

ABOUT NANOWORLD® AG:

Nanotechnology is our field. Precision is our tradition.

Innovation is our key instrument.
That's why we are located in Switzerland,
one of the most powerful and innovative areas in Europe.

Using our knowledge as well as our high precision probes, our clients are able to achieve the best results with Scanning Probe Microscopy (SPM) and particularly with Atomic Force Microscopy (AFM).

POINTPROBE®



Main Features

- most widely used and best known SPM and AFM probe world-wide
- silicon SPM and AFM probe for very high resolution imaging
- alignment grooves on backside of support chip
- tip radius typically < 8 nm
- guaranteed < 12 nm
- available with different tip shapes

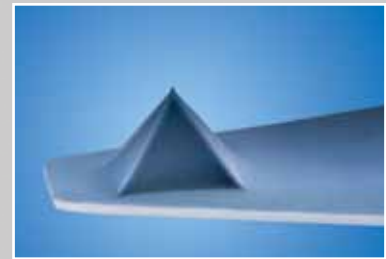
ARROW™



Main Features

- optimized positioning through maximized tip visibility
- three sided tip defined by real crystal planes
- tip at the very end of the cantilever
- tip radius typically < 10 nm
- guaranteed < 15 nm

PYREX-NITRIDE



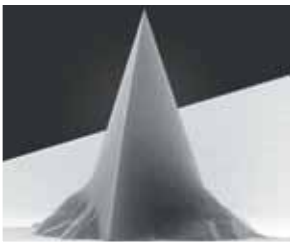
Main Features

- silicon nitride cantilevers and tips
- pyrex-glass support chip
- designed for various imaging applications in contact mode or dynamic mode
- oxide sharpened pyramidal probe tips
- tip radius typically < 10 nm
- available either with triangular or rectangular cantilevers



POINTPROBE® SILICON-AFM-PROBES

Most widely used and best-known high quality
SPM and AFM probe world-wide



Pointprobe® Tip



Pointprobe® Side View



Pointprobe® 3D View

Pointprobe® Tip (Standard)

The standard Pointprobe® tip is shaped like a polygon based pyramid. Its macroscopic halfcone angle is 20° to 25° viewed along the cantilever axis, 25° to 30° when looking from the side and virtually zero at the very tip end. The Pointprobe® tip is 10 - 15 µm high and shows a tip radius of typically smaller than 8 nm (smaller than 12 nm guaranteed).

General

- SPM and AFM probes for very high resolution imaging
- fits to all well-known commercial SPMs and AFMs
- cantilever and tip are supported by a single crystal silicon support chip
- monolithic design of support chip, cantilever and tip

Material Features

- highly doped, single crystal silicon (resistivity 0.01 - 0.025 Ohm•cm)
- no intrinsic stress and absolutely straight cantilevers
- chemically inert silicon for application in fluids or electrochemical cells

Cantilever

- rectangular cantilever with trapezoidal cross section
- wide detector side for easy laser beam adjustment
- small width at the tip side reduces damping

Support Chip

- cantilever is integrated into a silicon support chip
- dimensions of the support chip are very reproducible (1.6 mm x 3.4 mm)
- alignment grooves on backside of silicon support chip in conjunction with alignment chip ensure replacement of probes without major readjustment of the laser beam

Package Sizes

- small packages of 10, 20 or 50 scanning probes
- full wafer of 380 up to 388 scanning probes, depending on the product

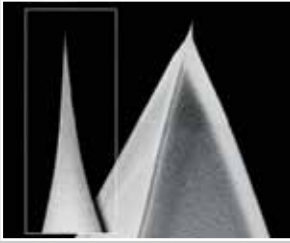
AVAILABLE COATINGS

Reflex Coating

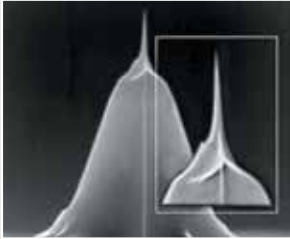
- 30 nm thick aluminum coating on the backside of the cantilever
- enhances reflectance of the laser beam by a factor of 2.5
- prevents light from interfering with the cantilever

Hard Magnetic + Soft Magnetic Coating

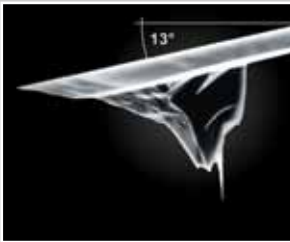
- hard magnetic coating: cobalt alloy coating on the tip side
- permanent magnetization of the tip
- soft magnetic coating: soft magnetic coating on tip side (coercivity of app. 0.75 Oe, remanence magnetization of app. 225 emu/cm³)



SuperSharpSilicon™ Tip (SSS)



High Aspect Ratio Tip (AR5)



Tilt compensated AR5T



Diamond Coated Tip (DT, CDT)

SuperSharpSilicon™ Tip (SSS)

For enhanced resolution of microroughness and nanostructures we have developed an advanced tip manufacturing process leading to a further improvement of the tip sharpness with tip radii as small as **2 nm**.

With these AFM tips we have pushed back the frontiers of technology.

Tip Features

The tip height is 10 - 15 μm and the typical radius of a SuperSharpSilicon™ tip is about **2 nm**. We guarantee a tip radius of smaller than **5 nm** (guaranteed yield: 80%). The half cone angle is smaller than 10° at the last 200 nm of the tip.

High Aspect Ratio Tip (AR5/AR5T)

For measurements on samples with sidewall angles approaching 90° , e.g. deep trench measurements or other semiconductor applications, we offer two different types of High Aspect Ratio Tips showing near vertical sidewalls.

These tips have an overall height of 10 - 15 μm which allows measurements on highly corrugated samples. At the last few micrometers the tips show a high aspect ratio portion that is symmetric when viewed from the side as well as along the cantilever axis. The tip radius is typically **10 nm** (smaller than **15 nm** guaranteed).

Tip Features

The high aspect ratio portion of the AR5/AR5T tip is larger than 2 μm and shows an aspect ratio of typically 7:1 (a minimum aspect ratio of 5:1 guaranteed).

Consequently the half cone angle of the high aspect ratio portion is typically smaller than 5° . Moreover the high aspect ratio portion of the AR5T is tilted 13° with respect to the center axis of the tip allowing absolutely symmetrical imaging.

Diamond Coated Tip (DT), Conductive Diamond Coated Tip (CDT)

For SPM and AFM applications that require hard contact between probe and sample we recommend our Diamond Coated Tip (DT). Some typical applications are friction force measurements, measurement of the elastic properties of samples, as well as wear measurements or nanostructuring. The Conductive Diamond Coated Tip (CDT) additionally offers a conductive, non passivated coating.

Tip and Coating Features

True polycrystalline diamond coating on the tip side of the cantilever with the unsurpassed hardness of diamond.

The tip height is 10 - 15 μm and the thickness of the diamond layer is approximately 100 nm. The macroscopic tip radius is in the range of 100 - 200 nm, but the tip often exhibits a nanoroughness in the 10 nm regime.

In case of the CDT the conductivity is in the range of 0.003 - 0.005 $\text{Ohm} \cdot \text{cm}$.

Diamond Coating

- 100 nm thick coating of polycrystalline diamond on the tip side
- unsurpassed hardness of the tip

PtIr5 Coating

- 25 nm layer of chromium/platinum iridium5 on both sides of the scanning probe
- stress-compensated and wear resistant
- detector side coating enhances the reflectance of the laser beam by a factor of 2
- allows electrical measurements

Gold Coating (on request)

- 70 nm thick chromium/gold coating on the backside of the cantilever
- 70 nm thick chromium/gold coating on both sides of the probe

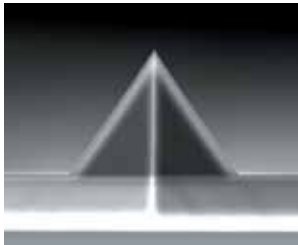


ARROW™ SILICON-AFM-PROBES

Optimized positioning through maximized tip visibility



Arrow™ Top View



Arrow™ Front View



Arrow™ Side View

General

- SPM and AFM probe for high resolution imaging
- fits to all well-known commercial SPMs and AFMs
- cantilever and tip are supported by a single crystal silicon support chip (monolithic design)

Material Features

- highly doped, single crystal silicon (resistivity 0.01 - 0.025 Ohm·cm)
- no intrinsic stress and absolutely straight cantilevers
- chemically inert silicon for application in fluids or electrochemical cells

Cantilever

- rectangular cantilever with triangular free end
- easy positioning of tip on the area of interest due to the Arrow™ shape
- consistent distance between tip and cantilever end
- trapezoidal cross section with wide backside for easy laser adjustment

Support Chip

- dimensions of the support chip are very reproducible (1.6 mm x 3.4 mm)
- etched corners of the support chip avoid contact between the support chip and the sample

Tip

- tip height 10 - 15 μm and radius of curvature typically < 10 nm (< 15 nm guaranteed)
- macroscopic half-cone angles
 - are 30° to 35° seen along the cantilever axis
 - are 20° to 25° seen from the side

Package Sizes

- small packages of 10, 20 or 50 scanning probes
- full wafer of at least 380 scanning probes

AVAILABLE COATINGS

Reflex Coating

- 30 nm thick aluminum coating on the backside of the cantilever
- enhances reflectance of the laser beam by a factor of 2.5

PtIr5 Coating

- 25 nm thick double layer of chromium and platinum iridium5 on both sides of the scanning probe
- allows electrical measurements

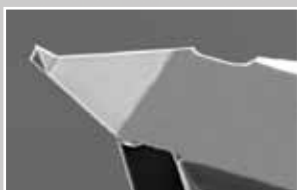
- **Other coatings for standard SPM and AFM probes available on request**

ARROW™ Ultra High Frequency Scanning Probes (UHF)

ARROW™ Tipless Cantilevers and Cantilever Arrays (TL)



Arrow™ UHF



Arrow™ UHF 3D-View

Arrow™ UHF

The Arrow™ UHF (Ultra High Frequency) is a silicon SPM and AFM probe with a tetrahedral tip and a triangular cantilever capable of resonating with an ultra high frequency of up to 1.5 MHz.

The Arrow™ UHF cantilever has a length of 35 μm and a base width of 42 μm . Cantilever thicknesses between 0.6 and 1.0 μm are possible. The tip height is 3 μm .

On request, specific cantilever thicknesses are selected within very narrow tolerances for an extra selection fee.

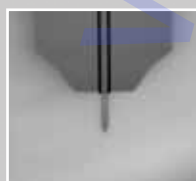
Arrow™ TL (Tipless Cantilevers for Special Applications)

The Arrow™ TL SPM and AFM probes have tipless cantilevers for special applications. They can for example be used for attaching spheres and other objects to the free end of the cantilever, or for functionalizing and sensing applications.

All scanning probes of the Arrow™ series are made from monolithic silicon which is highly doped to dissipate static charge and are chemically inert.

The products of the Arrow™ tipless series (Arrow™ TL) are available with either 1 cantilever or with cantilever arrays consisting of 2 or 8 rectangular cantilevers with a triangular free end. The Arrow™ TL are optionally available with a top side coating of 5 nm titanium / 30 nm gold.

Cantilever Data	Value	Range
Thickness	1.0 μm	0.5 - 2.5 μm
Width (rectangular part)	100 μm	95 - 105 μm
Length	500 μm	495 - 505 μm
Force Constant	0.03 N/m	0.04 - 0.54 N/m
Resonance Frequency	6 kHz	3 - 14 kHz



Arrow™ TL1
Tipless cantilever,
single cantilever beam on silicon
support chip



Arrow™ TL2
Tipless cantilever array,
two cantilever beams on single
crystal silicon support chip

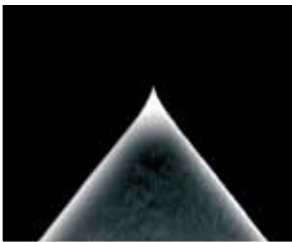


Arrow™ TL8
Tipless cantilever array, eight
cantilever beams on a single crystal
silicon support chip



PYREX-NITRIDE-AFM-PROBES

Leading edge in sharpness and durability



Pyrex-Nitride AFM probe Close-up



Pyrex-Nitride AFM probe
Triangular Cantilevers 3D Sketch



Pyrex-Nitride AFM probe
Rectangular (Diving Board) Cantilevers 3D Sketch

General

- SPM and AFM probe for a wide range of applications in contact mode or dynamic mode
- fits to all well-known commercial SPMs and AFMs
- silicon nitride cantilevers and tips
- cantilevers are supported by a support chip made of pyrex-glass
- delivered as separated single support chips for easy handling

Material Features

- low-stress silicon nitride for lowest cantilever bending
- excellent hardness for wear resistance and extended lifetime

Cantilevers

- multi-lever design with either four rectangular cantilevers or four triangular cantilevers
- reflective chromium/gold coating on the backside of the cantilevers
- stress compensated with bending below 2°

Support Chip

- support chips made of pyrex-glass (3.4 mm x 1.6 mm x 0.5 mm)
- easy handling due to single support chips

Tips

- oxide sharpened pyramidal probe tips
- tip height 3.5 μm and tip radius of curvature typically $< 10 \text{ nm}$
- macroscopic half-cone angles 35°

Package Sizes

- small packages of 20 and 50 scanning probes

AVAILABLE COATINGS

Gold Coating

- 65 nm thick chromium/gold coating on the backside of the cantilevers
- enhances reflectance of the laser beam
- 35 nm thick chromium/gold coating on both sides of the scanning probe

PYREX-NITRIDE-AFM-PROBES

Triangular Cantilevers (PNP-TR)

Diving Board Shaped Cantilevers (PNP-DB)



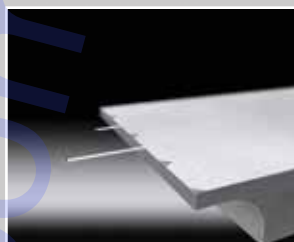
Triangular Cantilevers (PNP-TR)

- triangular shaped cantilevers
- multi-lever design
- 4 cantilevers per chip, 2 long and 2 short cantilevers
- reflective chromium/gold coating on the backside of the scanning probe
- available with chromium/gold coating on both sides of the probe
- available as tipless version with backside chromium/gold coating
- available as tipless version with chromium/gold coating on both sides

Cantilever #	1	2
Shape	Triangular	
Overall Thickness*	600 nm	600 nm
Length	100 μm	200 μm
Width	2 x 13.5 μm	2 x 28 μm
Force Constant	0.32 N/m	0.08 N/m
Resonance Frequency	67 kHz	17 kHz

*Overall cantilever thickness including coating.

Please note: The above given mechanical properties are typical values.



Diving Board Cantilevers (PNP-DB)

- rectangular diving board shaped cantilevers
- multi-lever design
- 4 cantilevers per chip, 2 long and 2 short cantilevers
- reflective chromium/gold coating on the backside of the cantilevers

Cantilever #	1	2
Shape	Rectangular	
Overall Thickness*	600 nm	600 nm
Length	100 μm	200 μm
Width	40 μm	40 μm
Force Constant	0.48 N/m	0.06 N/m
Resonance Frequency	67 kHz	17 kHz

*Overall cantilever thickness including coating.

Please note: The above given mechanical properties are typical values.



Pyrex-Nitride AFM Probe
Triangular Tipless Cantilevers



Pyrex-Nitride AFM Probe
Triangular Tipless Long Cantilever
Close-up



Pyrex-Nitride AFM Probe
Triangular Tipless Short Cantilever
Close-up

QUICK SELECTION TABLE

Application	Type	Coating Front Side	Coating Back Side	Tip Shape	Force Constant	Resonance Frequency	
Contact Mode	Arrow CONT	-	-	Arrow™	0.2 N/m	14 kHz	
	CONT	-	-	Pointprobe®	0.2 N/m	13 kHz	
	Arrow CONTR	-	Reflex (Al)	Arrow™	0.2 N/m	14 kHz	
	CONTR	-	Reflex (Al)	Pointprobe®	0.2 N/m	13 kHz	
	Arrow CONTPt	PtIr5	PtIr5	Arrow™	0.2 N/m	14 kHz	
	CONTPt	PtIr5	PtIr5	Pointprobe®	0.2 N/m	13 kHz	
Contact Mode (short cantilever)	CONTSC	-	-	Pointprobe®	0.2 N/m	25 kHz	
	CONTSCR	-	Reflex (Al)	Pointprobe®	0.2 N/m	25 kHz	
Contact Mode or TappingMode	PNP-TR (triangular cantilevers)	Cantilever 1	-	Reflex (Cr/Au)	0.32 N/m	67 kHz	
		Cantilever 2	-		0.08 N/m	17 kHz	
	PNP-TR-Au (triangular cantilevers)	Cantilever 1	Cr/Au	Cr/Au	Silicon nitride casted	0.32 N/m	67 kHz
		Cantilever 2				0.08 N/m	17 kHz
	PNP-DB (rectangular cantilevers)	Cantilever 1	-	Reflex (Cr/Au)		0.48 N/m	67 kHz
		Cantilever 2	-			0.06 N/m	17 kHz
Non-Contact / TappingMode (high frequency)	Arrow NC	-	-	Arrow™		42 N/m	285 kHz
	NCH	-	-	Pointprobe®		42 N/m	330 kHz
	Arrow NCR	-	Reflex (Al)	Arrow™	42 N/m	285 kHz	
	NCHR	-	Reflex (Al)	Pointprobe®	42 N/m	330 kHz	
	Arrow NCPt	PtIr5	PtIr5	Arrow™	42 N/m	285 kHz	
	NCHPt	PtIr5	PtIr5	Pointprobe®	42 N/m	330 kHz	
	SSS-NCH	-	-	SuperSharpSilicon™			
	AR5-NCHR	-	Reflex (Al)	High Aspect Ratio (5:1)			
	AR5T-NCHR (Tilt Compensated)	-	Reflex (Al)	High Aspect Ratio (5:1)			
	AR10-NCHR	-	Reflex (Al)	High Aspect Ratio (10:1)			
	DT-NCHR	Diamond	Reflex (Al)	Diamond			
	CDT-NCHR	Diamond	Reflex (Al)	Diamond			
Non-Contact/Soft-TappingMode	NCST	-	-	Pointprobe®	7.4 N/m	160 kHz	
	NCSTR	-	Reflex (Al)	Pointprobe®			
Non-Contact / TappingMode (long cantilever)	NCL	-	-	Pointprobe®	48 N/m	190 kHz	
	NCLR	-	Reflex (Al)				
	NCLPt	PtIr5	PtIr5				
	SSS-NCL	-	-	SuperSharpSilicon™			
	AR5-NCLR	-	Reflex (Al)	High Aspect Ratio (5:1)			
	DT-NCLR	Diamond	Reflex (Al)	Diamond			
CDT-NCLR	Diamond	Reflex (Al)	Diamond				
Non-Contact / TappingMode (Seiko Non-Contact Mode)	SEIHR	-	Reflex (Al)	Pointprobe®	15 N/m	130 kHz	
	SSS-SEIH	-	-	SuperSharpSilicon™			
Non-Contact / TappingMode (Ultra High Frequency)	Arrow UHF	-	Reflex (Al)	Arrow™	-	up to 1.5 MHz	
Force Modulation Mode	Arrow FM	-	-	Arrow™	2.8 N/m	75 kHz	
	FM	-	-	Pointprobe®			
	Arrow FMR	-	Reflex (Al)	Arrow™			
	FMR	-	Reflex (Al)	Pointprobe®			
	DT-FMR	Diamond	Reflex (Al)	Diamond			
	CDT-FMR	Diamond	Reflex (Al)	Diamond			
Electrostatic Force Microscopy	Arrow EFM	PtIr5	PtIr 5	Arrow™	2.8 N/m	75 kHz	
	EFM	PtIr5	PtIr5	Pointprobe®			
Magnetic Force Microscopy	MFMR	Hard magnetic	Reflex (Al)	Pointprobe®	2.8 N/m	75 kHz	
	S-MFMR	Soft magnetic	Reflex (Al)				
Tipless Cantilevers	Arrow TL1	1 cantilever	-	-	Tipless Silicon nitride	0.03 N/m	6 kHz
	Arrow TL1-Au	1 cantilever	Ti/Au	-			
	Arrow TL2	Array of 2 cantilevers	-	-			
	Arrow TL2-Au	Array of 2 cantilevers	Ti/Au	-			
	Arrow TL8	Array of 8 cantilevers	-	-			
	Arrow TL8-Au	Array of 8 cantilevers	Ti/Au	-			
	PNP-TR-TL	triangular cantilevers	Cantilever 1	-	Reflex (Cr/Au)	0.32 N/m	67 kHz
			Cantilever 2	-		0.08 N/m	17 kHz
	PNP-TR-TL-Au	triangular cantilevers	Cantilever 1	Cr/Au	Cr/Au	0.32 N/m	67 kHz
			Cantilever 2			0.08 N/m	17 kHz

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