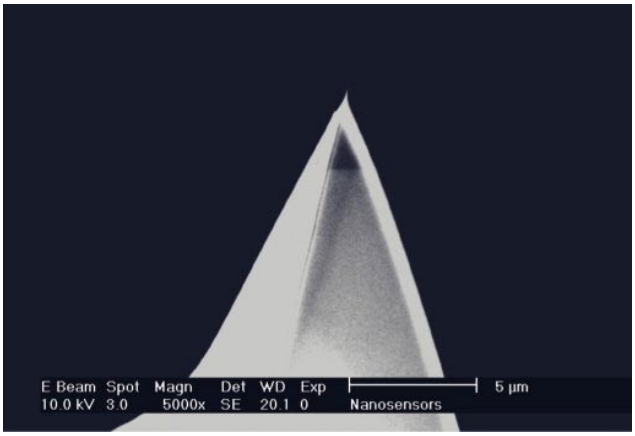
SuperSharpSilicon™

Silicon-SPM-Probes

NANOSENSORS™ SuperSharpSilicon™ tips are designed for measurements with enhanced resolution of nanostructures and microroughnesses. They are realised by an unique tip manufacturing process leading to a further improvement of the tip sharpness with radii typically as low as 2 nm. With these tips the frontiers of technology have been pushed back.

The SuperSharpSilicon™ tips are fabricated on the base of the NANOSENSORS™ advanced PointProbe® Plus tip manufacturing process. Thus the geometry of holder and cantilever equals that of the PointProbe® Plus Silicon-SPM-probes. The advanced SuperSharpSilicon™ tip shape is available for many different cantilever geometries.



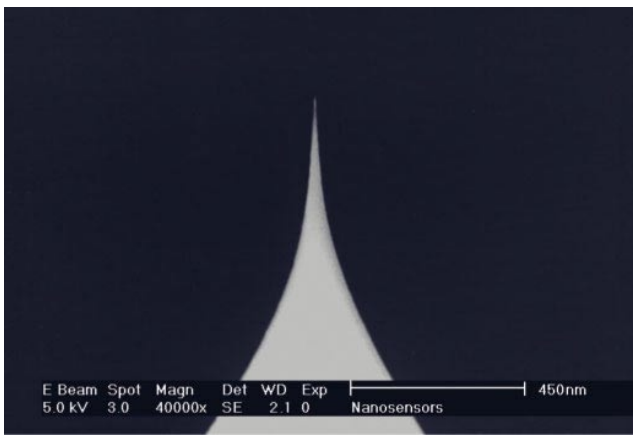
SEM image of a SuperSharpSilicon™ probe. Side view.

Tip Features at a Glance

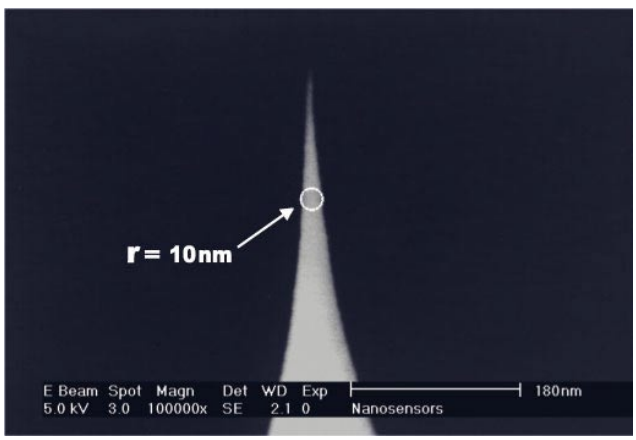
- The typical radius of a SuperSharpSilicon™ tip is about 2 nm.
- A tip radius of smaller than 5 nm is guaranteed.
- The half cone angle is better than 7° at the last 150 nm of the tip.
- The aspect ratio is better than 4:1 at the last 150 nm of the tip.
- The tip height is 10 to 15 µm allowing measurements on fairly rough surfaces.

Cantilever

The cross section of the cantilever is trapezoidal which offers several advantages. The detector side of the cantilever is rather wide. This enables an easy adjustment of the optical system. However, the mean width of the cantilever, which determines the spring constant is much smaller. The small cantilever width at the tip side reduces the damping of the cantilever which is important for the operation in a dynamic mode (Non-Contact / Tapping Mode).



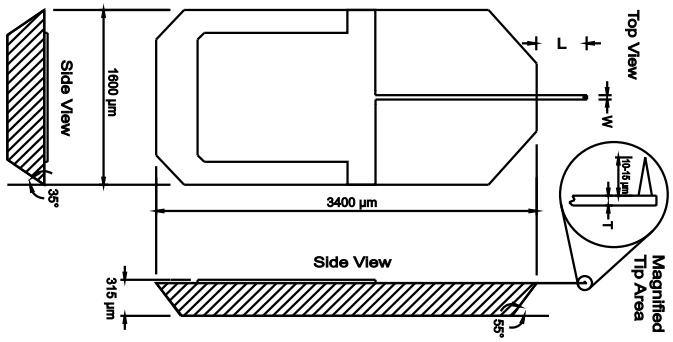
SEM image, close-up of the tip apex.



SEM image, extreme close-up of the tip apex.

Support Chip

The cantilever is fixed to a silicon support chip which can be seen in the sketch of the SPM probe assembly. The support chip as an integral part of the probe is designed for manipulating the probe and fixing it to the SPM. The geometric dimensions of the support chip are very reproducible enabling the replacement of the probes without major readjustment of the laser. This is further improved by the alignment grooves on the support chip`s backside in combination with our alignment chip. The chamfered edges of the support chip avoid contact between chip and sample if either of them is tilted.



Material Features

NANOSENSORS™ SuperSharpSilicon™ SPM-probes are manufactured from highly doped, single crystal silicon which leads to unique features. Silicon is a well-known and established material for semiconductor technology. The high conductivity of the doped silicon avoids electrostatic charging. The resistivity is as low as 0.01 - 0.025 Ωcm. The fabrication out of bulk material results in a monolithic design of support chip, cantilever and tip. This avoids any intrinsic stress and leads to absolutely straight cantilevers. Even if ambient temperature changes no bending of the cantilever will occur. The chemically inert silicon allows the application in fluids or electrochemical cells.

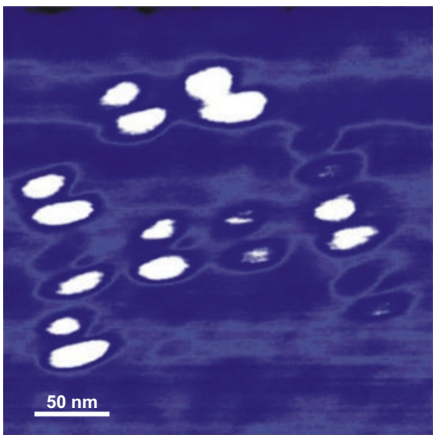
Reflex Coating

The reflex coating is an approximately 30 nm thick aluminum coating on the detector side of the cantilever which enhances the reflectivity of the laser beam by a factor of 2.5. Furthermore it prevents light from interfering within the cantilever. It has been proven by Transmission Electron Microscopy and Energy Dispersive X-Ray Spectroscopy that no aluminum will be found at the SuperSharpSilicon™ tip apex.

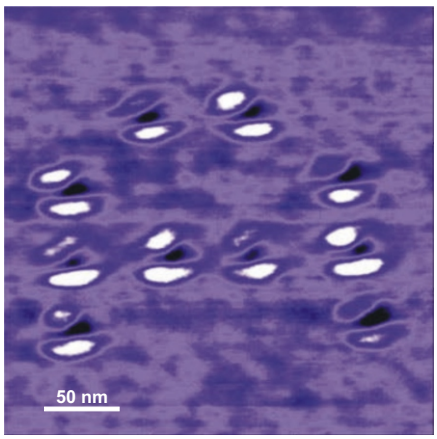
Application Examples

Enhanced Resolution on an Nanoindented Structure

Images of an "A" realised by nano-indentation with a diamond coated PointProbe® Plus DT-NCHR tip. The left image was taken with a standard PointProbe® Plus tip. Since the tip diameter is larger than the holes (resulting from indenting of the DT-NCHR probe) only the bulged sidewalls of the holes are imaged. The right image was taken with a SuperSharpSilicon™ probe (SSS-NCH). Due to the improved sharpness of the tip the picture shows the true width and depth of the holes and the bulged sidewalls.



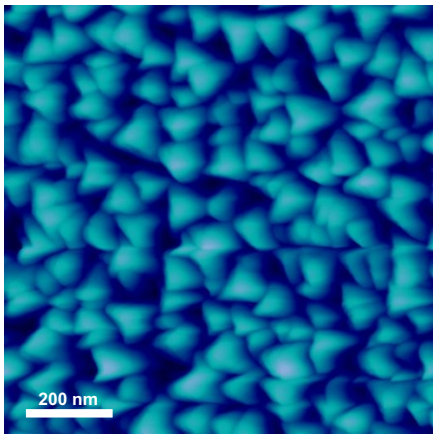
Height image of nanoindented letter with a standard PointProbe® Plus tip.



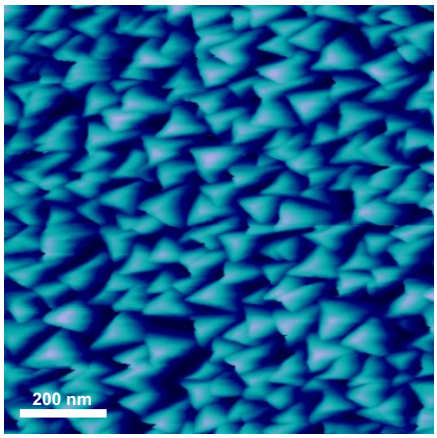
Height image of nanoindented letter with a SuperSharpSilicon™ tip.

Improved Imaging of Nanocrystallites

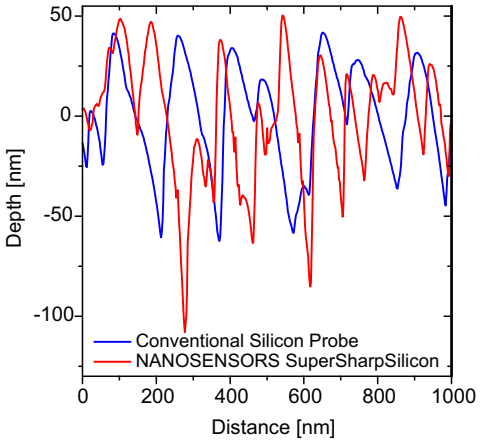
Imaging of nanocrystallites either with a non-NANOSENSORS™ Silicon-SPM-Probe (left side) and a NANOSENSORS™ SuperSharpSilicon™ probe (middle). On the scanned image in the middle the nanocrystallites appear much sharper and the topography is more distinctive than on the left image. The cross section view of scaned lines (right image) is showing clearly that the edges and ridges of the nanocrystallites, imaged with the NANOSENSORS™ SuperSharpSilicon™ probe have by far smaller edge radii compared to a conventional silicon probe, which is related to a much smaller tip radius. Also, through the higher aspect ratio of the NANOSENSORS™ SuperSharpSilicon™ probe the tip can penetrate the space between the nanocrystallites to much further depths than the conventional probe.



Height image of nanocrystallites imaged with a conventional non-NANOSENSORS™ Silicon-SPM-Probe.



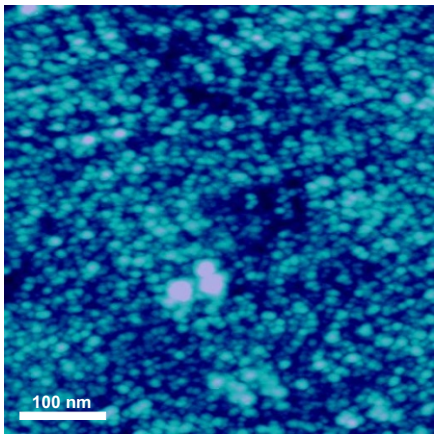
Height image of a nanocrystallites imaged with a NANOSENSORS™ SuperSharpSilicon™ probe.



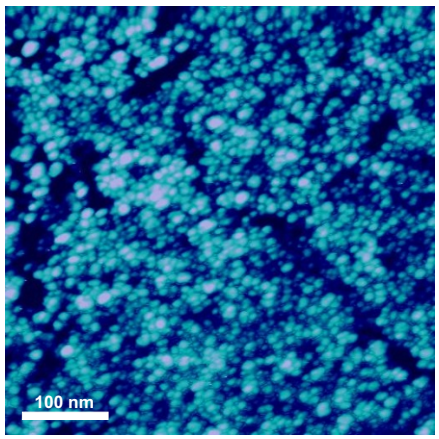
Cross section of scanned lines from the left side images.

Enhanced Resolution on a Polycrystalline Silicon Surface

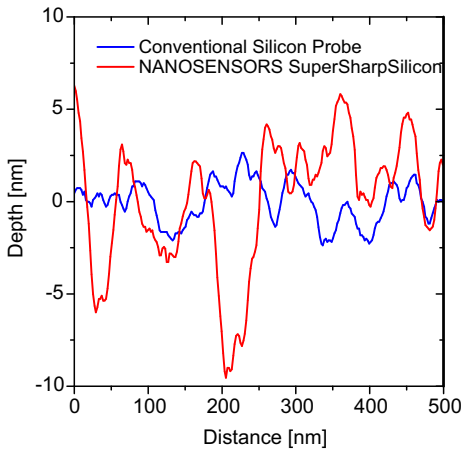
A polycrystalline silicon layer was imaged either with a conventional non-NANOSENSORS™ Silicon-SPM-Probe (left side) and a NANOSENSORS™ SuperSharpSilicon™ probe (middle). Again, with the NANOSENSORS™ SuperSharpSilicon™ probe the sphere-like structure of the polycrystalline silicon appears much sharper. Also, the interspace between the structures are imaged much better with the SuperSharpSilicon™ probe than with the conventional silicon probe.



Height image of a polycrystalline silicon surface imaged with a conventional non-NANOSENSORS™ Silicon-SPM-Probe.



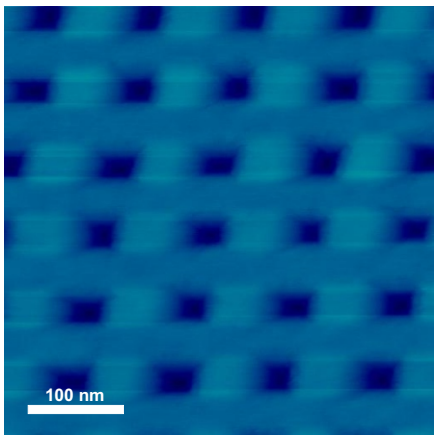
Height image of a polycrystalline silicon surface imaged with a NANOSENSORS™ SuperSharpSilicon™ probe.



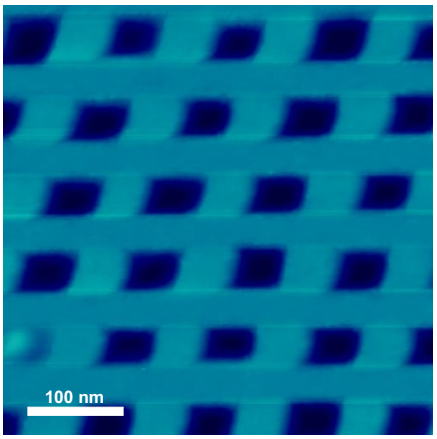
Cross section of scanned lines from the left side images.

Improved Resolution of Pyramidal Shaped Etch Pitches in <100> Silicon

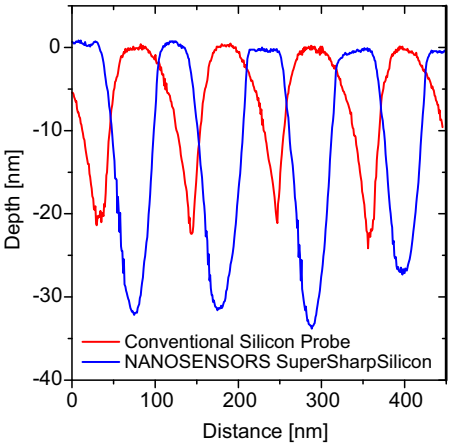
The sample consists of pyramidal shaped etch pitches in <100>-direction orientated silicon and is imaged either with a conventional non-NANOSENSORS™ Silicon-SPM-Probe (left side) and a NANOSENSORS™ SuperSharpSilicon™ probe (middle). The image scanned with the NANOSENSORS™ SuperSharpSilicon™ probe shows much deeper features (dark blue) than the conventional silicon probe. Due to the extreme discrepancy between the NANOSENSORS™ SuperSharpSilicon™ tip radius of about 2 nm and common tip radii (10 to 20 nm) of non-NANOSENSORS™ Silicon-SPM-Probes, the SuperSharpSilicon™ tip can reproduce the original surface (the edges of the pyramids as well as the pyramids bottom) more correctly than a conventional silicon probe. As a result of this the pyramids depth is much larger on the SuperSharpSilicon™ micrograph than for conventional silicon probes (right image).



Height image of the sample imaged with a conventional non-NANOSENSORS™ Silicon-SPM-Probe.



Height image of the sample imaged with a NANOSENSORS™ SuperSharpSilicon™ probe.



Cross section of scanned lines from the left side images.

Product List

	Type	Application	Force Constant [N/m] (nominal)	Res. Frequency [kHz] (nominal)	Coating (backside)
Non-Contact	SSS-NCH	Non-Contact / Tapping Mode (high frequency)	42	330	Reflex
	SSS-NCL	Non-Contact / Tapping Mode (long cantilever)	48	190	Reflex
	SSS-SEIH	Non-Contact / Tapping Mode (Seiko NC-mode)	15	130	Reflex
Special	SSS-FM	Force Modulation Mode	2.8	75	Reflex

For more details please refer to the product datasheet on our website
www.nanosensors.com
info@nanosensors.com

SSS_v12