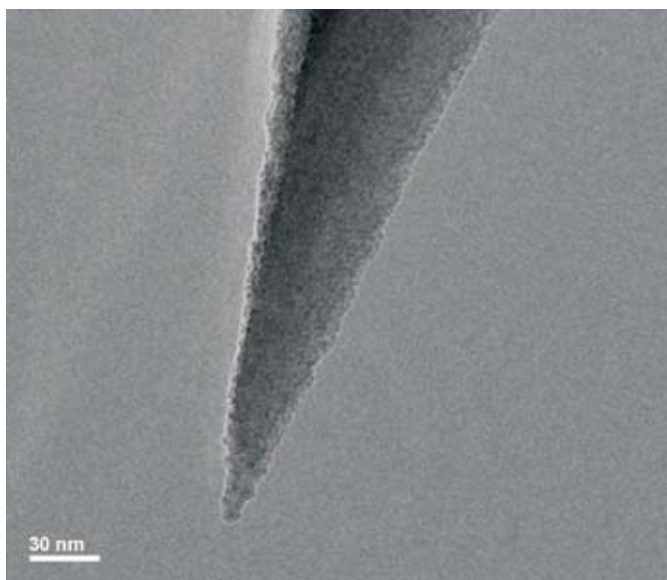




PointProbe® Plus

Silicon-SPM-Probes

■ Improved Consistency and Resolution through an Advanced Tip Manufacturing Process



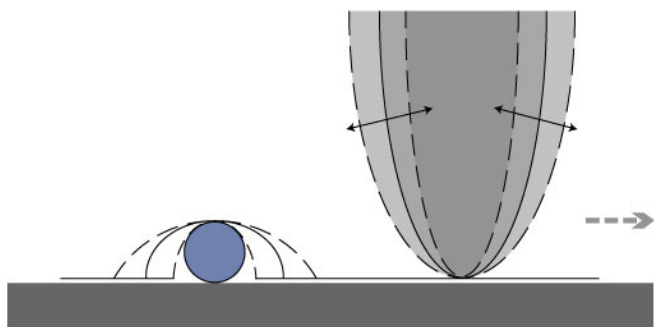
TEM image of the PointProbe® Plus tip apex.

The PointProbe® Plus (PPP) combines the well-known features of the proven PointProbe® series such as high application versatility and compatibility with most commercial SPMs with a further reduced and more reproducible tip radius as well as a more defined tip shape. The typical tip radius of less than 7 nm and the minimized variation in tip shape provide more reproducible images and enhanced resolution.

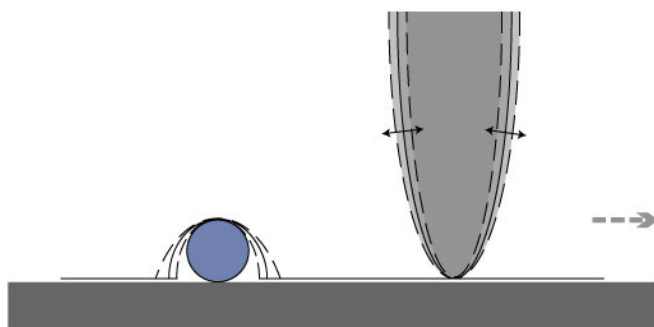
More than 15 years of experience in producing high quality SPM probes resulted in this state of the art product. A continuously improved and refined manufacturing process and many quality control steps during the production ensure a stable and reliable fabrication that yields a top notch-product with the consistent quality NANOSENSORS™ users have come to expect over the years.

■ Comparison of Conventional SPM Tips with the PointProbe® Plus

Conventional manufacturing processes of SPM tips lead to inevitable variations in the tip apex. The advanced NANOSENSORS™ fabrication process has significantly improved the tip consistency and radius: This is illustrated by the following schematic drawings of the last few hundred nanometers of the tip apex.



Effect of shape and radius variations of conventional AFM tips



Result of reduced tip radius and shape variation of the PointProbe® Plus AFM tips

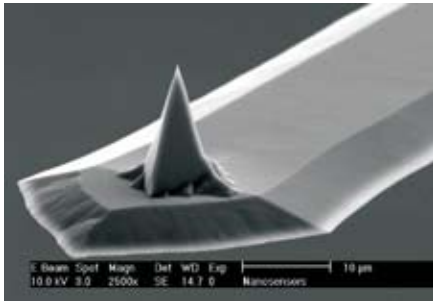
■ General

PointProbe® Plus SPM probes are manufactured from highly doped, single crystal silicon without any intrinsic mechanical stress. Its low resistivity of 0.01 - 0.025 Ωcm avoids electrostatic charging of the probe. The monolithic design of tip, cantilever and support chip leads to an absolutely straight cantilever without any bending. The chemical inertness allows application in fluids or electrochemical cells. The tip is pointing into the $\langle 100 \rangle$ crystal direction.

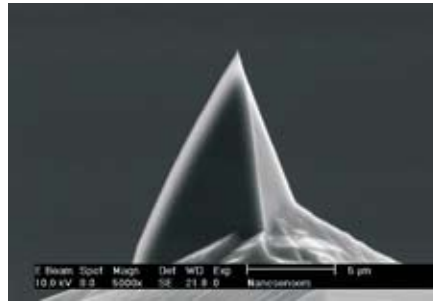


■ PointProbe® Plus (PPP) Tip Shape

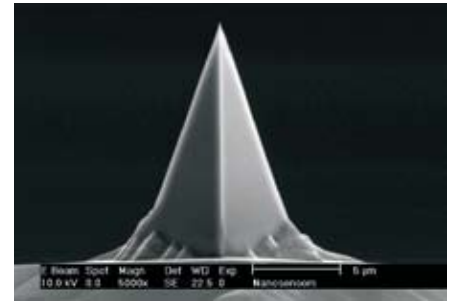
The tips are shaped like a polygon based pyramid. The macroscopic half cone angles are 20° when seen along the direction of the cantilever axis and 25° to 30° when seen from the side. In the last 200 nm the vertex angle of the tip tapers from its macroscopic value to a half cone angle of about 10° at the very end of the tip. This value by far exceeds those achievable with other technologies thus offering an unrivalled resolution.



PointProbe® Plus 3D view (SEM image)



PointProbe® Plus side view (SEM image)



PointProbe® Plus front view (SEM image)

Tip Features at a Glance

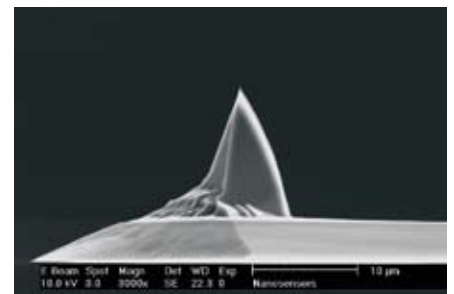
- Improved tip apex consistency
- Tip radii are typically better than 7 nm
- Tip height is 10 - 15 μm
- Half cone angle at the tip apex is typically 10°

Special Versions based on the PointProbe® Plus Series

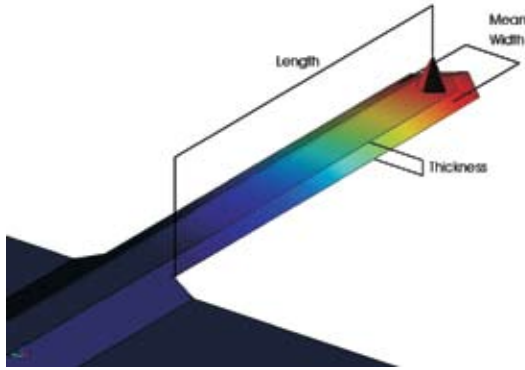
- SuperSharpSilicon™ tips are offering radii of typically 2 nm. We guarantee at least 5 nm (refer to SuperSharpSilicon™ flyer).
- High Aspect Ratio tips with and without compensation of the standard tilt angle of most AFM heads of 13° . They offer an aspect ratio of more than 5:1 or more than 10:1 over the last 2.0 μm (5:1) or 1.5 μm (10:1) of the tip (refer to High Aspect Ratio flyer).
- Hard and soft magnetic thin films on adapted PointProbe® Plus tips for high resolution and minimal invasive Magnetic Force Microscopy (refer to Magnetic Force Microscopy flyer).
- Diamond coating (optional electrically conductive) for ultimate robustness of the tip (refer to Diamond Coated PointProbe® Plus flyer).
- Tipless cantilevers for selected Contact, Non-Contact and Force Modulation Mode scanning probes.
- Selected Non-Contact and Force Modulation Mode scanning probes with an outstanding mechanical quality factor of over 30,000 under UHV conditions.

PointProbe® Plus (PPP) Rotated Tip Shape

In 1996 NANOSENSORS™ developed the rotated PointProbe® Plus tip. Since 1997 this special tip shape is offered by NANOSENSORS™ for selected Contact, Non-Contact and Force Modulation Mode scanning probes. For certain applications the rotated PointProbe® Plus tip offers more symmetric imaging capabilities. The rotated tip shape is identical to the classic tip shape but it is rotated by 180° with respect to the cantilever beam direction.



PointProbe® Plus rotated tip (SEM image)



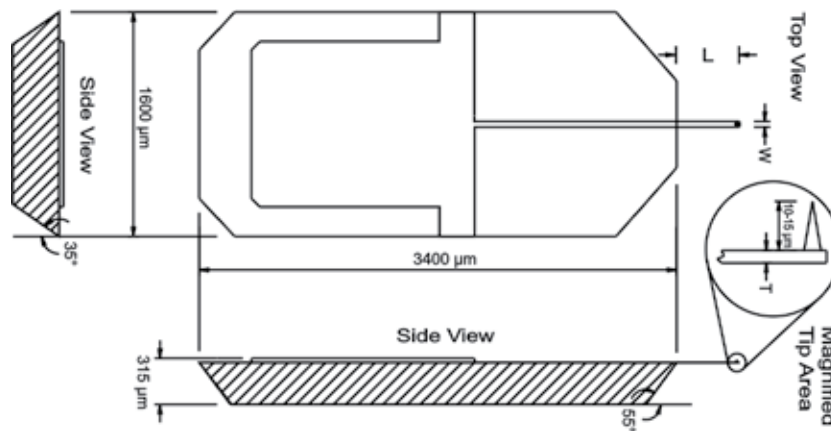
Dynamic FEM simulation of a PPP-NCH probe. The colours represent the total translation in the resonant case of the cantilever.

■ 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).

■ 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 probes without major readjustment of the detector. This is further improved by alignment grooves on the backside of the support chip (compare also PointProbe® Plus XY-Alignment Series flyer). The chamfered edges of the support chip avoid the contact between support chip and sample if either of them is tilted.



■ Coatings

- **Reflex Coating:** 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. As the coating is almost stress free, the bending of the softest PointProbe® Plus cantilever (PPP-CONT) is less than 2°
- **Au Coating:** 70 nm thick double layer of chromium and gold either on both sides or only on the detector side of the cantilever. The gold coating enables e.g. the chemical functionalisation of the tip using sulfur chemistry or the application of the probes in aggressive media.
- **PtIr5 Coating:** 25 nm thick double layer of chromium and platinum-iridium5 alloy on both sides of the cantilever. The wear resistant metallic coating allows a low ohmic electrical contact between sample and probe. The bending of the cantilever is less than 2°.
- **Diamond Coating:** Selected PPP probes are covered with real diamond for applications that require a hard contact between sample and probe e.g. friction measurements (refer to Diamond Coated PointProbe® Plus flyer).
- **Magnetic Coating:** For the visualisation of magnetic domains selected PPP probes with different hard and soft magnetic coatings are offered (refer to Magnetic Force Microscopy flyer).



■ Product List

	Type	Application	Force Constant [N/m] (nominal)	Res. Frequency [kHz] (nominal)	Coatings (tipside/backside)
Contact	PPP-CONT	Contact Mode	0.2	13	Reflex, PtIr5, Au
	PPP-CONTSC	Contact Mode (short cantilever)	0.2	25	Reflex, PtIr5, Au
	PPP-ZEILR	Contact Mode (Seiko or Zeiss)	1.6	27	Reflex
Non-Contact	PPP-NCH	Non-Contact / Tapping Mode (high frequency)	42	330	Reflex, PtIr5, Au
	PPP-QNCHR	Non-Contact / Tapping Mode for UHV (high Q)	42	330	Reflex
	PPP-NCL	Non-Contact / Tapping Mode (long cantilever)	48	190	Reflex, PtIr5, Au
	PPP-NCST	Non-Contact / Tapping Mode (soft tapping)	7.4	160	Reflex, PtIr5, Au
	PPP-SEIH	Non-Contact / Tapping Mode (Seiko NC-mode)	15	130	Reflex
Special	PPP-LFM	Lateral / Friction Force Microscopy	0.2	25	Reflex
	PPP-FM	Force Modulation Mode	2.8	75	Reflex, PtIr5, Au, Magnetic
	PPP-QFMR	Force Modulation Mode for UHV	2.8	75	Reflex, Magnetic

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

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