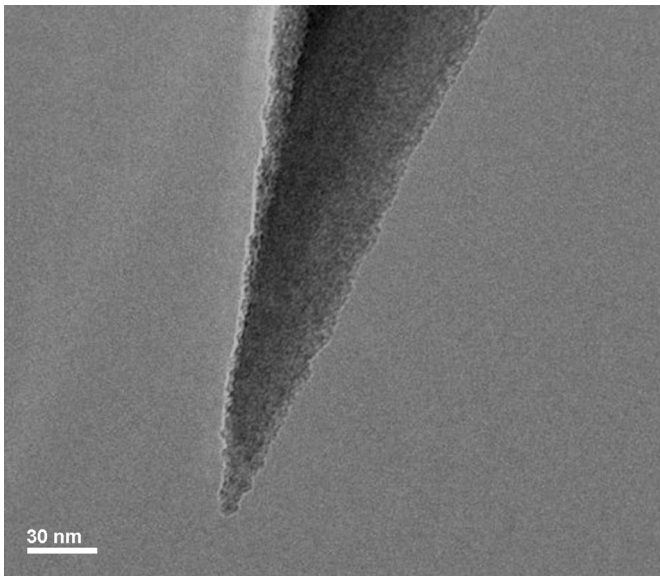




## PointProbe® Plus Silicon-SPM-Probes

### ■ Improved Consistency and Resolution through an Advanced Tip Manufacturing Process



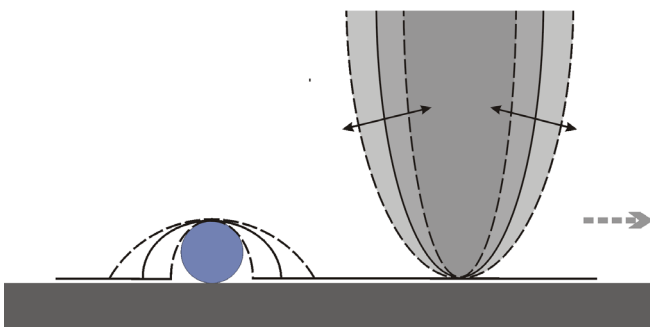
TEM image of the PointProbe® Plus tip apex

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.

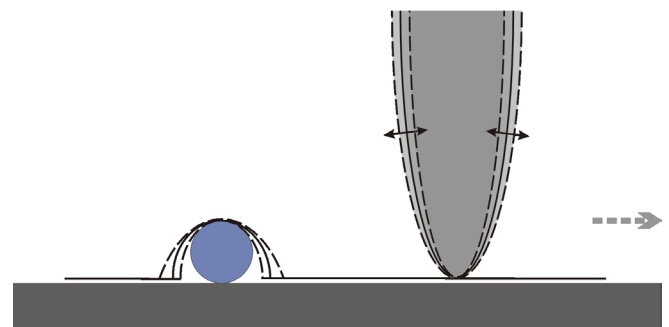
More than 25 years of experience in producing high quality SPM probes resulted in this state of the art product. A continuously improved and refined manufacturing process and many quality control steps during the production ensure a stable and reliable fabrication that yields a top notch-product with 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

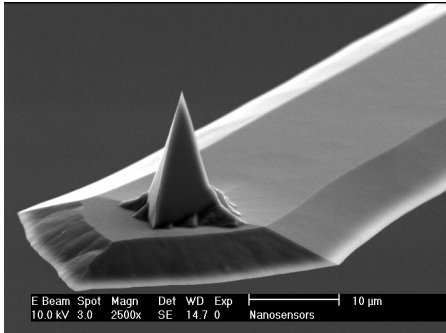
### ■ General

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  $\Omega\text{cm}$  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.

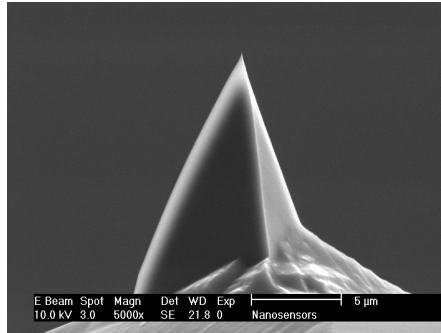


## PointProbe® Plus (PPP) Tip Shape

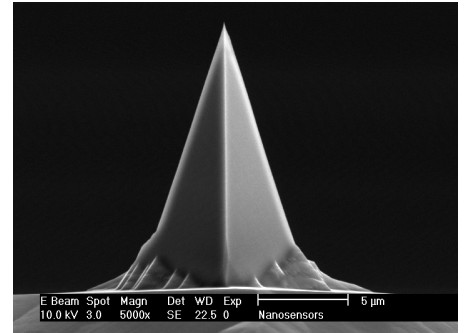
The tips are shaped like a polygon based pyramid. The macroscopic half cone angles are 20° when seen along the direction of the cantilever axis and 25° to 30° when seen from the side. In the last 200 nm the vertex angle of the tip tapers from its macroscopic value to a half cone angle of about 10° at 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

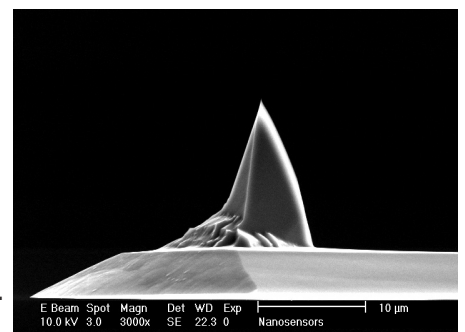
- Improved tip apex consistency
- Tip radii are typically smaller than 7 nm
- Tip height is 10 - 15 μm
- Half cone angle at the tip apex is typically 10°

## Special Versions based on the PointProbe® Plus Series

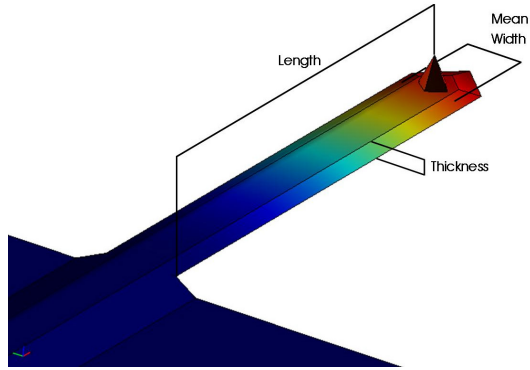
- **SuperSharpSilicon™ tips (SSS)** are offering radii of typically 2 nm. We guarantee at least 5nm (refer to SuperSharpSilicon™ flyer).
- **High Aspect Ratio tips (AR10T, AR10, AR5T, AR5)** with and without compensation of the cantilever tilt, which offer an aspect ratio of more than 5:1 over the last 2.0 μm of the tip or more than 10:1 over the last 1.5 μm of the tip (refer to High Aspect Ratio flyer).
- **Platinum Silicide (PtSi)** coatings for selected Contact, Non-Contact and Force Modulation Mode scanning probes for enhanced conductivity combined with robustness and tip sharpness (see Platinum Silicide SPM-Probes flyer).
- **Hard and soft magnetic thin films (M, LM-M, LC-M)** on adapted PointProbe® Plus tips for high resolution and minimal invasive Magnetic Force Microscopy (refer to Magnetic Force Microscopy flyer).
- **Diamond coating (DT) (optional electrically conductive(CDT))** for ultimate robustness of the tip (refer to Diamond Coated PointProbe® Plus flyer).
- **Tipless cantilever (TL)** 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 (QR).

## PointProbe® Plus Rotated Tip Shape (RT)

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)



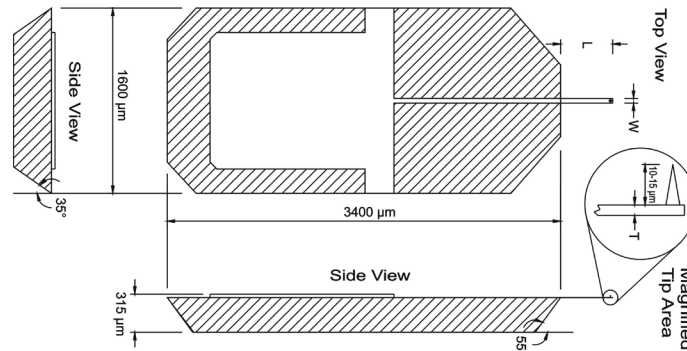
Dynamic FEM simulation of a PPP-NCH probe. The colours represent the total translation in the resonant case of the cantilever

## 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 X-Y 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 (R):** 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.
- **Au Coating on detector side (AuD):** 70 nm thick layer of gold which enhances the reflectivity of the laser beam by a factor of about 2.
- **Au Coating on both sides (Au):** 70 nm thick layer of gold on both sides 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.
- **Platinum-Iridium5 Coating (PtIr5):** 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.
- **Platinum Silicide Coating (PtSi):** PtSi coating on both sides of the cantilever for high conductivity combined with robustness and high lateral resolution.
- **Diamond Coating (DI, CDT):** 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 (M, LM-M, LC-M):** For the visualisation of magnetic domains selected PPP probes with different hard and soft magnetic coatings are offered (refer to Magnetic Force Microscopy flyer).

All coatings are almost stress free, the bending of the softest cantilever (PPP-CONT) is less than 2°.



Product List

	Type	Application	Force Constant [N/m] (nominal)	Resonance Frequency [kHz] (nominal)	Coatings	Tip Versions
Contact	PPP-CONT	Contact-Mode	0.2	13	Reflex, AuD, Au, PtIr5, PtSi (optional)	DT, CDT, RT, PL2, TL
	PPP-XYCONTR	Contact Mode	0.2	13	Reflex	
	PPP-CONTSC	Contact Mode	0.2	25	Reflex, AuD, Au, PtIr5 (optional)	
	PPP-ZEILR	Contact Mode	1.6	27	Reflex	
Non-Contact	PPP-NCH	Non-Contact / Tapping Mode (high frequency)	42	330	Reflex, AuD, Au, PtIr5, PtSi, QR (optional)	SSS, AR5T, AR5, AR10T, AR10, DT, CDT, RT, PL2, TL
	PPP-XYNCHR	Non-Contact / Tapping Mode (high frequency)	42	330	Reflex	
	PPP-NCST	Non-Contact / Soft Tapping	7.4	160	Reflex, AuD, Au, PtIr5 (optional)	
	PPP-XYNCSTR	Non-Contact / Soft Tapping	7.4	160	Reflex	
	PPP-NCL	Non-Contact / Tapping Mode (long cantilever)	48	190	Reflex, AuD, Au, PtIr5 (optional)	SSS, AR5, DT, CDT, PL2, TL
	PPP-SEIH	Non-Contact / Tapping Mode (special)	15	130	Reflex (optional)	SSS
Special	PPP-LFMR	Lateral / Friction Force Microscopy	0.2	13	Reflex	
	PPP-FM	Force Modulation Mode	2.8	75	Reflex, AuD, Au, PtIr5, PtSi, QR (optional)	DT, CDT, RT, PL2, TL
	PPP-MFMR PPP-LM-MFMR PPP-QMFMR	Magnetic Force Microscopy	2.8	75	Hard Magnetic, Reflex	SSS
	PPP-LC-MFMR PPP-LC-QMFMR	Magnetic Force Microscopy	2.8	75	Soft Magnetic, Reflex	
	PPP-EFM	Electrostatic Force Microscopy	2.8	75	PtIr5	

For more details please refer to the product datasheet on our website

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