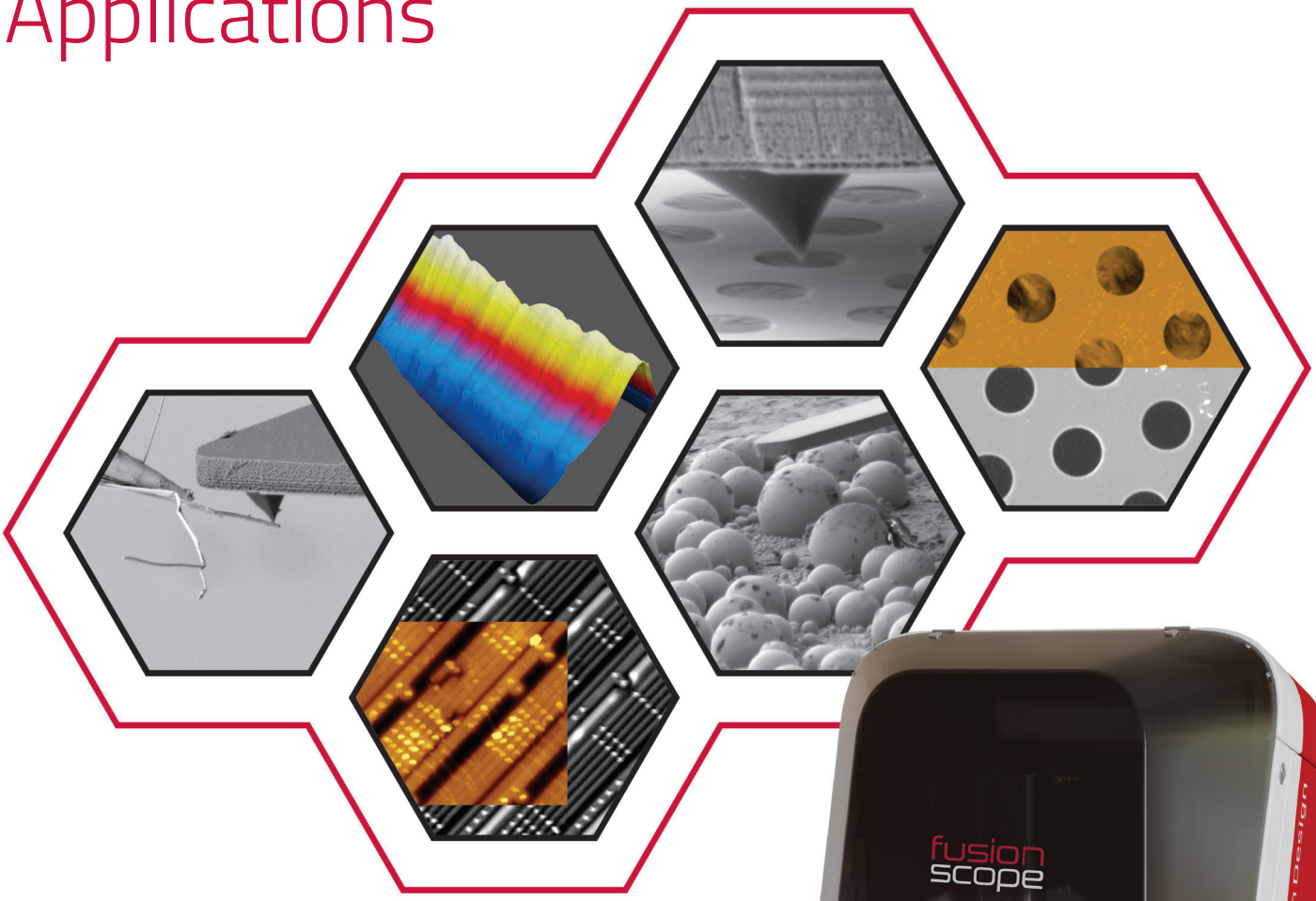
fusion scope®

Applications



Quantum Design
MICROSCOPY

Applications

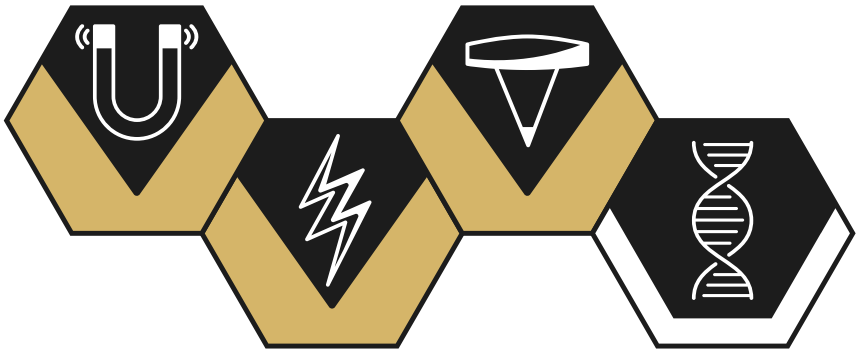
By combining the complementary strengths of SEM and AFM, FusionScope opens the door to a whole world of new application possibilities.

Use the FusionScope for detailed **Material Characterization** of your samples and perform correlative analysis of their structural, mechanical, electrical, magnetic, and chemical properties on exactly the region of interest.

Whether you are looking for high-level **Quality Control** of component parts or want to perform **Failure Analysis** on electrical components or semiconductor devices, FusionScope will help you to get the job done. Benefit from the fast and intuitive workflow to extract the data you are looking for.

Combining high-resolution SEM and state-of-the-art AFM you can easily characterize **Nanostructures** such as nanowires, 2D-materials, and nanoparticles. FusionScope gives you full control to locate the Nanostructures and perform the measurements of your choice.

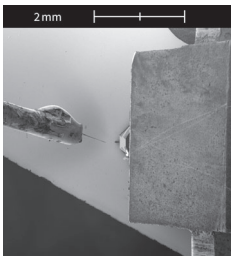
Using FusionScope in **Life Science** applications allows you to acquire the nanoscale morphology of biological samples accurately and easily. Especially for hard-to-reach sample areas or very small features, FusionScope allows you to characterize physical properties such as 3D topography, stiffness, and adhesion with the highest precision.



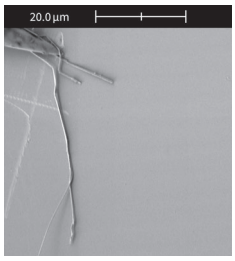
Nanostructures

Analyze Individual Nanowires using Profile View

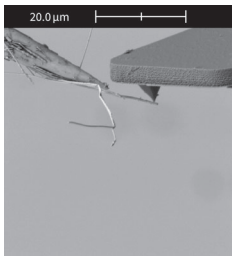
Mode: AFM Topography
Sample: Nanowires



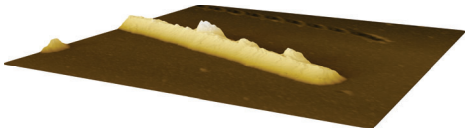
(Figure 1) Top view of AFM and Nanowire on positioner.



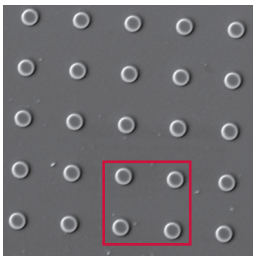
(Figure 2) Nanowires on posiitioner.



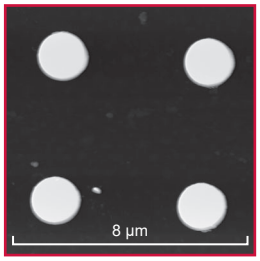
(Figure 3) Profile View of AFM cantilever approaching Nanowire.



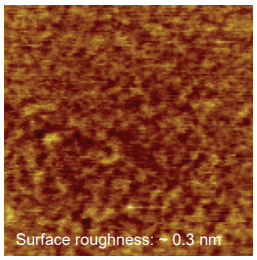
(Figure 4) 3D model of AFM topography data of Nanowire.



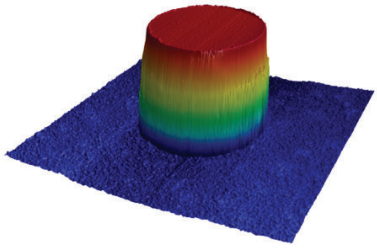
(Figure 5) SEM Image of Nanowire tops.



(Figure 6) AFM Image of Nanowire tops.



(Figure 7) Surface roughness of top of Nanowire Captured by AFM.

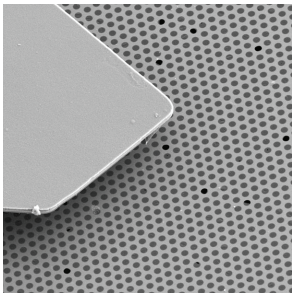


(Figure 8) 3D model of AFM topography data of Nanowire top.

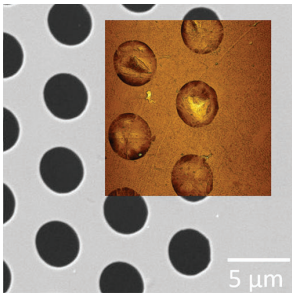
The detailed characterization of individual nanowires using conventional AFM in combination with an optical microscope is always a challenge, as single nanowires cannot be easily identified and imaged with this setup. Using the Profile View in FusionScope allows one to overcome these limitations. The visibility of the cantilever tip in combination with the high-resolution SEM enables the user to navigate the cantilever precisely to the specific nanowire of interest. Once there, measurements such as topography and side-wall roughness, as well as mechanical and electrical properties, can then be obtained. This method gives the user a completely new and interactive way of performing nanowire measurements.

Achieve Better Knowledge of 2D Materials using Atomic Force Microscopy

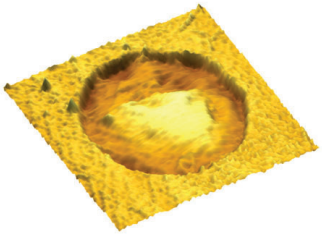
Mode: AFM Topography
Sample: Freestanding Graphene



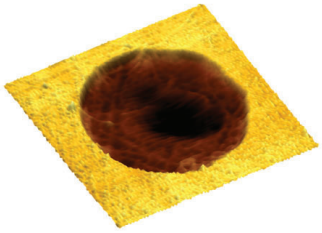
(Figure 1) SEM image of free-standing graphene membranes with cantilever.



(Figure 2) Correlative SEM & AFM image of freestanding graphene membranes.



(Figure 3) AFM topography image of freestanding graphene with low force load.



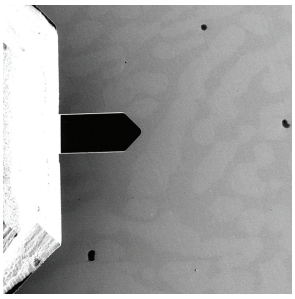
(Figure 4) AFM topography image of freestanding graphene with high force load.

Freestanding suspended membranes of two-dimensional materials (2D) are of great interest for many applications ranging from nanoelectromechanical sensors to optical devices. Much of their characterization relies on scanning probe microscopy techniques such as atomic force microscopy (AFM). Unlike rigid samples, the suspended atomically thin 2D membranes are, however, flexible and do not remain mechanically undisturbed during AFM measurements, which can lead to a misinterpretation of actual membrane topography and nanomechanical properties. FusionScope can circumvent these shortcomings by visualizing the membrane deformation during the AFM analysis, which leads to a better understanding of the acquired AFM data.

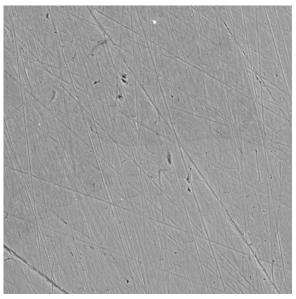
Materials Characterization

Characterize Magnetic Phase Structures using Magnetic Force Microscopy

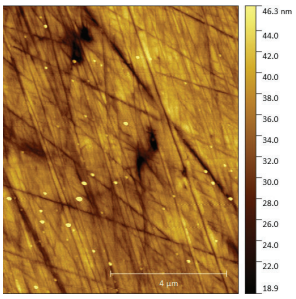
Mode: MFM
Sample: Duplex Steel



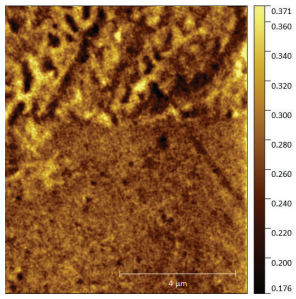
(Figure 1) Overview SEM image of duplex steel with cantilever.



(Figure 2) SEM image of grain boundry on duplex steel.



(Figure 3) AFM topography image at duplex steel grain boundry.



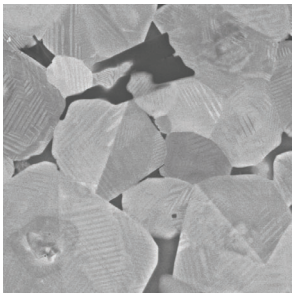
(Figure 4) MFM image at duplex steel grain boundry showing ferromagnetic phase structure.

Duplex is a family of stainless steel grades that contain a mixture of austenitic and ferritic phases that provide higher mechanical strength and ductility compared to standard steel grades. In-situ Magnetic Force Microscopy (MFM) enables the detailed analysis of the magnetic properties of different types of duplex steel samples.

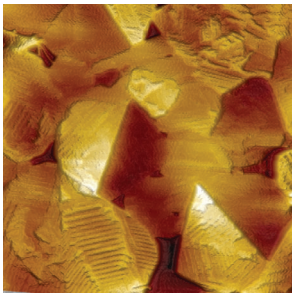
With the FusionScope the different phases of the steel surfaces can be visualized, and the cantilever is easily positioned at the grain boundary of two distinct phases. Using a magnetic cantilever tip the magnetic properties can be analyzed, and the ferromagnetic sub domains can be imaged with high resolution.

Evaluate Barriers in Materials using Electrostatic Force Microscopy

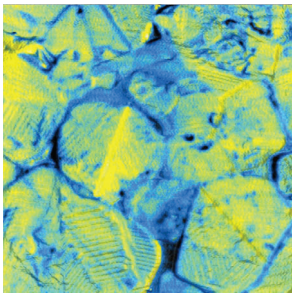
Mode: EFM
Sample: BaTiO3



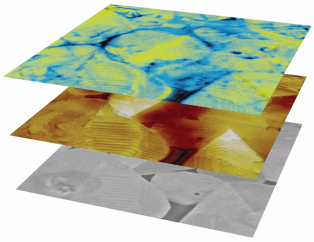
(Figure 1) SEM image of BaTiO3 sample.



(Figure 2) AFM topography image of BaTiO3 sample.



(Figure 3) EFM phase image of BaTiO3 sample (+1.5V).



(Figure 4) Correlative 3D overlay of SEM, topography, and EFM signal.

Barium titanate (BaTiO3) is a ceramic material exhibiting interesting optical, electrical, and thermal properties shifting it to the center of scientific attention. More recently BaTiO3 is gaining importance also for engineering applications. Ferroelectric BaTiO3 is a non-linear positive-temperature-coefficient (PTC) material and is used in resistors. Polycrystalline doped barium titanate exhibits a wide range of electrical resistance depending on the temperature which is employed in sensors and actuators.

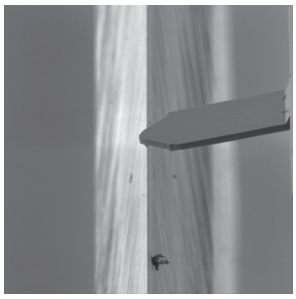
The macroscopic electronic properties of polycrystalline BaTiO3 ceramics are governed by potential barriers forming between single grains. To reach a better understanding of the overall resistance of barium titanate it is essential to be able to characterize the potential differences in the crystalline material at the nanoscale.

This characterization can be done with Electrostatic Force Microscopy (EFM). It is widely used in electronics development to map electronic characteristics of complex, sub-micron electrical materials. FusionScope enables the possibility for in-situ EFM analysis. The high resolution of the SEM can be used to easily identify grain boundaries and perform the EFM analysis directly at the region of interest.

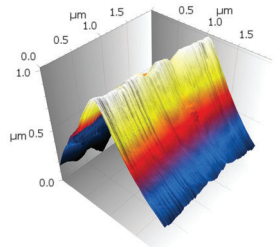
Quality Control & Failure Analysis

Analyze Materials with Difficult Geometries using Atomic Force Microscopy

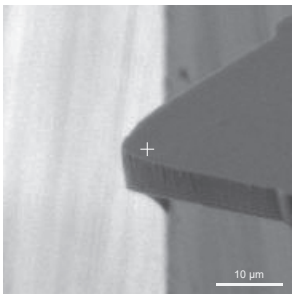
Modes: SEM, AFM Topography
Sample: Razor Blade



(Figure 1) SEM image of AFM tip over blade edge.



(Figure 2) Correlated data image of razor blade edge radius.



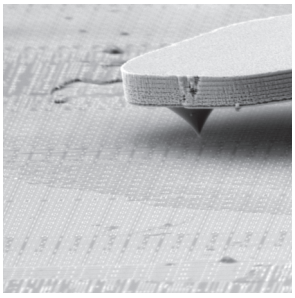
(Figure 3) SEM video of AFM tip scanning blade edge.

Typically, in atomic force microscopy, measurements of very pointed sample geometries are difficult. Firstly, due to the convolution of the geometry of the tip with the topography of the sample surface, but also the correct and reliable positioning of the tip over the sample is a challenge. SEM is used here to position the sample in the best possible way and to monitor the AFM measurement in real time.

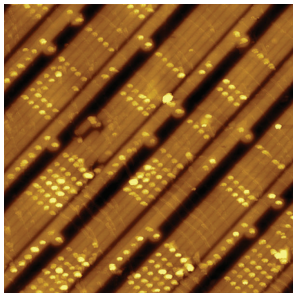
A commercially available razor blade was installed in the sample holder with the aim of imaging the surface of the blade with the AFM and, in particular, determining the radius of the blade edge. The measurement comprises several steps: the coarse positioning, the fine positioning, the approach of the tip and finally the measurement of the topography. With the help of the fine positioning made possible by the SEM, different areas on the razor blade can be quickly selected and measured. Different material properties, such as a coatings applied to the razor blade, also can be compared. An important parameter is the radius of the razor blade, as well as the roughness of the surface.

Analyze Electronic Components or Semiconductor Devices using Atomic Force Microscopy

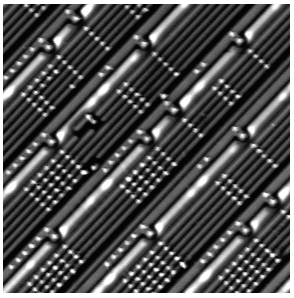
Modes: AFM Topography, SEM
Sample: CPU Chip



(Figure 1) SEM image of CPU chip with cantilever tip positioned on the region of interest.



(Figure 2) Correlative AFM image of specific area of transistor structures.



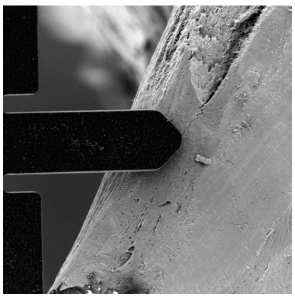
(Figure 3) Correlative SEM image of specific area of transistor structures.

Detailed location and analysis of nanometer-sized structures is a challenging and time-consuming task for all AFM operators. The size reduction in recent generations of transistors creates especially high demands on quality control and failure analysis. With FusionScope and Profile View you can easily navigate the cantilever tip to the region of interest and perform high resolution AFM analysis of your sample. Measure the real 3D topography with sub-nanometer resolution or extract additional information using conductive AFM.

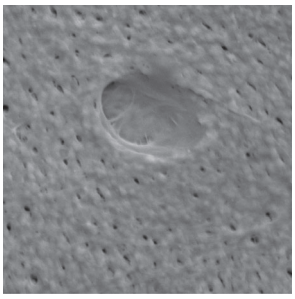
Life Sciences

Discover Properties of Hard-To-Reach Sample Areas using Atomic Force Microscopy

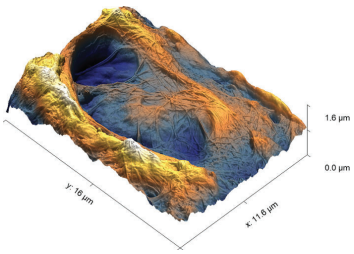
Mode: AFM Topography
Sample: Bone



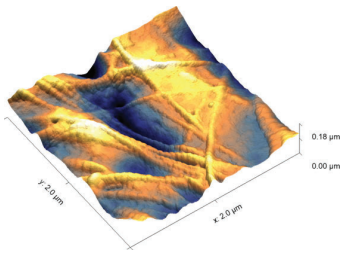
(Figure 1) SEM image of bone surface with cantilever.



(Figure 2) SEM image of lacunae structure.



(Figure 3) 3D AFM topography image of lacunae structure.



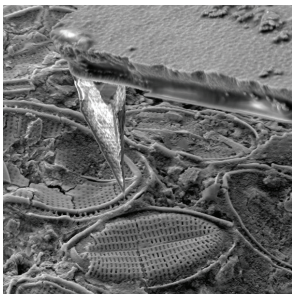
(Figure 3) High-resolution AFM image of collegen fibers located inside the lacunae structure.

The correlative analysis of hard-to-reach sample areas is always a challenging task. One example is the analysis of bone tissue, especially the detailed measurements of lacunae and collagen fibers on the bone surface.

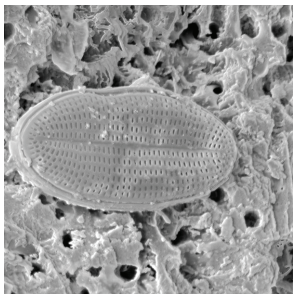
FusionScope offers a fast and easy identification and imaging of the lacunae structures. With the large field of view of the SEM the lacunae can be identified, and the cantilever positioned directly on the lacunae structures. Using the AFM, the real 3D topography of the lacunae and the collagen fibers can be extracted with sub-nm resolution.

Easily Locate and Image Diatoms on a Seashell Surface

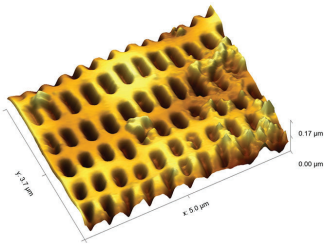
Mode: AFM Topography, SEM
Sample: Seashell



(Figure 1) SEM image of seashell surface in profile view with cantilever tip.



(Figure 2) SEM image of diatom structure on seashell surface.



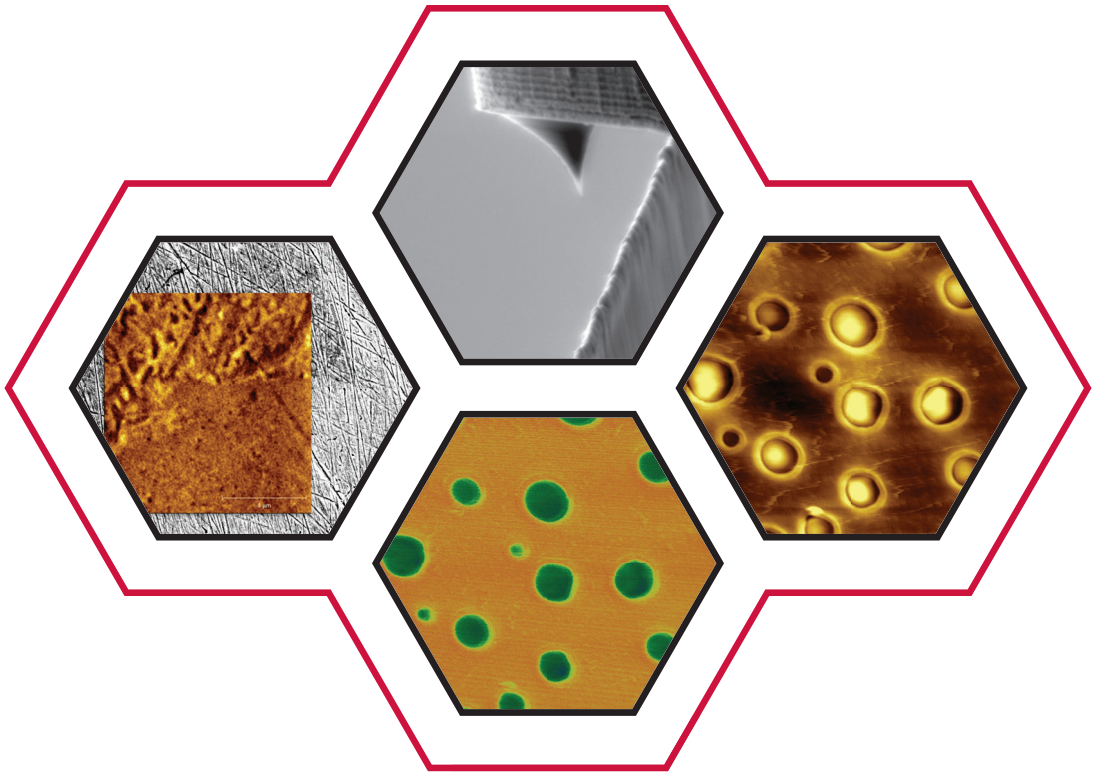
(Figure 3) 3D AFM topography image of diatom surface.

Diatom are fascinating unicellular organisms that make up a significant amount of the Earth's biomass. In this application we used the power of correlative microscopy to locate diatoms on the surface of a seashell using the high-resolution of the FusionScope SEM. With Profile view you can easily position the AFM cantilever tip on a diatom structure of your choice and perform a 3D topography analysis.

Specifications*

AFM	Scan Range XY:	22 x 22 μm (Closed Loop)
	Scan Range Z:	11 μm
	Imaging Noise:	< 50 pm @ 1 kHz
	Cantilever Probes:	Self-Sensing Piezoresistive
	Measurement Modes:	Contact, Dynamic, FIRE, MFM, C-AFM, ...
SEM	Electron Source:	Thermal Field Emission
	Acceleration Voltage:	3.5 kV – 15 kV
	Probe Current:	5 pA – 2.5 nA (300 pA typical)
	Magnification:	25 X – 200,000 X
	Detectors:	In-Chamber SE (Everhart-Thornley)
Sample	Max. Sample Diameter:	20 mm (12 mm Full Correlated Mode)
	Max. Sample Height:	20 mm
	Max. Sample Weight:	500 g
	Eucentric Alignment::	Automatic
Chamber	Typical Chamber Vacuum:	1-10 μTorr
	Pumping Time:	< 5 min
	Trunnion Tilt:	-10 to 80 Degrees
System	Power:	200-230 VAC; 50/60 Hz; Single Phase 15 A
	Dimensions (W x L x H):	690 x 835 x 1470 mm
	Weight:	330 kg

*For complete specifications, contact your local Quantum Design office.
Specifications subject to change without notice.



fusion scope®

Quantum Design

Quantum Design, Inc.
10307 Pacific Center Court, San Diego, CA 92121
Tel: 858-481-4400 Fax: 858-481-7410
www.qdusa.com (Rev. Feb. 2024)
www.fusionscope.com | info@fusionscope.com