



# Pointprobe®

## Silicon-SPM-Sensors

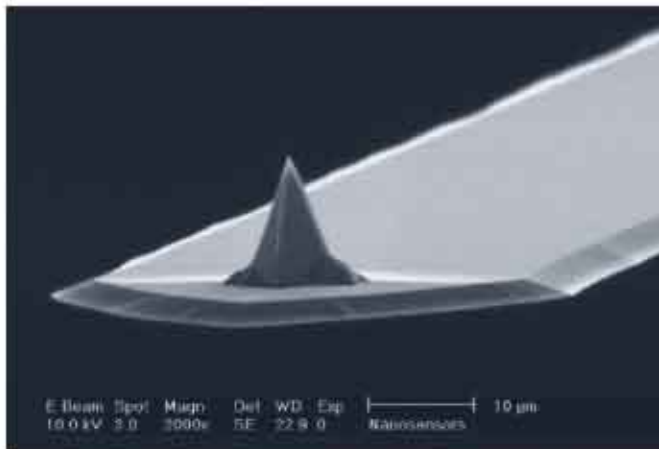
### ■ Pointprobe® Silicon-SPM-Sensors

NANOSENSORS™ Silicon-SPM-Sensors are designed for high application versatility, very high resolution imaging and compatibility to most commercial SPMs. The sensor consists of a single crystal silicon cantilever with integrated single crystal silicon tip. The tip is pointing into the  $\langle 100 \rangle$  direction. The cantilever and the tip are supported by a single crystal silicon holder.

### ■ Tip Shape

#### Classic Tip Shape

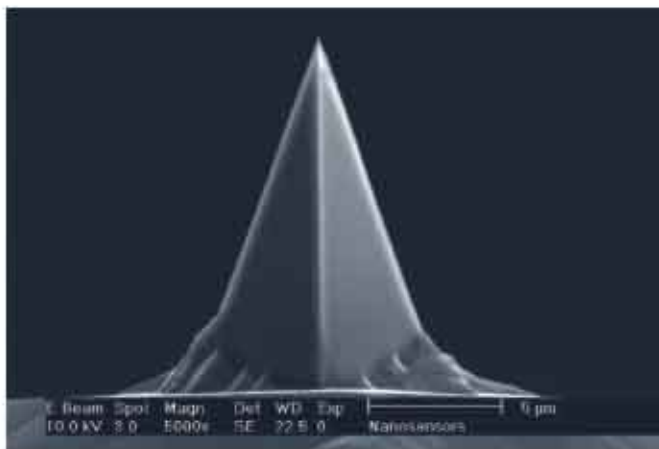
The tips are shaped like a polygon based pyramid. The macroscopic half cone angles are  $20^\circ$  to  $25^\circ$  when seen along the direction of the cantilever axis and  $25^\circ$  to  $30^\circ$  when seen from the side. This shape changes at the apex of the tip. In the last 200 nm the vertex angle of the tip tapers from its macroscopic value to virtually zero at the very end. The tip radius is extremely small with typical values of better than 10 nm. This value by far exceeds those achievable with other technologies thus offering an unrivalled resolution.



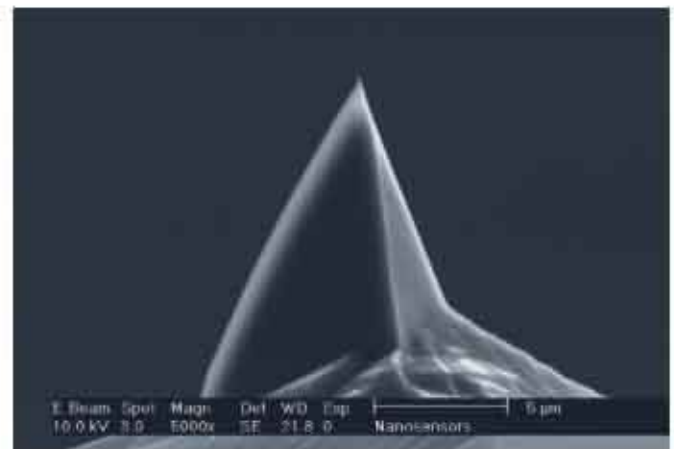
Pointprobe® 3D View

#### Tip Features at a Glance:

- The tip radii are typically better than 10 nm. We guarantee at least 15 nm.
- The tip height is 10-15  $\mu\text{m}$ .
- The half cone angle is better than  $10^\circ$  at the apex.
- Half cone angles are  $20^\circ$  to  $25^\circ$  when seen along the direction of the cantilever axis and  $25^\circ$  to  $30^\circ$  when seen from the side



Pointprobe® Front View



Pointprobe® Side View

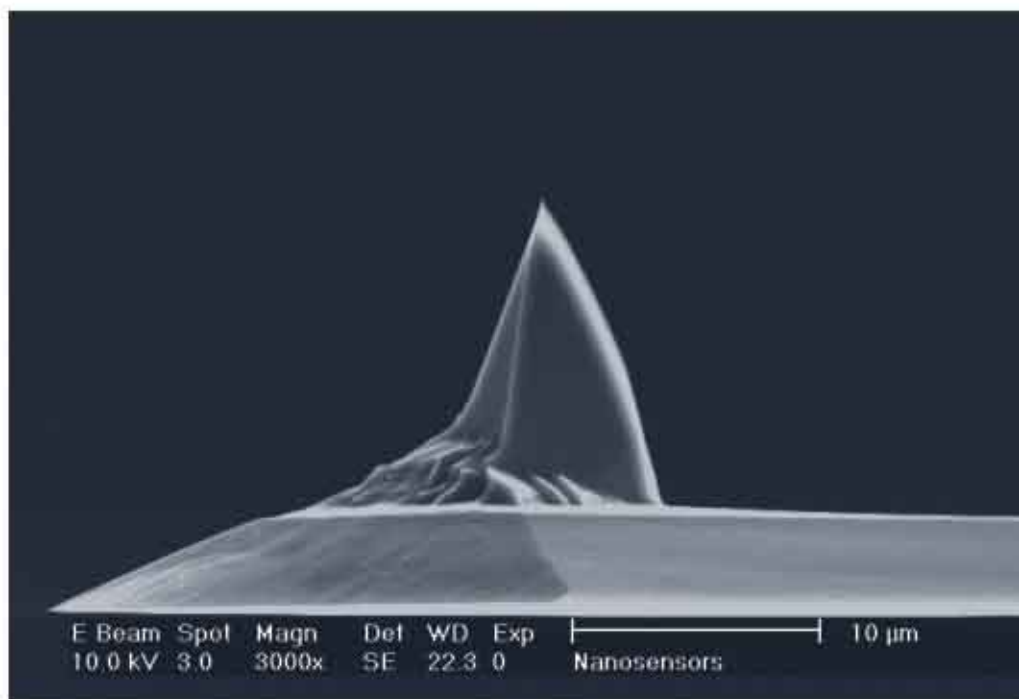


### Special Tip Features Available:

- SuperSharpSilicon Tips offering tip radii of typically 2 nm. We guarantee at least 5 nm.
- High Aspect Ratio Tips with and without compensation of the cantilever tilt, which offer an aspect ratio of more than 5:1 or more than 10:1 over the last 2.0  $\mu\text{m}$  (5:1) or 1.5  $\mu\text{m}$  (10:1) of the tip.
- Diamond coating (optional electrically conductive) for ultimate robustness of the tip.

### Rotated Tip Shape (optional)

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



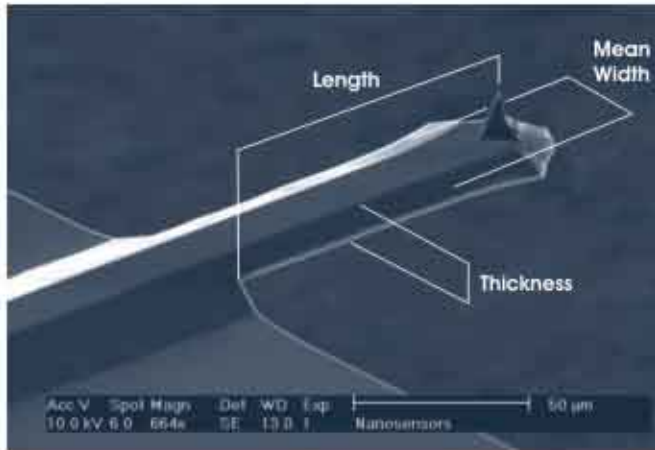
Pointprobe® Rotated Tip

### ■ 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 detection 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 (Non-Contact / Tapping Mode™) mode.

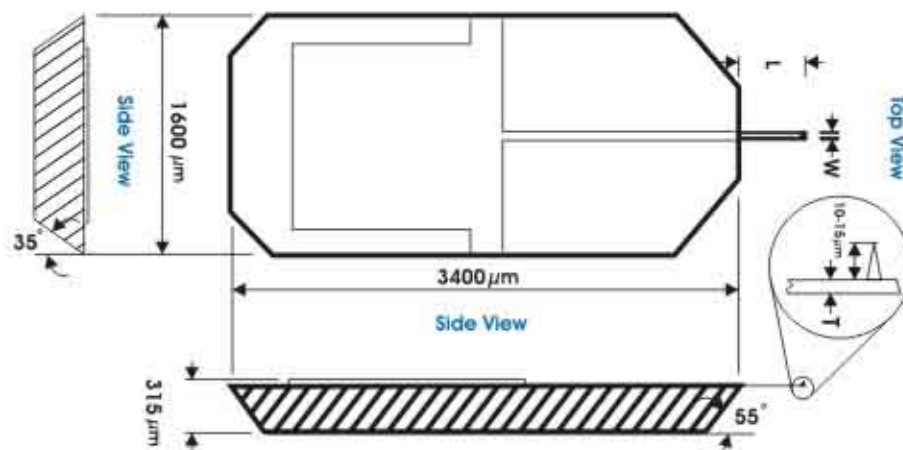
In capacitive measurements the smaller area of the cantilever's tip side results in a smaller contribution and cantilever capacity is decreased.



Depending on the application the cantilever geometry ranges from 125  $\mu\text{m}$  to 450  $\mu\text{m}$  in length, 20  $\mu\text{m}$  to 60  $\mu\text{m}$  in width and 0.3  $\mu\text{m}$  to 8  $\mu\text{m}$  in thickness. For special applications cantilevers with dimensions exceeding the above ones have been manufactured.

### ■ Holder

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



### ■ Material Features

Pointprobe® Silicon-SPM-Sensors 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  $\Omega\cdot\text{cm}$ .

The fabrication out of bulk material results in a monolithic design of holder, cantilever and tip. This avoids any intrinsic stress and leads to absolutely straight cantilevers. Even if ambient temperature changes, no bending of the cantilever with uncontrolled forces will occur.

The chemically inert silicon allows the application in fluids or electrochemical cells.



## ■ Coatings (optional)

### 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. As the coating is almost stress-free the bending of the cantilever due to stress is less than 2°.

### PtIr5

The PtIr5 coating is an approximately 23 nm thick double layer of chromium and platinum iridium5 on both sides of the cantilever. The tip side coating enhances the conductivity of the tip and allows electrical contacts. The detector side coating enhances the reflectivity of the laser beam by a factor of 2 and prevents light from interfering within the cantilever. The coating process is optimized for stress compensation and wear resistance. The bending of the cantilever due to stress is less than 2°.

### Hard Magnetic

The hard magnetic coating is an approximately 40 nm thick cobalt alloy coating on the tip side of the cantilever. It leads to a permanent magnetization of the tip with the direction usually perpendicular to the cantilever axis. In rare cases the tip needs to be magnetized by means of an external strong magnet (e.g. a NdFeB magnet, a few millimeters in size). This pre-treatment has not been done by NANOSENSORS™! Although the coating is almost stress-free, it cannot be avoided completely. The stress-induced bending of the cantilever is less than 2°. Soft magnetic samples may be influenced by the tip!

## ■ Applications

For different applications of Scanning Probe Microscopy we offer sensors with force constants ranging from 0.01 N/m to several 100 N/m and with resonance frequencies from 10 kHz to 600 kHz corresponding to the wide range of applications.

Below please find a table with mechanical properties of our standard Pointprobe® products. Cantilevers with different mechanical properties customized for special applications can be manufactured on request.

## ■ Product List

	Type	Application	Force Constant [N/m] (typical)	Resonance Frequency / [kHz] (typical)	Coatings (tipside/backside)
Contact	CONT	Contact Mode	0,2	13	Reflex, PtIr5 (optional)
	ZEILR	Contact Mode, Seiko or Zeiss Contact Mode	1,6	27	Reflex
Non-Contact	NCH	Non-Contact / Tapping Mode™ (high frequency)	42	330	Reflex, PtIr5 (optional)
	NCL	Non-Contact / Tapping Mode™ (long cantilever)	48	190	Reflex (optional)
	ZEIHR	Non-Contact / Tapping Mode™ Zeiss Verlekt Step Mode	27	130	Reflex
	SEIHR	Non-Contact / Tapping Mode™ Seiko Non-Contact Mode	15	130	Reflex
Special	LFM	Lateral / Friction Force Microscopy	0,2	25	Reflex (optional)
	FM	Force Modulation Mode	2,8	75	Reflex (optional)
	EFM	Electrostatic Force Microscopy	2,8	75	PtIr5
	MFMR	Magnetic Force Microscopy	2,8	75	Hard Magnetic and Reflex