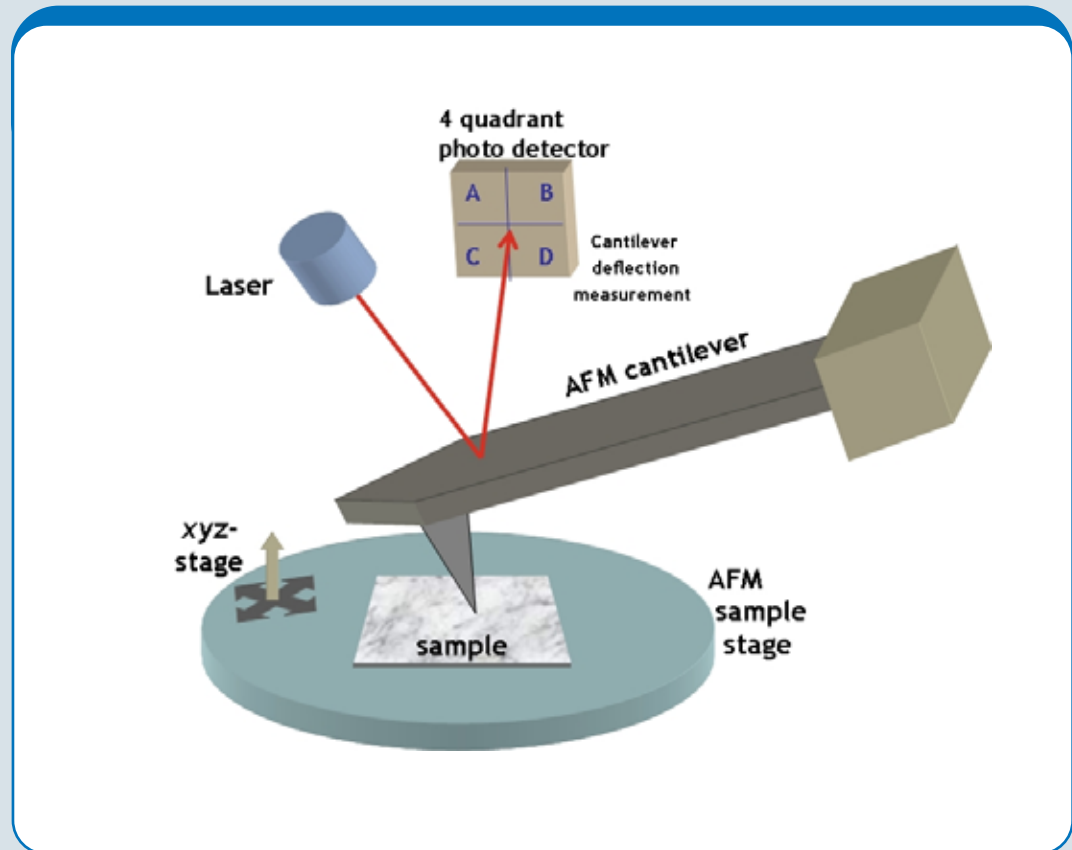


# Cantilever Detection: The Industry Norm

Laser Beam Bounce Detection is the industry norm

advantage:  
Simple setup, cheap

disadvantage:  
Alignment procedure,  
larger head design



# The Bruker Difference

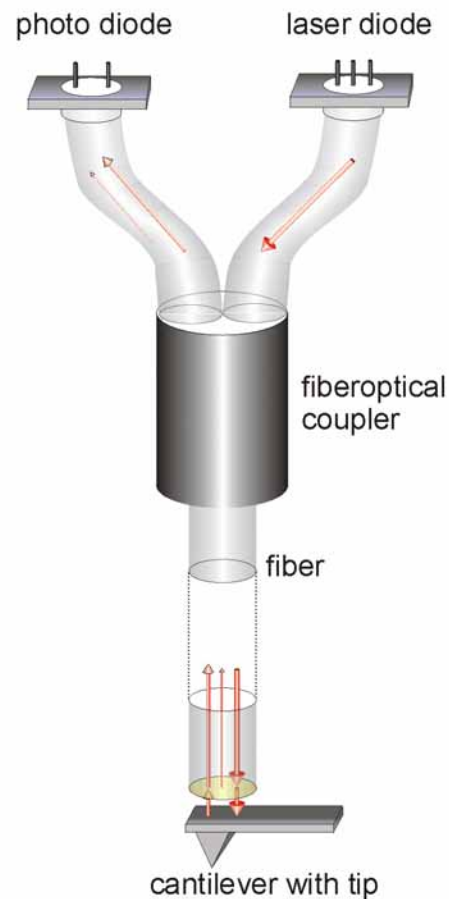
## Interferometric Detection

advantage:

Compact design, accurate  
tip deflection information,  
No laser alignment –  
Easier to use

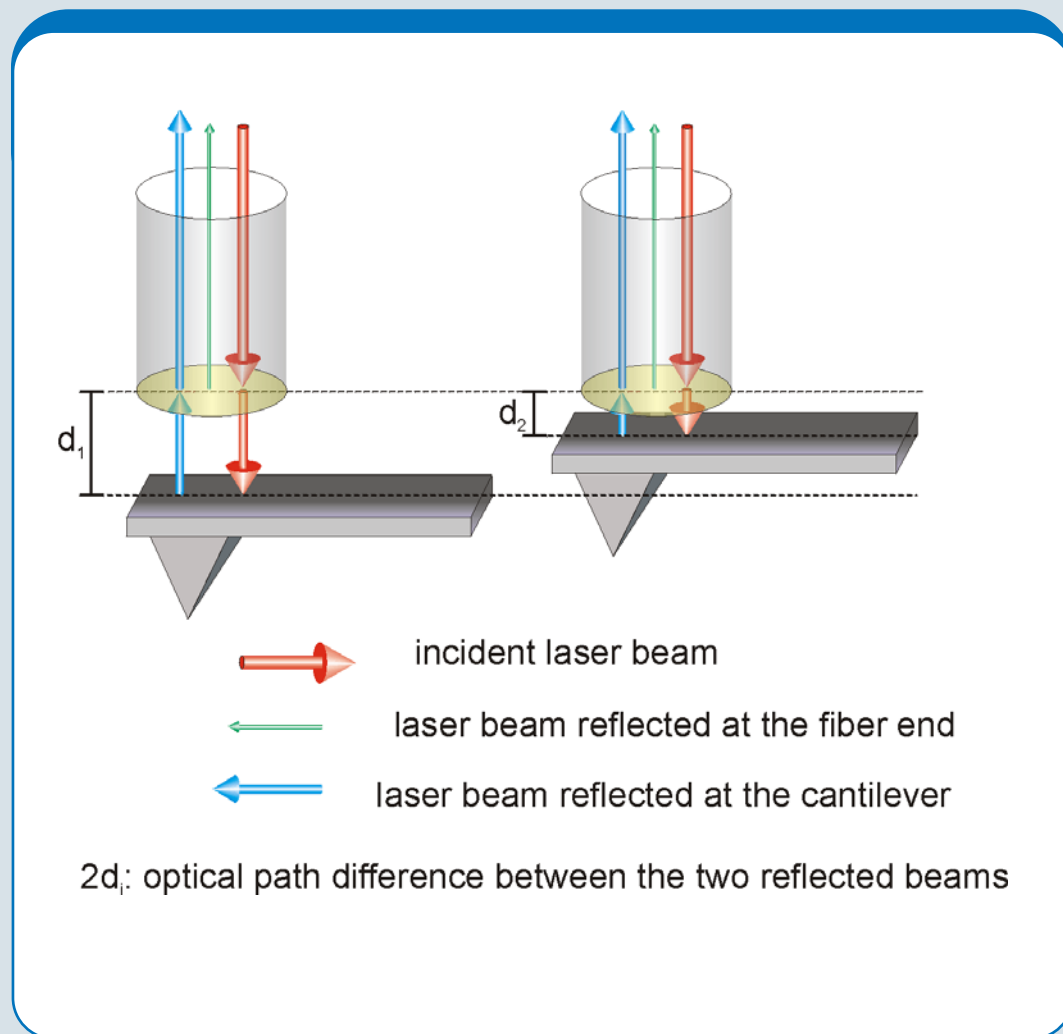
disadvantage:

Slightly more complex  
deflection detection  
system



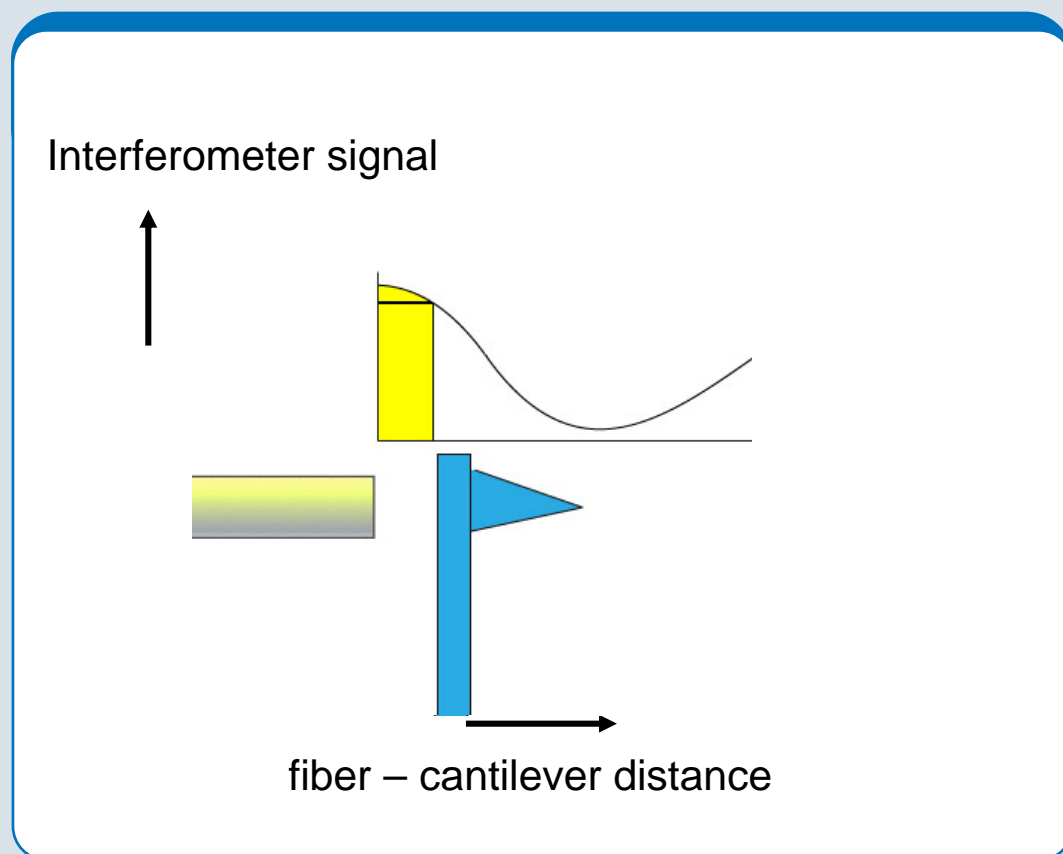
# Interferometric Detection

Fiberoptic Interferometry  
for cantilever deflection  
detection



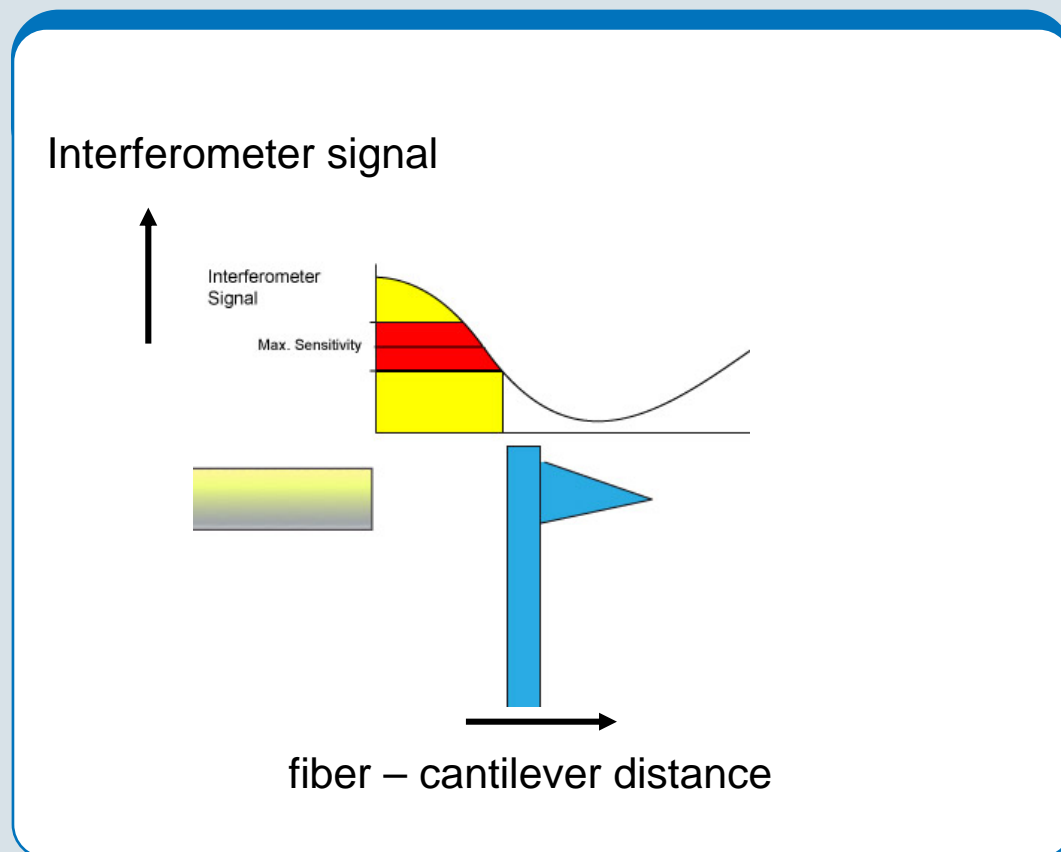
# Interferometric Detection

Fiberoptic Interferometry  
for cantilever deflection  
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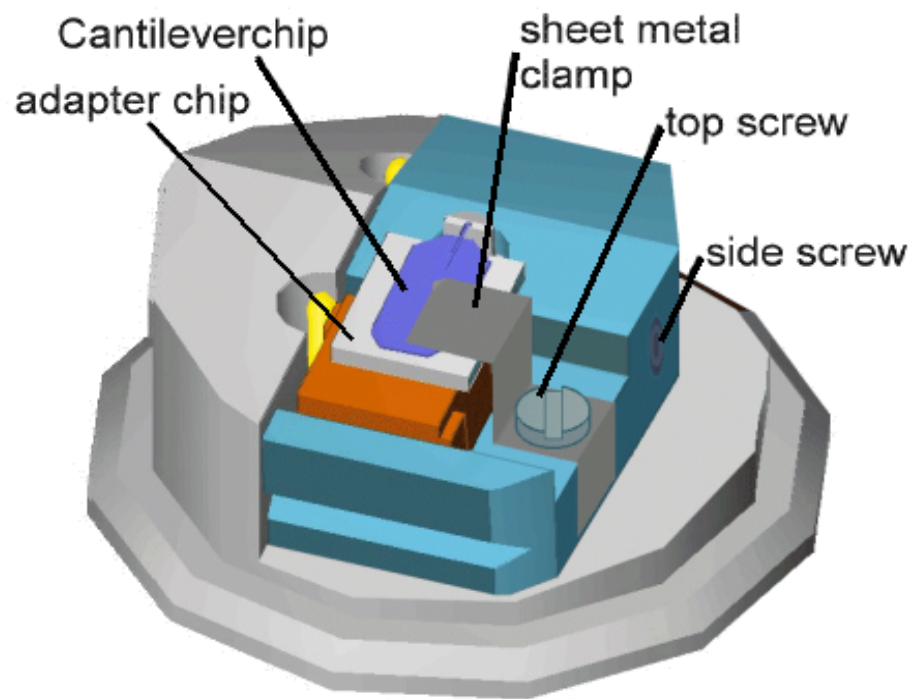
# Interferometric Detection

Fiberoptic Interferometry  
for cantilever deflection  
detection



# The Bruker Difference

## The NANOS head design



# NANOS Modes

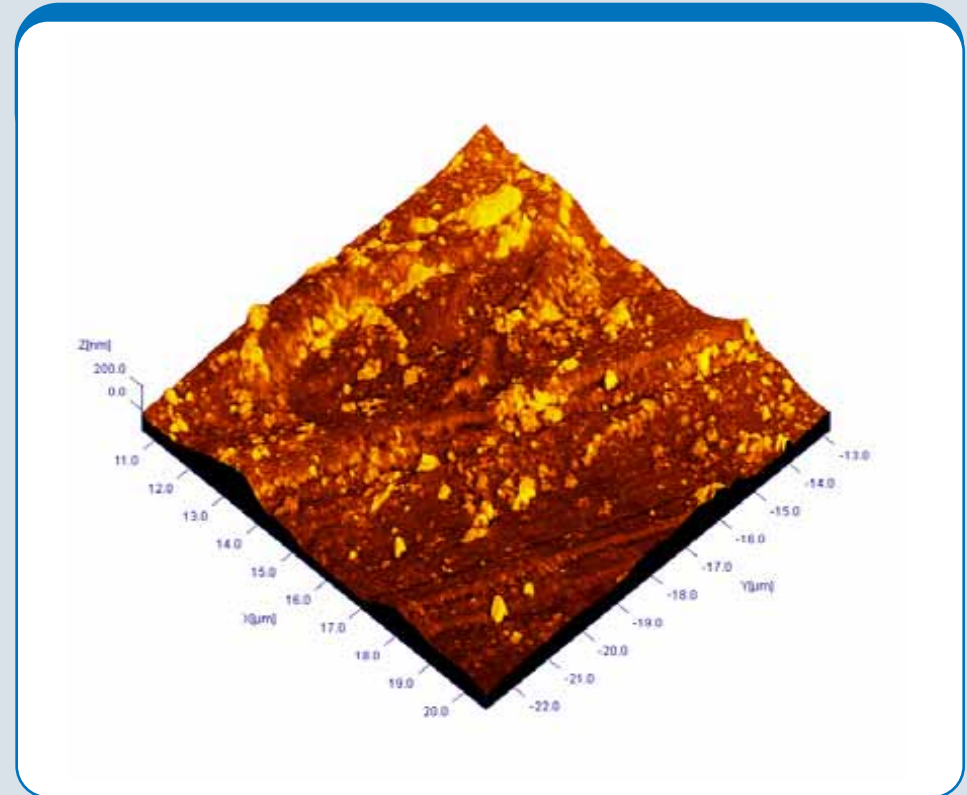
- **Contact Mode**
- **Oscillation Modes (Non-Contact, Intermittent Contact)**
- **Phase Contrast**
- Magnetic Force (MFM)
- Electrostatic Force (EFM)
- Friction Force Mode (FFM)
- Force Modulation (SFM)
- Spreading Resistance (SSR)
- Conductive AFM (C-AFM)
- Surface Potential, Kelvin Probe (SSPM)
- Scanning Capacitance (SCM)
- Scanning Tunneling (STM)
- Frequency Modulation and Self-Excitation, Q-Control
- Spectroscopy, Force vs Distance, I-V Curves
- Lithography/Surface Manipulation
- Liquid Compatible Version

# What is an AFM?

The Bruker Difference

**NANOS in Action**

What's new



# NANOS – The Basis for Advanced AFM/SPM Instruments



N8 ARGOS

N8 NEOS

N8 RADOS

N8 TITANOS



# N8 NEOS – The Workhorse in Surface Inspection



## Design Objective

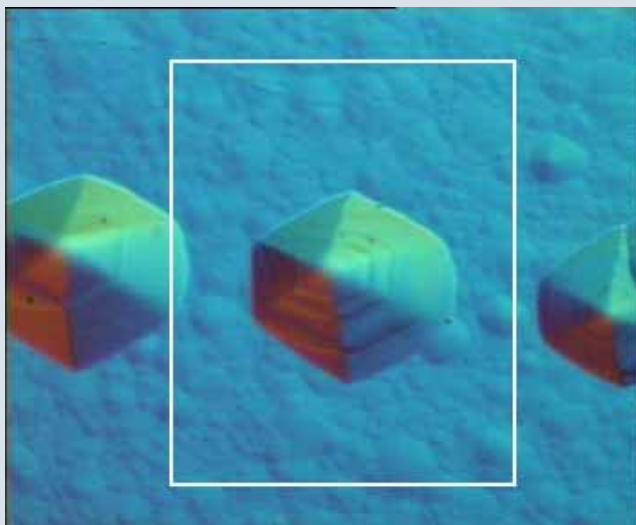
Objective based AFM that combines a research quality optical microscope with a research quality AFM

Maintaining all AFM functionality and angstrom level noise floor

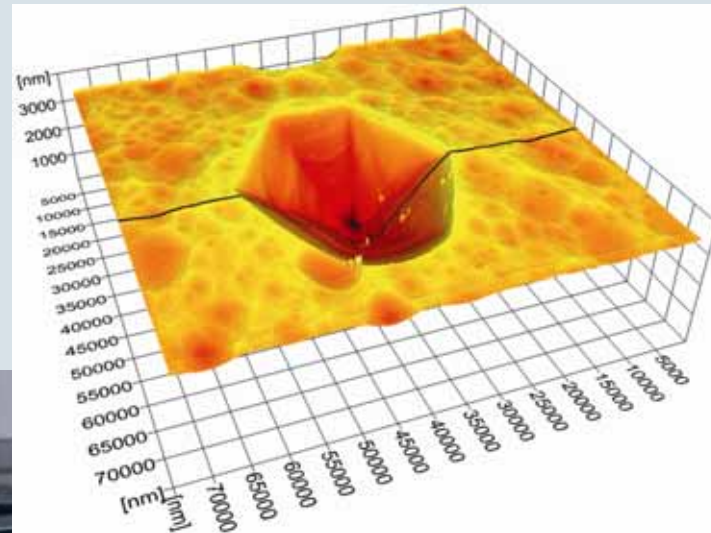
- excellent time-to-result performance
- rigid combination of optical microscopy and AFM/SPM
- simple switching between techniques
- flexible sample handling
- resolution below 1 nm



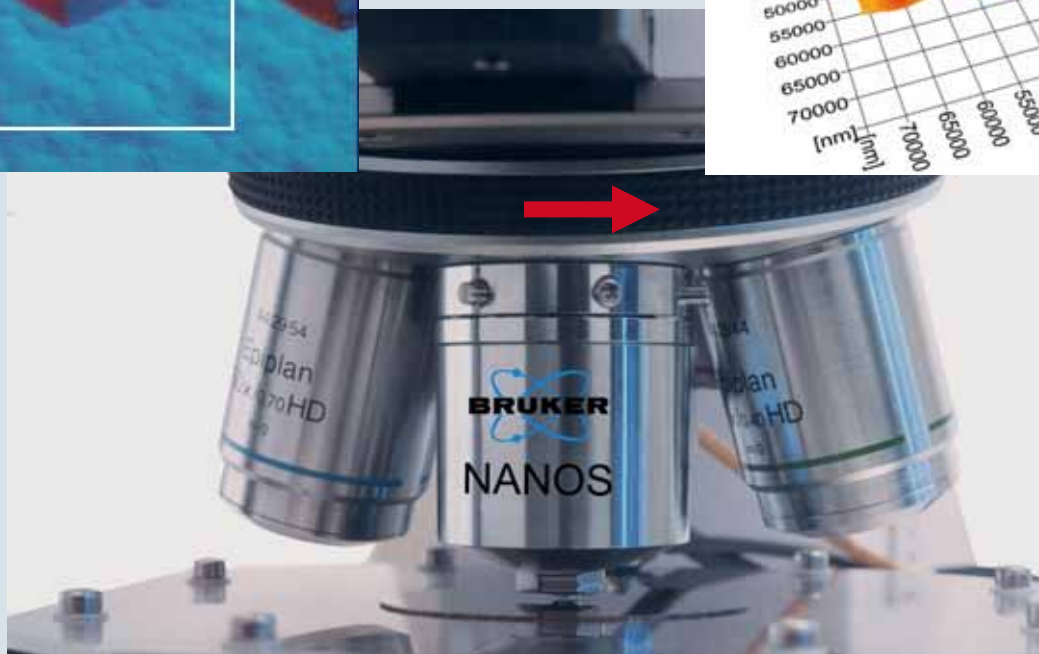
# NANOS – The Unique AFM/SPM Most Compact AFM on the Market



DIC Image



AFM Image

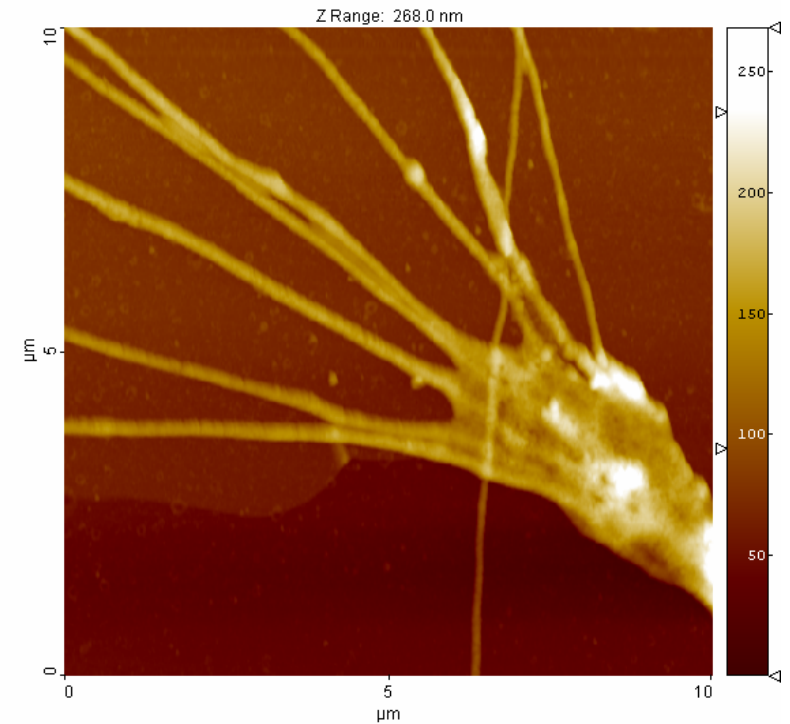
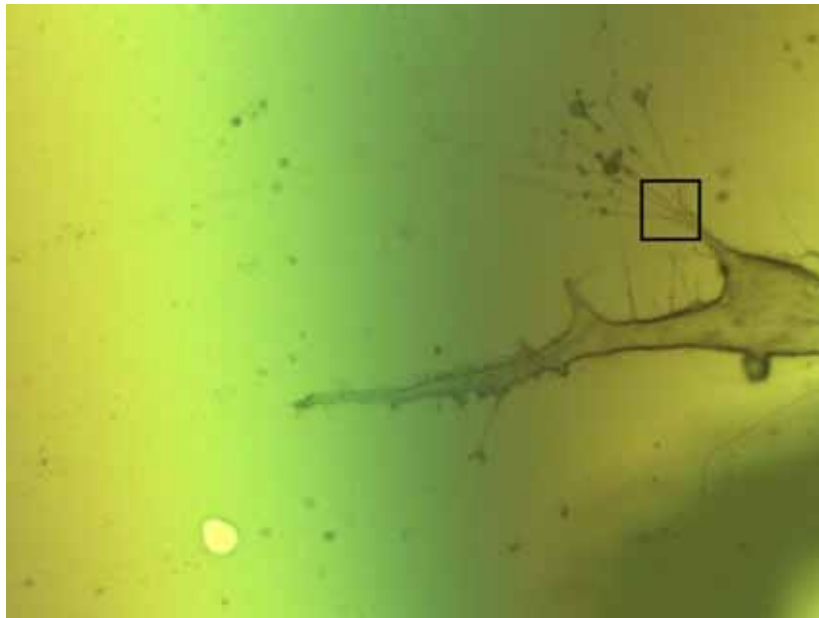


# NANOS – The Unique AFM/SPM Most Compact AFM on the Market



## Combination with optical microscope

### Melanocyte Cell



Optical Image  
500x magnification

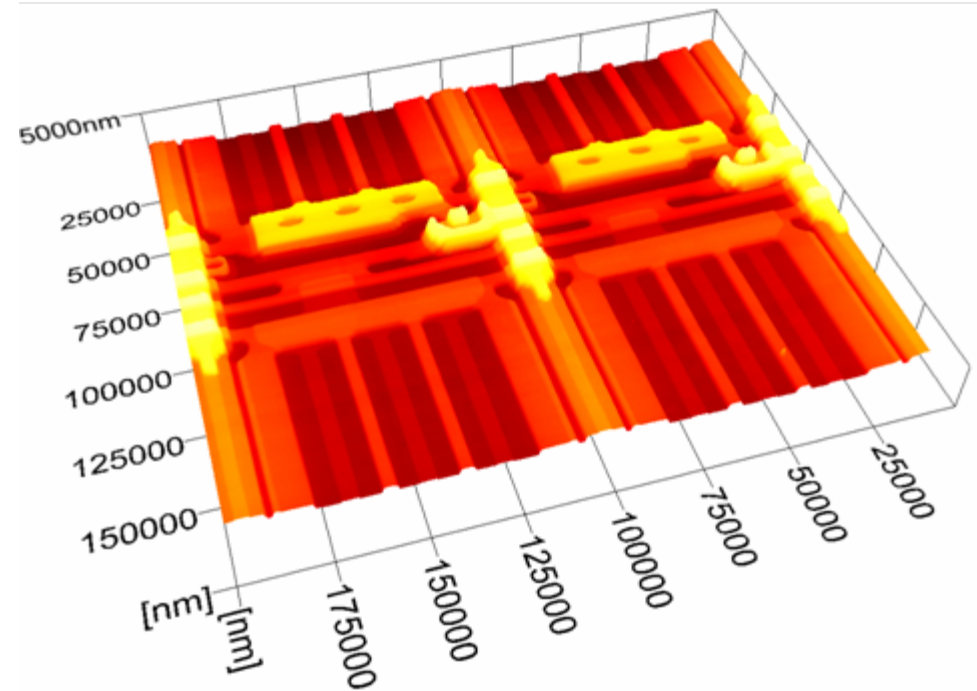
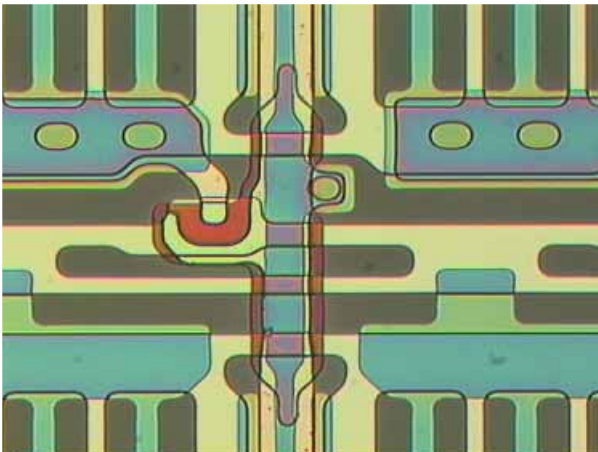
AFM Image  
10 μm x 10 μm, Z-Range: 268 nm

# NANOS – The Unique AFM/SPM Most Compact AFM on the Market



Combination with optical microscope

**TFT Display**



Optical Image:  
DIC contrast, 500x magnification

AFM Image:  
200 μm x 175 μm, Z-Range: 4980 nm

# NANOS – The Basis for Advanced AFM/SPM Instruments



N8 ARGOS

N8 NEOS

**N8 RADOS**

N8 TITANOS



# N8 RADOS – The Industrial AFM/SPM

## Design Objective

Inspection AFM that combines a research quality optical microscope with a research quality AFM

Employing a translation stage to shuttle the sample between the Optical Microscope and the AFM

- surface roughness  $<0.2\text{nm}$
- location: near production line, rough environment
- high optical resolution to detect defects in Darkfield and DIC contrast
- height of scratches and defects  $<2\text{nm}$
- automatic measurements



# N8 RADOS – The Industrial AFM/SPM

- motorized stages
- in X-Y or X-Z version



# N8 RADOS – The Industrial AFM/SPM

- motorized stages
- in X-Y or X-Z version
- high quality optics with BF/DF, DIC, etc.



# N8 RADOS – The Industrial AFM/SPM

- motorized stages
- in X-Y or X-Z version
- high quality optics with BF/DF, DIC, etc.
- separated AFM/SPM on rigid stand
- up to 100  $\mu\text{m}$  scan range
- resolution  $< 0.1 \text{ nm}$
- auto measurements

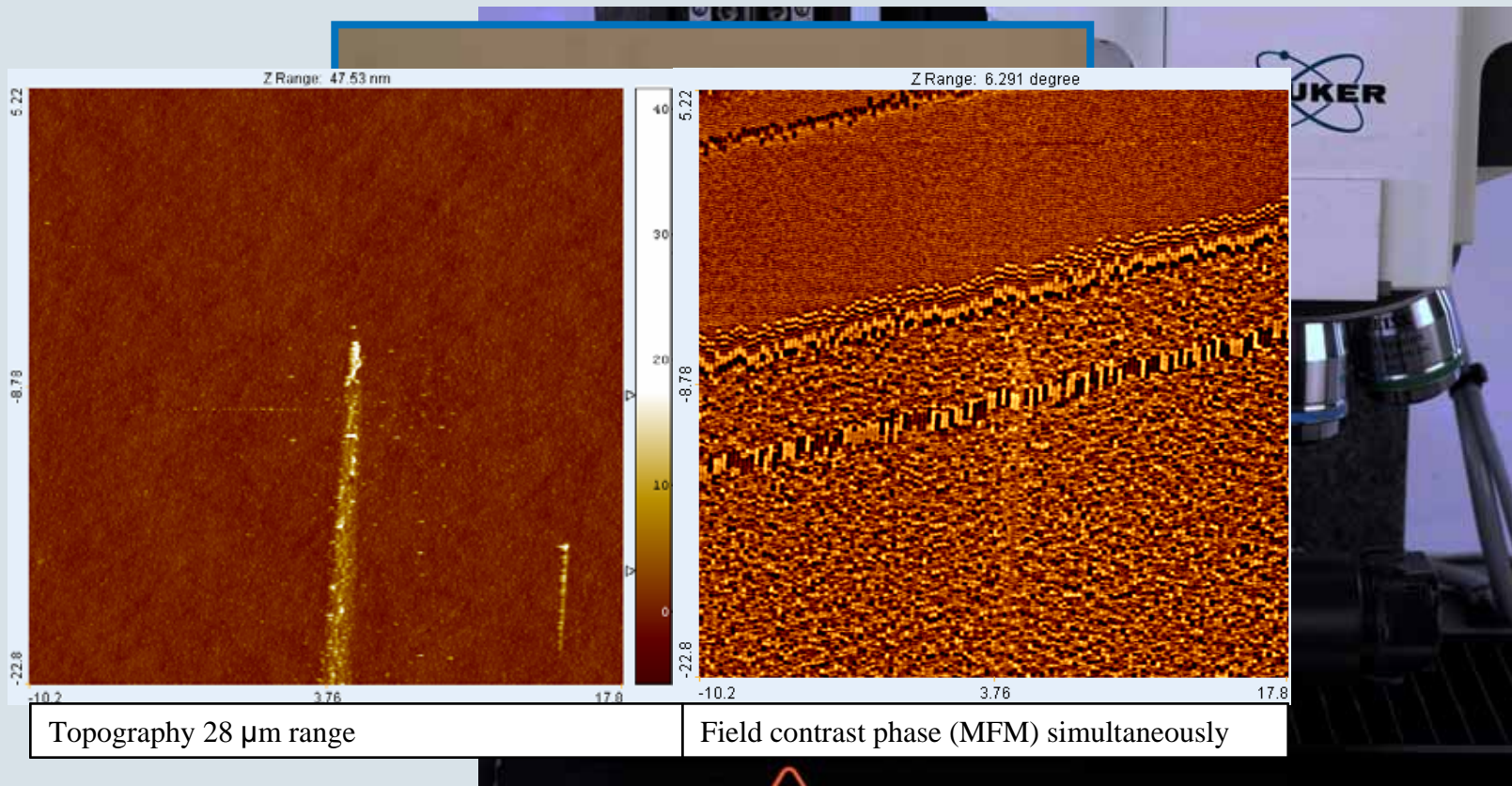


# N8 RADOS – The Industrial AFM/SPM

- motorized stages
- in X-Y or X-Z version
- highest quality optics with BF/DF, DIC, etc.
- separated AFM/SPM on rigid stand
- up to 100  $\mu\text{m}$  scan range
- resolution  $< 0.1 \text{ nm}$
- auto measurements
- scribe tool



# N8 RADOS – The Industrial AFM/SPM



# NANOS – The Basis for Advanced AFM/SPM Instruments



N8 ARGOS

N8 NEOS

N8 RADOS

N8 TITANOS



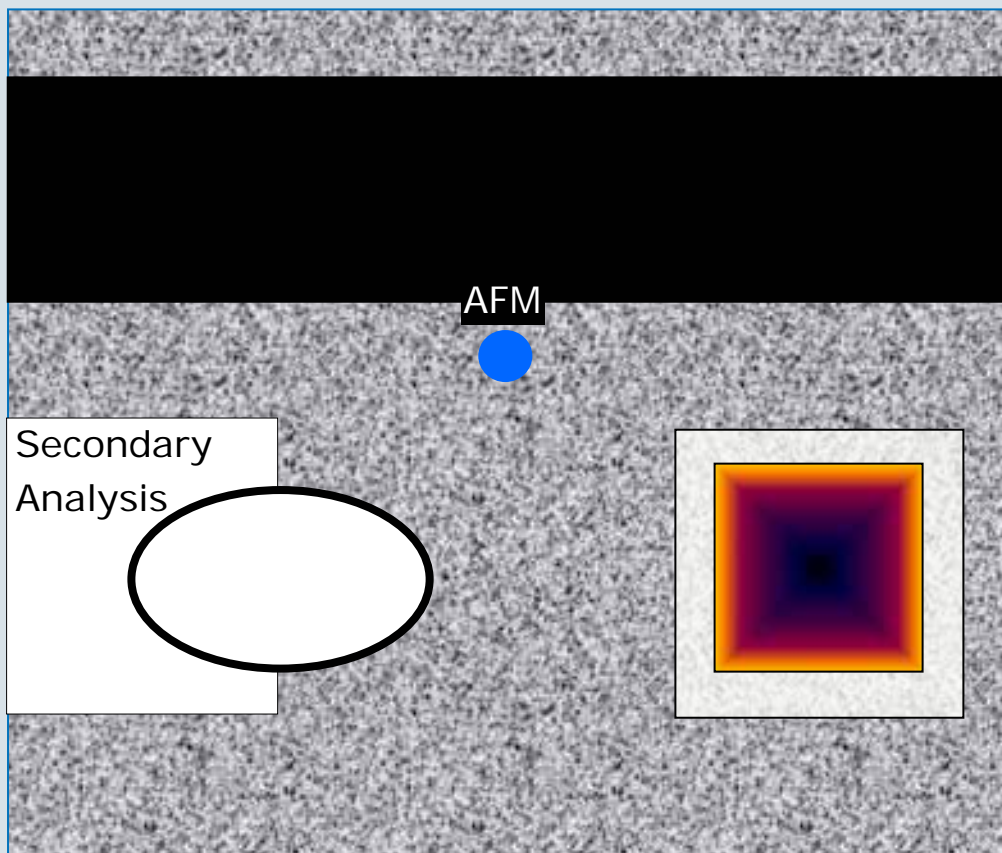
# N8 TITANOS – The Large Sample AFM/SPM Tool



- High efficiency for large sample AFM/SPM inspection: no sample transfer needed
- Measures samples of up to 300 mm size with quasi-atomic resolution
- Combined with automated wafer-inspection microscope or confocal microscope
- High position accuracy of  $\pm 100$  nm
- Near Zero X-Y stage drift, air-bearing stages
- Macro programmable and fully automated measurements
- Extremely rigid by using a solid granite body
- Highly flexible design



# N8 TITANOS – The Large Sample AFM/SPM Tool



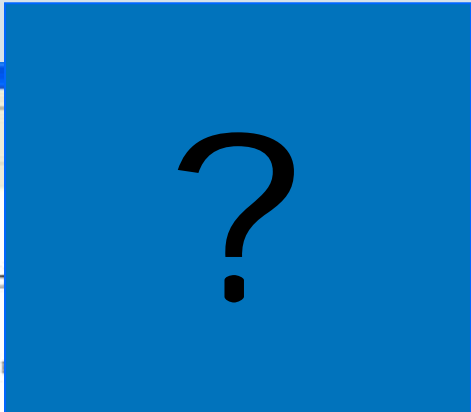
# N8 TITANOS – The Large Sample AFM/SPM Tool



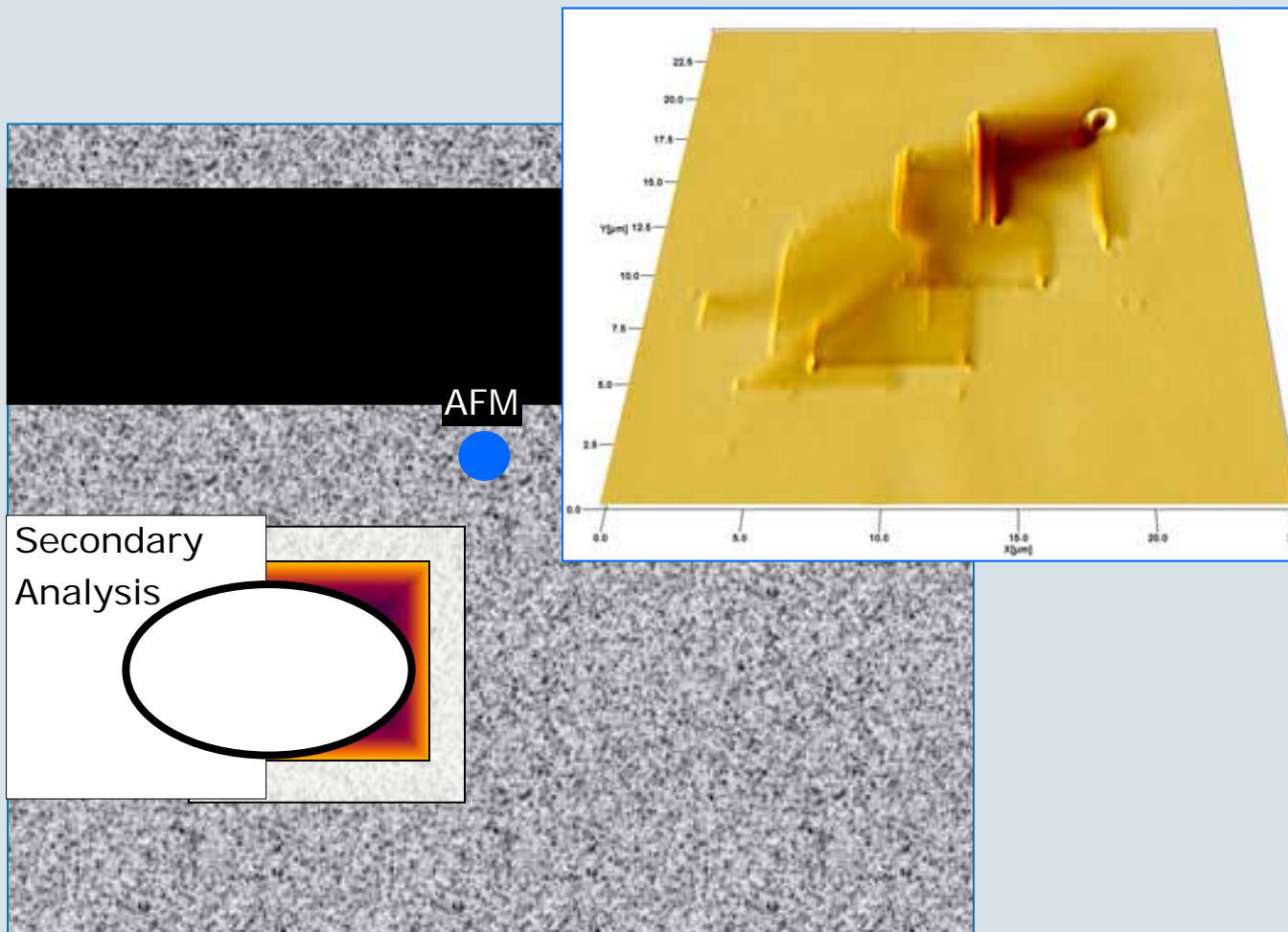
The screenshot displays the Microscope software interface with the following components:

- File Movement:** Radio buttons for calibration types: 3 Points Calibration (coarse), 2 File Points Calibration (fine) (selected), and 2 Points + Notch Calibration (coarse). A "File Target Position / μm" section with X and Y input fields (both 0.000) and a "MOVE" button.
- Stage Position:** "Joystick enabled" status and a 2D plot showing "sample area" (blue square) and "observation position" (yellow dot).
- Defect Position:** A 2D plot showing a distribution of defects (small squares) with a red square highlighting a specific defect.
- Stage Control:** "Target Position (absolute) / μm" and "Target Position (relative) / μm" sections, each with X and Y input fields (both 0.000) and "MOVE" buttons. "Constant Movement" and "Automatic Movement" (LOAD, AFM) buttons are also present.
- Microscope Control:** "AD" (4, OFF, 0) and "AF" (SF, DF, ICR, GF, AF) buttons. A "Focus" button and a row of buttons labeled 1 through 6.
- Position Data:**
  - Stage Position / μm: X: -43431.979, Y: 40622.866
  - Wafer File Absolute Position / μm: X: 936750.013, Y: 102444.000
  - Wafer File Relative Position / μm: X: 45750.013, Y: 46956.952
  - Microscope Position / μm: Z: 310000
- Table:** A table with columns: DEFECTID, X(REL), Y(REL), X(INDEX), Y(INDEX), X(COOR), Y(COOR), DEPTH. Row 28 is highlighted.
 

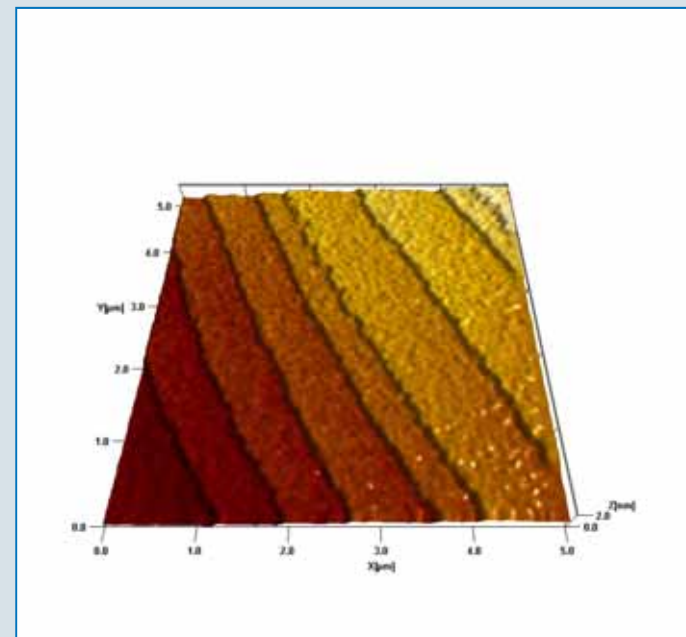
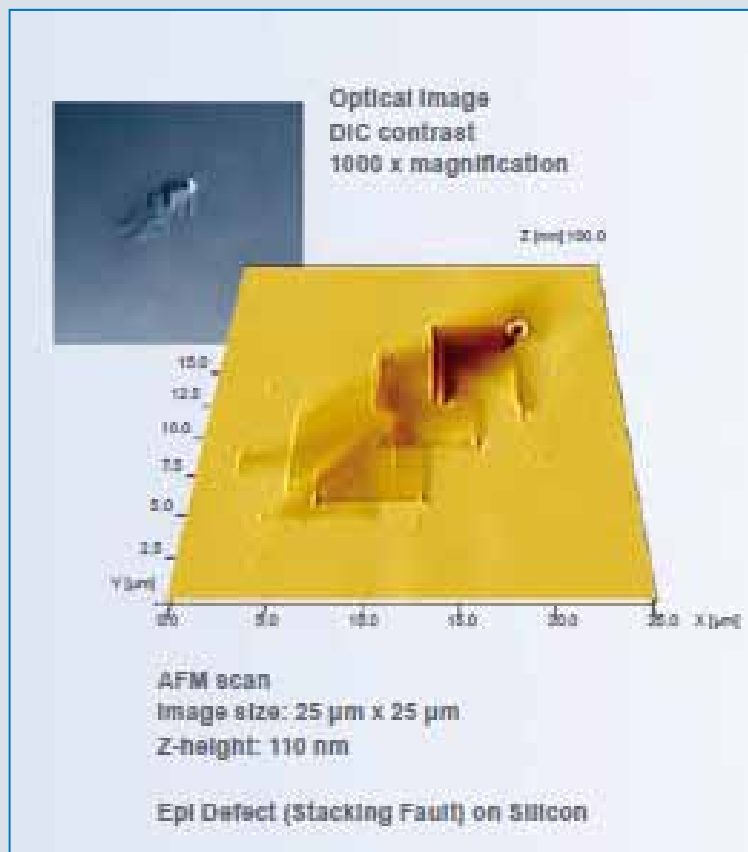
DEFECTID	X(REL)	Y(REL)	X(INDEX)	Y(INDEX)	X(COOR)	Y(COOR)	DEPTH
27	0.007062	0.135032	0	0	0	0	0.0
28	0.070000	0.000000	0	0	0	0	0.0
29	0.195078	0.103364	0	0	0	0	0.0
30	0.187899	0.102963	0	0	0	0	0.0
31	0.182943	0.102174	0	0	0	0	0.0
32	0.187271	0.102824	0	0	0	0	0.0
33	0.197389	0.102943	0	0	0	0	0.0
34	0.196474	0.102497	0	0	0	0	0.0
35	0.199309	0.102286	0	0	0	0	0.0
36	0.199539	0.102303	0	0	0	0	0.0
37	0.093332	0.191162	0	0	0	0	0.0
38	0.202228	0.101382	0	0	0	0	0.0
39	0.078364	0.164379	0	0	0	0	0.0
40	0.094372	0.190332	0	0	0	0	0.0
- Line Scan Graph:** A plot of intensity versus "wavenumber [nm<sup>-1</sup>]" showing a single sharp peak.
- 3D Surface Plot:** A grayscale image showing a 3D surface profile of a defect.



# N8 TITANOS – The Large Sample AFM/SPM Tool



# N8 TITANOS – The Large Sample AFM/SPM Tool



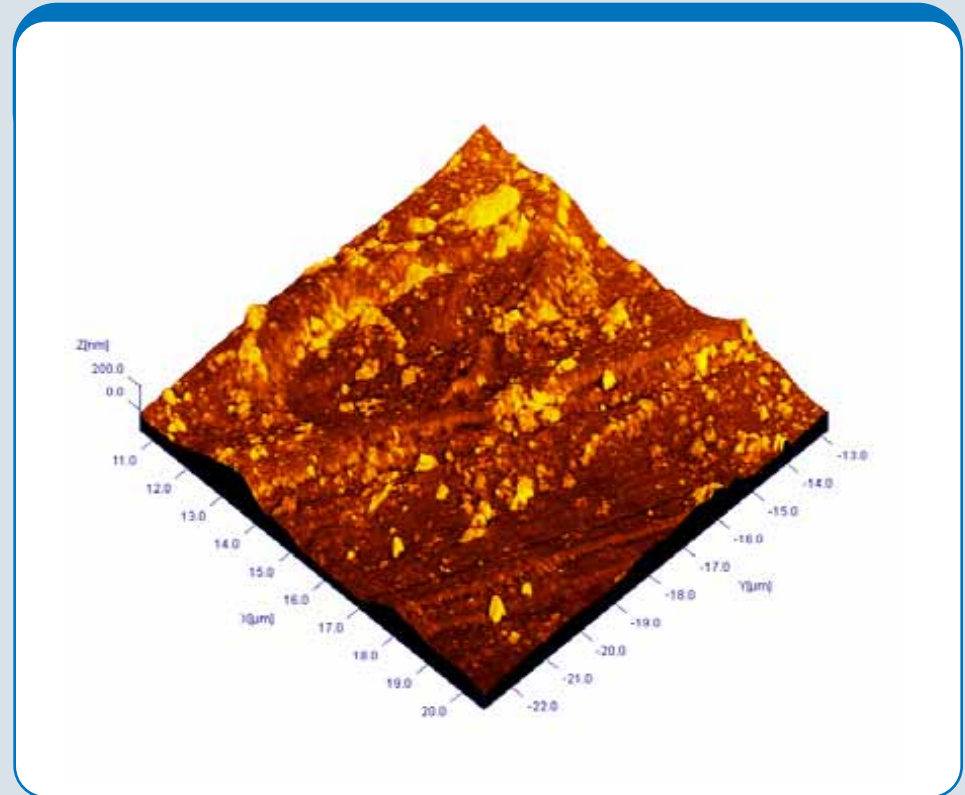
mono-atomic steps on Si 111

# What is an AFM?

The Bruker Difference

NANOS in Action

**What's New**

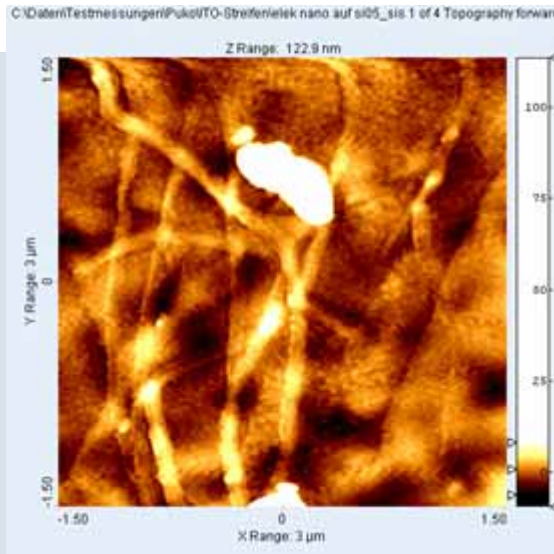




## **Bruker Nano's AFM objective**

- including scanner and cantilever
- mounted on the nosepiece as any optical objective
- Senterra mounted on a granite stand

# SENTERRA with AFM



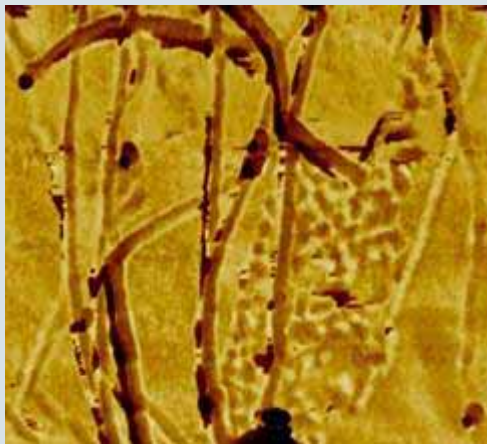
topography



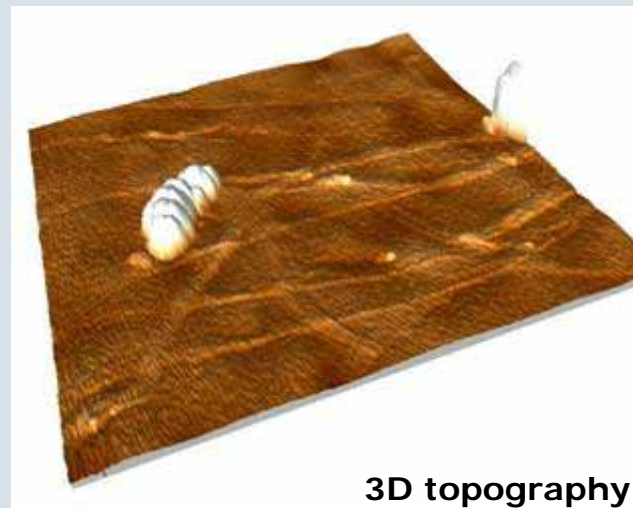
amplitude

## Nanotubes on silicon

- Field of view: 3 x 3  $\mu\text{m}$
- Diameter of nanotubes about 100 nm



phase

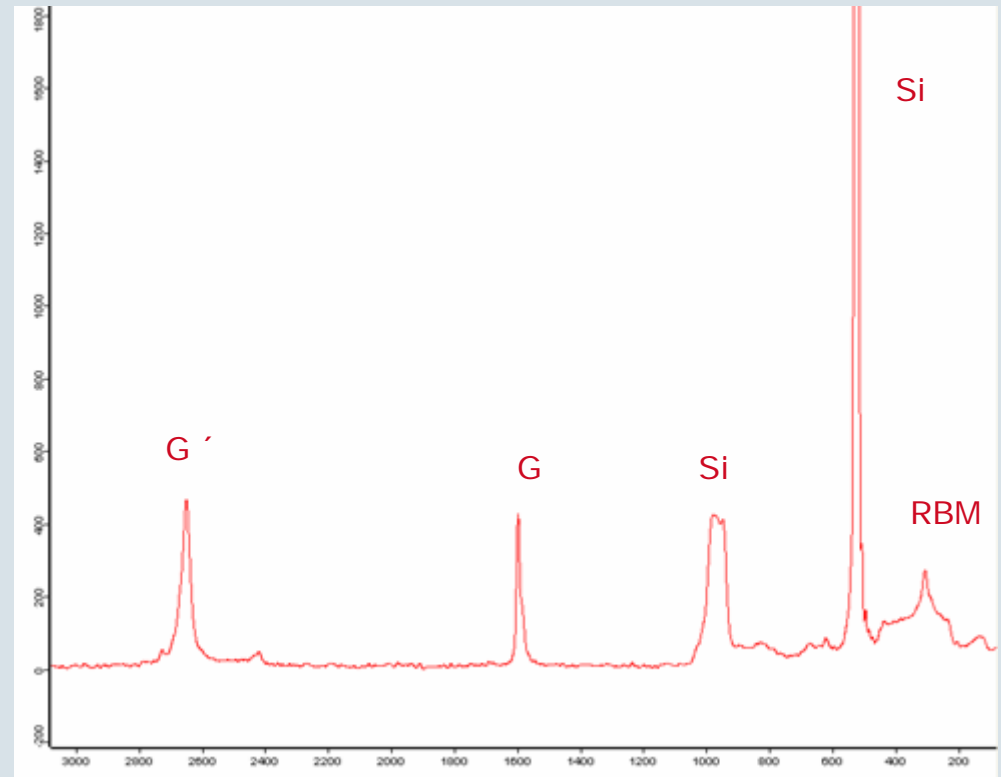
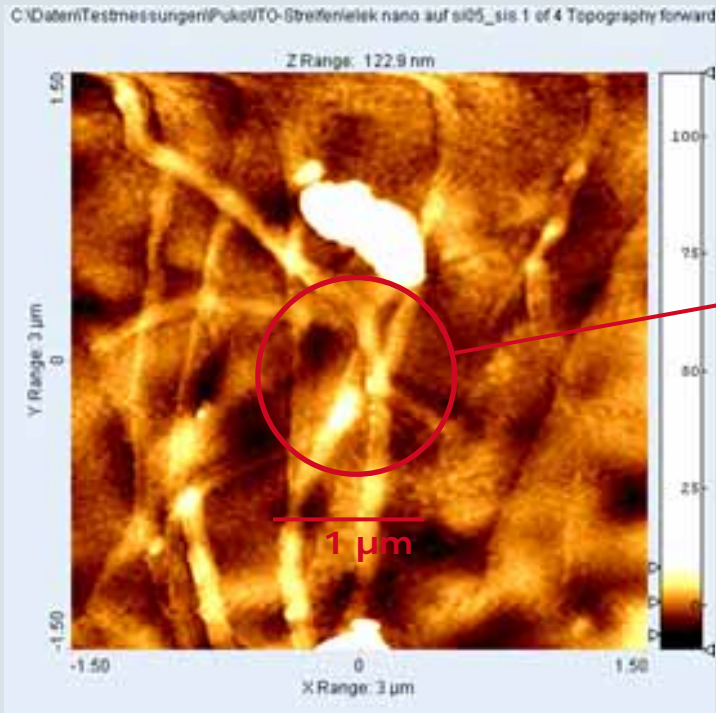


3D topography

# SENTERRA with AFM



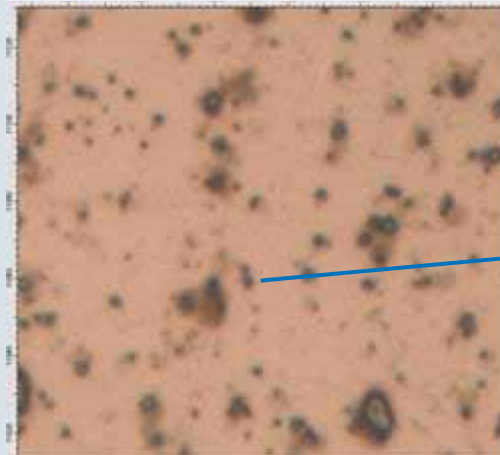
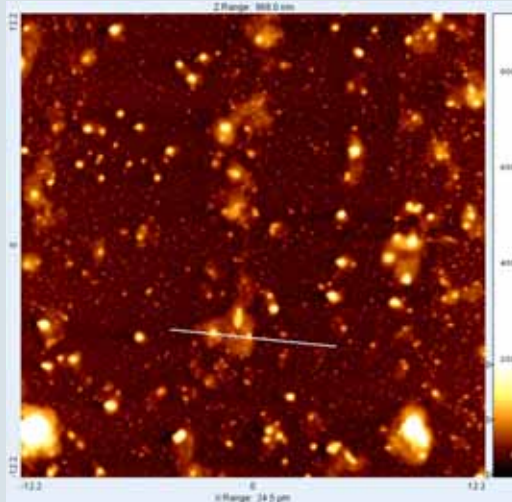
- Nanotubes on silicon
- Field of view: 3 x 3  $\mu\text{m}$
- Diameter of nanotubes about 100 nm



# SENTERRA with AFM



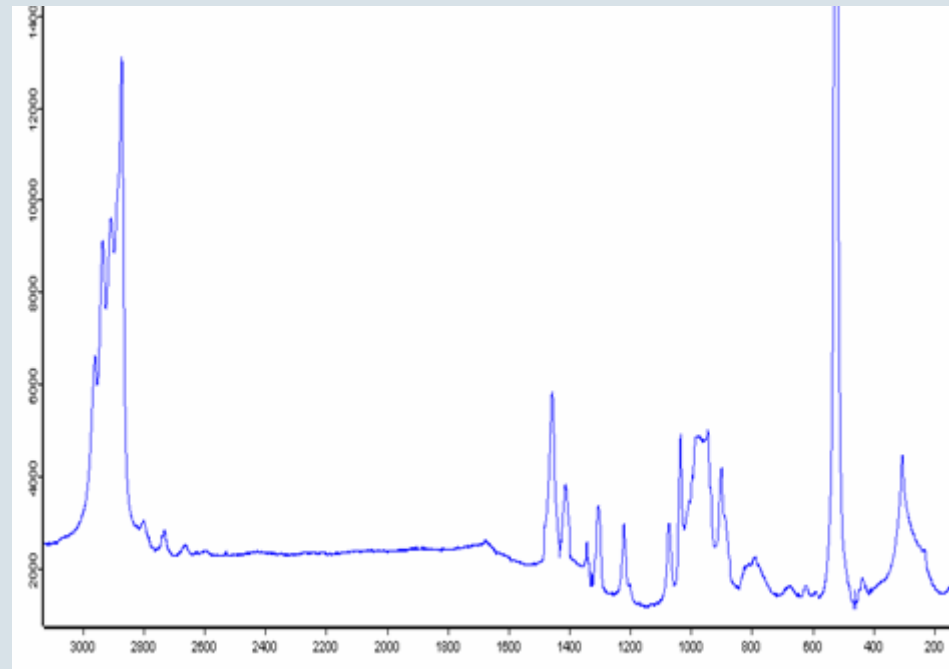
AFM topography



100x obj.

**Siloxane on silicon**

Field of view: 20 x 20  $\mu\text{m}$



# NANOS

We have created an easy-to-use, customizable high-resolution metrology solution that couples research quality microscopy with state-of-the-art scanning probe technology.

Whether you need a basic research system or a 300-millimeter highly automated system, Bruker has an AFM that will meet your needs.

# Bruker Nano AFMs

	NANOS	N8 NEOS	N8 ARGOS	N8 RADOS	N8 TITANOS
upgrade AFM	X				
routine lab instrument	X	X			
routine lab instrument, automated				X	
localized objects, defect inspection	X	X		X	X
sample sizes up to 50 mm	X	X	X	X	
sample sizes up to 100 mm		X	X	X	
sample sizes up to 150 mm		X		X	X
sample sizes up to 300 mm					X
application in liquids	X	X	X		

# Bruker Nano AFMs

	NANOS	N8 NEOS	N8 ARGOS	N8 RADOS	N8 TITANOS
req. resolution ~ 1 nm	X	X	X	X	X
req. resolution ~ 0.1 nm		X	X	X	X
req. resolution > 0.05 nm			X	X	X
quasi atomic resolution			X		
semiconductor industry				X	X
Industry, R&D, QA		X		X	
basic research		X	X		
automated systems				X	X
teaching instrument		X	X		



## Any Questions?

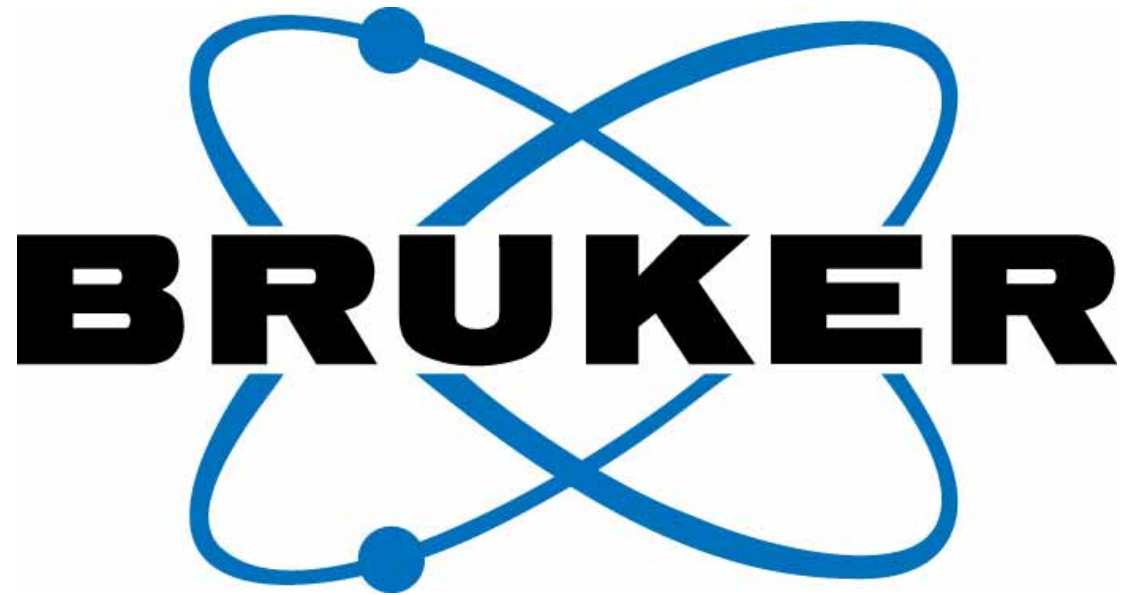
Please type any questions you may have in the Q&A panel and then click Submit.



## Thank you for attending!

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Please take a moment to complete the brief survey on your screen. Your feedback is very important to us.



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