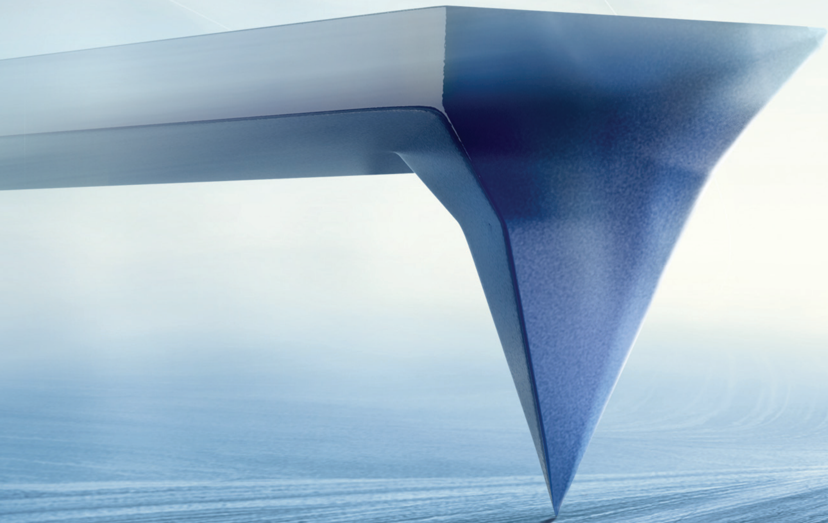
μmasch MikroMasch

SPM PROBES & TEST STRUCTURES

MikroMasch® product catalogue

2013



HQ probes

All MikroMasch® SPM Tips upgraded to new **HQ (high quality)** technology

- Tip sharpness better than 10 nm
- High Q-factor and smooth resonance curves
- Ideal reflectivity from the backside of the cantilever
- For the old non-HQ price

MikroMasch®
SPM Probes & Test Structures

www.spmtips.com

MikroMasch® Headquarters

Innovative Solutions Bulgaria Ltd.

48 Joliot Curie St.
1113 Sofia, Bulgaria
phone: +359 2 865-8629
fax: +359 2 963-0732
info@mikromasch.com
sales@mikromasch.com

MikroMasch® Europe

NanoAndMore GmbH

Spilburg Bld. A1,Steinbühlstrasse 7
D-35578 Wetzlar, Germany
Toll Free (EU): +8000 SPMTIPS (776-8477)
phone: + 49 6441-870-6272
fax: + 49 6441-870-6274
europe@mikromasch.com

MikroMasch® USA

NanoAndMore USA Corp.

9 James F. Byrnes Street
Lady's Island, SC 29907, USA
Toll Free (US): +1 866 SPMTIPS (776-8477)
phone: +1 843-521-1108
fax: +1 843-521-1148
usa@mikromasch.com

MikroMasch® Distributor

Improved HQ Probes

All MikroMasch probes have been upgraded to an improved design, called the HQ Line (High Quality Line).

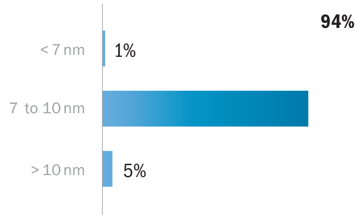
"HQ" is a new series of probes distinguished by their high quality and high repeatability of characteristics, available due to a brand new manufacturing process. In particular, the probes have much more consistent reflectivity from uncoated cantilevers, tip radius and quality factor compared to our former non-HQ probes. The chips also have cut corners that allow them to be used at an angle from the vertical.

Nominal characteristics of the premium quality probes are kept close to the former non-HQ MikroMasch product line. Described below are some of the main advantages of the improved HQ Probes.

RADIUS OF CURVATURE

The radius of curvature measures the sharpness of a particular probe. Typically, the sharper the curvature radius the more fragile a silicon tip is. Conversely, a larger curvature radius provides greater durability, but reduces the benefits of a sharper tip.

Achieving a consistent balance delivers reliable and accurate results. 94% of HQ probes have a radius of curvature between 7 and 10 nm.

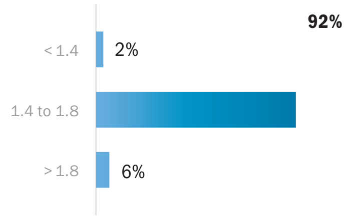


**for all standard, uncoated tips*

TIP SHAPE FACTOR

A higher value indicates a higher aspect ratio probe. A tighter range of values indicates a more consistent tip shape.

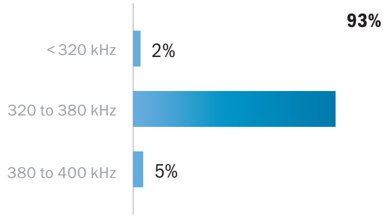
Results of the tip shape factor tests show consistent and close grouping of data. Known tip shape insures accuracy of results. 92% of HQ probes have an aspect ratio between 1.4 and 1.8.



**for all standard, uncoated tips*

RESONANCE FREQUENCY

Probes are designed to maintain a tight range of resonance frequencies. Reliability in cantilever specifications ensures dependable measurement results.



**NSC15 Probes*

The New HQ Line & Test Structures

Probe chip specifications 5

REGULAR

Noncontact and Contact silicon probes 6

TIPLESS

Noncontact and Contact Tipless silicon probes 8

LONG SCANNING / LIFETIME

Hardened DLC coated silicon probes 9

CONDUCTIVE

DPER: High Resolution Conductive silicon probes. 10

DPE: Low Noise Conductive silicon probes 11

Conductive Noncontact and Contact silicon probes 12

MAGNETIC

Magnetic Noncontact silicon probes 14

HIGH RESOLUTION

Hi'Res-C: High Resolution silicon probes 15

TEST STRUCTURES

TGXYZ Series Calibration standards 16

TGX Series Calibration standards 16

PA Series Calibration standards 17

HOPG. 17

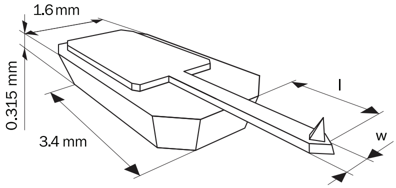
RECOMENDATIONS

Recommendations for specific applications 18

HQ:NSC/CSC 1-lever

Cantilever material	n-type silicon
Tip shape	pyramidal
Tip height	12 - 18 µm

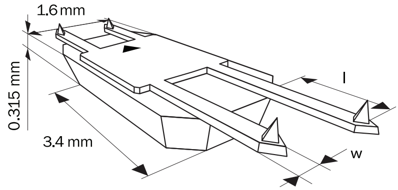
Series: 14, 15, 16, 17, 18, 19



HQ: 4-lever

Cantilever material	n-type silicon
Tip shape	pyramidal
Tip height	12 - 18 µm

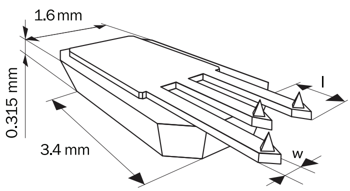
Series: XSC11



HQ:NSC 3-lever

Cantilever material	n-type silicon
Tip shape	pyramidal
Tip height	12 - 18 µm

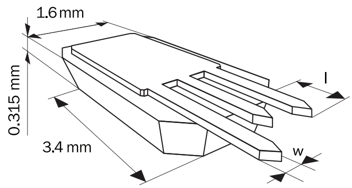
Series: 35, 36



HQ: NSC Tipless 3-lever

Cantilever material	n-type silicon

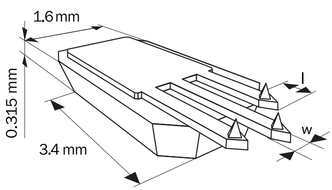
Series: 35,36 Tipless



HQ:CSC 3-lever

Cantilever material	n-type silicon
Tip shape	pyramidal
Tip height	12 - 18 µm

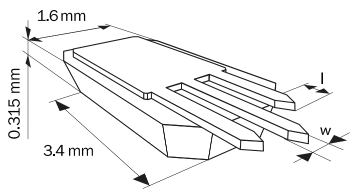
Series: 37, 38



HQ: CSC Tipless 3-lever

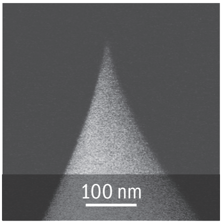
Cantilever material	n-type silicon

Series: 37, 38 Tipless



HQ: NSC, CSC & XSC

Noncontact (NSC), Contact (CSC) and 4-Lever (XSC) silicon probes



SEM image of the regular silicon tip

Pyramidal silicon etched probes* are characterized by high tip sharpness and narrow resonance peaks, making them very suitable for topography imaging in dynamic AFM modes and compositional mapping. These probes are available in a wide range of resonance frequencies and spring constants.

Tip properties:

Tip radius . . . . ~ **8 nm**
Tip material . . . . silicon

Backside coating:

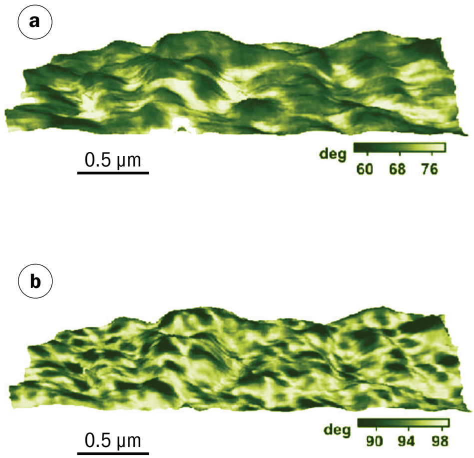
Al BS . . . . Al 30 nm
no Al . . . . none
Cr-Au BS . . . Au 30 nm on Cr 20 nm sublayer

Cantilever Series	Available Coatings	Length l, ±5 µm	Width w, ±3 µm	Thickness ±0.5 µm	Resonance Frequency kHz (typical)	(range)	Force Constant N/m (typical)	(range)
HQ:NSC14	/No Al, /Al BS	125	25	2.1	**160**	110 - 220	**5.0**	1.8 - 13
HQ:NSC15	/No Al, /Al BS, /Cr-Au BS	125	30	4.0	**325**	265 - 410	**40**	20 - 80
HQ:NSC16	/No Al, /Al BS	225	37.5	7.0	**190**	170 - 210	**45**	30 - 70
HQ:CSC17	/No Al, /Al BS	450	50	2.0	**13**	10 - 17	**0.18**	0.06 - 0.40
HQ:NSC18	/No Al, /Al BS, /Cr-Au BS	225	27.5	3.0	**75**	60 - 90	**2.8**	1.2 - 5.5
HQ:NSC19	/No Al, /Al BS	125	22.5	1.0	**65**	25 - 120	**0.5**	0.05 - 2.3
HQ:NSC35								
lever A	/No Al, /Al BS, /Cr-Au BS	110	35	2.0	**205**	130 - 290	**8.9**	2.7 - 24
lever B		90	35	2.0	**300**	185 - 430	**16**	4.8 - 44
lever C		130	35	2.0	**150**	95 - 205	**5.4**	1.7 - 14
HQ:NSC36								
lever A	/No Al, /Al BS, /Cr-Au BS	110	32.5	1.0	**90**	30 - 160	**1.0**	0.1 - 4.6
lever B		90	32.5	1.0	**130**	45 - 240	**2**	0.2 - 9
lever C		130	32.5	1.0	**65**	25 - 115	**0.6**	0.06 - 2.7
HQ:CSC37								
lever A	/No Al, /Al BS	250	35	2.0	**40**	30 - 55	**0.8**	0.3 - 2
lever B		350	35	2.0	**20**	15 - 30	**0.3**	0.1 - 0.6
lever C		300	35	2.0	**30**	20 - 40	**0.4**	0.1 - 1
HQ:CSC38								
lever A	/No Al, /Al BS	250	32.5	1.0	**20**	8 - 32	**0.09**	0.01 - 0.36
lever B		350	32.5	1.0	**10**	5 - 17	**0.03**	0.003 - 0.13
lever C		300	32.5	1.0	**14**	6 - 23	**0.05**	0.005 - 0.21
HQ:XSC11								
lever A	/No Al, /Al BS	500	30	2.7	**15**	12 - 18	**0.2**	0.1 - 0.4
lever B		210	30	2.7	**80**	60 - 100	**2.7**	1.1 - 5.6
lever C		150	30	2.7	**155**	115 - 200	**7**	3 - 16
lever D		100	50	2.7	**350**	250 - 465	**42**	17 - 90

** See specifications on page 5*

APPLICATION

Phase imaging is among the AFM techniques that can be used to determine nanoscale differences in the properties of a heterogeneous system or of samples with inherent heterogeneity. Phase contrast is dependent on interactions between the tip and the sample, but those interactions are in turn partially dependent on the scan parameters and whether the image is being taken in an attractive or repulsive mode. O'Dea and Burrato used phase imaging to map the proton-conducting domains of a Nafion membrane. They found that the specific interaction forces between the tip and the sample significantly affected the resolution of the proton conducting domains. Imaging in a repulsive regime resulted in an overestimation of the area of the domains and an underestimation in the number of domains. Imaging in an attractive regime resulted in the most accurate phase imaging of the aqueous and fluorocarbon domains of the membrane. When the feedback loop was not optimized or the cantilever was driven above resonance, the phase corresponded with changes in topography rather than changes in the composition of the sample.



In figures (a) and (b) the phase data from repulsive and attractive regimes, respectively, have been overlaid on the corresponding topography image. Features of the phase contrast in the repulsive regime correspond to some features in the topography, while the phase contrast in the attractive regime is independent of the topography. Images were taken with the NSC15/AlBS (now upgraded to HQ:NSC15/Al BS).

(O'Dea, J.R. and Burrato, S.K.; J. Phys. Chem. B 2011, 115, 1014-1020.)

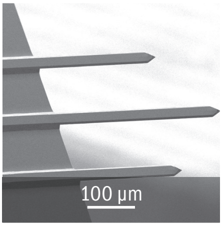
PART NUMBER **HQ: * SC * / * / ***

N, C, X	type
11, 14, 15, 16, 17, 18, 19, 35, 36	series
15, 50, 100, 200, 400	quantity*
/No Al, /Al BS, /Cr-Au BS	coating

** Please refer to our pricelist for available package sizes.*

Tipless Cantilevers

Tipless Noncontact (NSC) and Contact (CSC) three-lever silicon probes



SEM image of a tipless silicon cantilever

Probes of the Tipless Series feature 3 tipless cantilevers* with different spring constants and resonance frequencies on one side of the chip. This series replaces the former 12 Series.

Backside coating:

Al BS. Al 30 nm

no Al . . . . no

Cr-Au coated

Au overall coating . . . . 30 nm

Cr overall sublayer. . . . . 20 nm

Cantilever Series	Available Coatings	Length l, ± 5 µm	Width w, ± 3 µm	Thickness ±0.5 µm	Resonance Frequency kHz (typical)	(range)	Force Constant N/m (typical)	(range)
HQ:NSC35/Tipless								
lever A	/No Al, /Al BS, /Cr-Au	110	35	2.0	**205**	130 - 290	**8.9**	2.7 - 24
lever B		90	35	2.0	**300**	185 - 430	**16**	4.8 - 44
lever C		130	35	2.0	**150**	95 - 205	**5.4**	1.7 - 14
HQ:NSC36/Tipless								
lever A	/No Al, /Al BS, /Cr-Au	110	32.5	1.0	**90**	30 - 160	**1.0**	0.1 - 4.6
lever B		90	32.5	1.0	**130**	45 - 240	**2**	0.2 - 9
lever C		130	32.5	1.0	**65**	25 - 115	**0.6**	0.06 - 2.7
HQ:CSC37/Tipless								
lever A	/No Al, /Al BS	250	35	2.0	**40**	30 - 55	**0.8**	0.3 - 2
lever B		350	35	2.0	**20**	15 - 30	**0.3**	0.1 - 0.6
lever C		300	35	2.0	**30**	20 - 40	**0.4**	0.1 - 1
HQ:CSC38/Tipless								
lever A	/No Al, /Al BS	250	32.5	1.0	**20**	8 - 32	**0.09**	0.01 - 0.36
lever B		350	32.5	1.0	**10**	5 - 17	**0.03**	0.003 - 0.13
lever C		300	32.5	1.0	**14**	6 - 23	**0.05**	0.005 - 0.21

** See specifications on page 5*

APPLICATION

Tipless cantilevers can be used for measurements of material properties and interactions. Different objects such as glass spheres or polystyrene particles can also be mounted on tipless cantilevers to make them applicable for AFM-like experiments.

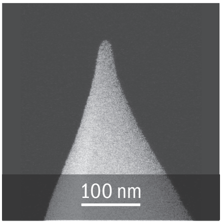
PART NUMBER **HQ: * SC * / Tipless / * / ***

N, C	type
35, 36, 37, 38	series
15, 50, 100, 200, 400	quantity*
/No Al, /Al BS, /Cr-Au	coating

** Please refer to our pricelist for available package sizes.*

Series HARD

Hardened DLC coated silicon probes



SEM image of the HARD tip

The HARD series silicon etched probe* tips have pyramidal shape. The probes are coated with a hard DLC film. The backside of the cantilevers is coated with the 30 nm aluminium reflective film.

Typical tip radius . . . . < 20 nm
Tipside coating . . . . DLC 20 nm
Backside coating. . . . . Al 30 nm

Cantilever Series	Available Coatings	Length l, ±5 µm	Width w, ±3 µm	Thickness ±0.5 µm	Resonance Frequency kHz (typical)	(range)	Force Constant N/m (typical)	(range)
HQ:NSC14	/Hard/Al BS	125	25	2.1	**160**	110 - 220	**5.0**	1.8 - 13
HQ:NSC15	/Hard/Al BS	125	30	4.0	**325**	265 - 410	**40**	20 - 80
HQ:NSC16	/Hard/Al BS	225	37.5	7.0	**190**	170 - 210	**45**	30 - 70
HQ:CSC17	/Hard/Al BS	450	50	2.0	**13**	10 - 17	**0.18**	0.06 - 0.40
HQ:NSC35								
lever A	/Hard/Al BS	110	35	2.0	**205**	130 - 290	**8.9**	2.7 - 24
lever B		90	35	2.0	**300**	185 - 430	**16**	4.8 - 44
lever C		130	35	2.0	**150**	95 - 205	**5.4**	1.7 - 14
HQ:NSC36								
lever A	/Hard/Al BS	110	32.5	1.0	**90**	30 - 160	**1.0**	0.1 - 4.6
lever B		90	32.5	1.0	**130**	45 - 240	**2**	0.2 - 9
lever C		130	32.5	1.0	**65**	25 - 115	**0.6**	0.06 - 2.7
HQ:XSC11								
lever A	/Hard/Al BS	500	30	2.7	**15**	12 - 18	**0.2**	0.1 - 0.4
lever B		210	30	2.7	**80**	60 - 100	**2.7**	1.1 - 5.6
lever C		150	30	2.7	**155**	115 - 200	**7**	3 - 16
lever D		100	50	2.7	**350**	250 - 465	**42**	17 - 90

** See specifications on page 5*

APPLICATION

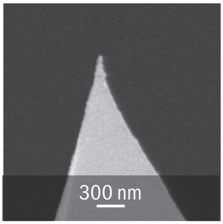
The wear-resistant diamond-like carbon (DLC) coating increases tip durability and lifetime. DLC coated probes are useful for scanning large areas and very hard materials.

PART NUMBER **HQ: * SC * / Hard / Al BS / ***

N, X	type
15, 50	quantity
11, 14, 15, 16, 17, 35, 36	series

DPER

High Resolution Conductive silicon probes



SEM image of the DPER silicon tip

DPER probes* are made by depositing a thin platinum coating on silicon tips. While the thickness of the coating on a flat cantilever surface is about 15 nm, there is only a 10 nm increase in the tip dimensions compared to bare silicon probes. These probes are recommended for electrical applications requiring higher resolution.

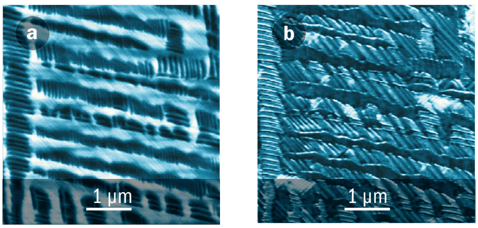
Pt coated resulting tip radius. . . . < 20 nm
Pt overall coating. . . . . 15 nm

Cantilever Series	Length l, ±5 µm	Width w, ±3 µm	Thickness ±0.5 µm	Resonance Frequency kHz (typical)	(range)	Force Constant N/m (typical)	(range)
HQ:DPER-XSC11							
lever A	500	30	2.7	**15**	12 - 18	**0.2**	0.1 - 0.4
lever B	210	30	2.7	**80**	60 - 100	**2.7**	1.1 - 5.6
lever C	150	30	2.7	**155**	115 - 200	**7**	3 - 16
lever D	100	50	2.7	**350**	250 - 465	**42**	17 - 90

** See specifications on page 5*

APPLICATION

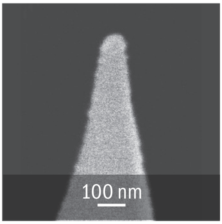
Topography (a) and in-plane piezoelectric force response (b) images of an approximately 80 nm thick $BiFeO_3$ film grown on a $LaAlO_3$ substrate taken with a DPER18 probe (now replaced by HQ:DPE-XSC11).
Image courtesy of Zuhuang Chen, Nanyang Technological University.



PART NUMBER	HQ: DPER - XSC11 / *	15, 50, 100	quantity

DPE

Low Noise Conductive silicon probes



SEM image of the DPE silicon tip

The DPE probes* feature silicon tips and a special structure of conductive layers, which provides a more stable electrical signal and less noise. However, some reduction in resolution for topography images is possible when using DPE probes due to the increased tip radius.

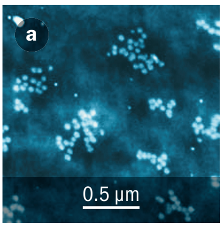
Pt coated resulting tip radius . . . . < 40 nm
Pt overall coating. . . . . 50 nm

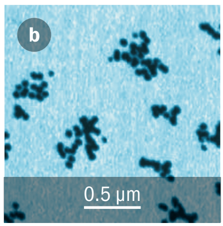
Cantilever Series	Length l, ± 5 µm	Width w, ± 3 µm	Thickness ± 0.5 µm	Resonance Frequency kHz (typical)	Resonance Frequency kHz (range)	Force Constant N/m (typical)	Force Constant N/m (range)
HQ:DPE-XSC11							
lever A	500	30	2.7	**15**	12 - 18	**0.2**	0.1 - 0.4
lever B	210	30	2.7	**80**	60 - 100	**2.7**	1.1 - 5.6
lever C	150	30	2.7	**155**	115 - 200	**7**	3 - 16
lever D	100	50	2.7	**350**	250 - 465	**42**	17 - 90

** See specifications on page 5*

APPLICATION

DPE probe topography (a) and surface potential (b) images of a fluoroalkane ($F_{12}H_{20}$) on a Silicon substrate.
Image was taken using single-pass KFM with an Agilent 5500 by S. Magonov.

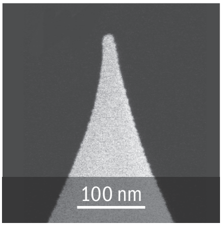




PART NUMBER	HQ: DPE - XSC11 / *	15, 50, 100	quantity

Pt and Cr-Au Coated

Conductive Noncontact (NSC), Contact (CSC) and 4-Lever (XSC) silicon probes



SEM image of the conducting silicon tip

Pyramidal silicon etched probes* with conductive platinum or gold coatings are suitable for a wide range of electrical applications of AFM. Gold and platinum coatings are inert, which makes these probes applicable for many experiments in biology and chemistry.

Pt coated resulting tip radius . . . . < 30 nm
Pt overall coating. . . . . 30 nm

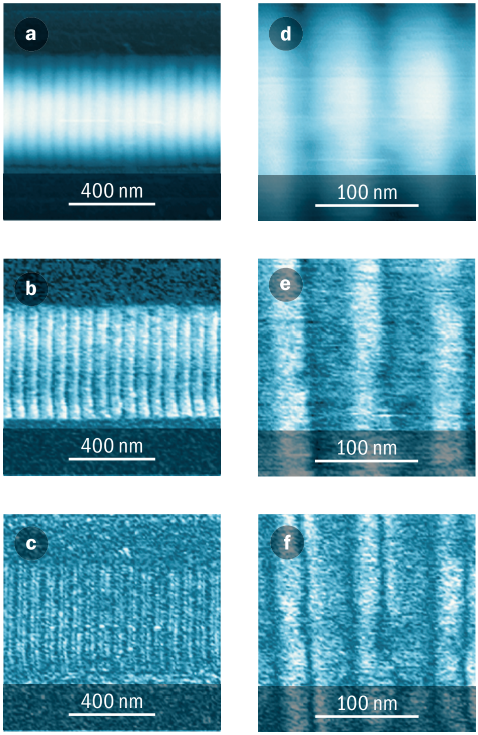
Cr-Au coated resulting tip radius < 35 nm
Au overall coating . . . . 30 nm
Cr overall sublayer . . . . 20 nm

Cantilever Series	Available Coatings	Length l, ±5 µm	Width w, ±3 µm	Thickness ±0.5 µm	Resonance Frequency kHz (typical)	Resonance Frequency kHz (range)	Force Constant N/m (typical)	Force Constant N/m (range)
HQ:NSC14	/Cr-Au, /Pt	125	25	2.1	**160**	110 - 220	**5.0**	1.8 - 13
HQ:NSC15	/Cr-Au, /Pt	125	30	4.0	**325**	265 - 410	**40**	20 - 80
HQ:NSC16	/Cr-Au,	225	37.5	7.0	**190**	170 - 210	**45**	30 - 70
HQ:CSC17	/Cr-Au, /Pt	450	50	2.0	**13**	10 - 17	**0.18**	0.06 - 0.40
HQ:NSC18	/Cr-Au, /Pt	225	27.5	3.0	**75**	60 - 90	**2.8**	1.2 - 5.5
HQ:NSC19	/Cr-Au	125	22.5	1.0	**65**	25 - 120	**0.5**	0.05 - 2.3
HQ:NSC35								
lever A	/Cr-Au, /Pt	110	35	2.0	**205**	130 - 290	**8.9**	2.7 - 24
lever B		90	35	2.0	**300**	185 - 430	**16**	4.8 - 44
lever C		130	35	2.0	**150**	95 - 205	**5.4**	1.7 - 14
HQ:NSC36								
lever A	/Cr-Au, /Pt	110	32.5	1.0	**90**	30 - 160	**1.0**	0.1 - 4.6
lever B		90	32.5	1.0	**130**	45 - 240	**2**	0.2 - 9
lever C		130	32.5	1.0	**65**	25 - 115	**0.6**	0.06 - 2.7
HQ:CSC37								
lever A	/Cr-Au, /Pt	250	35	2.0	**40**	30 - 55	**0.8**	0.3 - 2
lever B		350	35	2.0	**20**	15 - 30	**0.3**	0.1 - 0.6
lever C		300	35	2.0	**30**	20 - 40	**0.4**	0.1 - 1
HQ:CSC38								
lever A	/Cr-Au	250	32.5	1.0	**20**	8 - 32	**0.09**	0.01 - 0.36
lever B		350	32.5	1.0	**10**	5 - 17	**0.03**	0.003 - 0.13
lever C		300	32.5	1.0	**14**	6 - 23	**0.05**	0.005 - 0.21
HQ:XSC11								
lever A	/Pt	500	30	2.7	**15**	12 - 18	**0.2**	0.1 - 0.4
lever B		210	30	2.7	**80**	60 - 100	**2.7**	1.1 - 5.6
lever C		150	30	2.7	**155**	115 - 200	**7**	3 - 16
lever D		100	50	2.7	**350**	250 - 465	**42**	17 - 90

* See specifications on page 5

APPLICATION

AFM is capable of mapping different electric properties of materials to topography images. These data can be used for analysis of the structure and composition of heterogeneous samples as well as for quantitative characterization of individual grains or defects on the surface. Electric properties of a sample can be mapped using probes with conducting coatings, when AC or DC bias is applied between the tip and the sample. Contact mode or two-pass operation techniques can be used for this purpose.



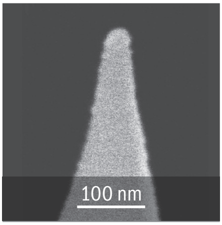
Although traditional piezoelectric and ferroelectric materials are often the samples studied using piezoresponse force microscopy, Minary-Jolandan and Yu showed that the electromechanical properties of collagen fibrils can also be investigated with PFM. They found via high resolution PFM with a Pt coated CSC17 probe (now upgraded to HQ:CSC17/Pt) that collagen fibrils have piezoelectrically heterogeneous gap and overlap regions. The gap regions exhibit little to no piezoelectricity, while the overlap regions show piezoelectricity. Images (a) and (d) show the topography of the collagen fibril, while (b) and (e) show the PFM amplitude. (c) and (f) are the 2ω signal measured to rule out any electrostatic interference with the PFM signal. The Pt only coating on the CSC17 probe (now upgraded to HQ:CSC17/Pt) allowed for the resolution of features ~30 nm. (Minary-Jolandan, M. and Yu, M.-F.; ACS Nano 2009, 3, 1859-1863.)

PART NUMBER HQ: * SC * / * / *

N, C, X	type
11, 14, 15, 16, 17, 18, 19, 35, 36	series
15, 50, 100	quantity
/Cr-Au, /Pt	coating

Co-Cr Coated

Magnetic Noncontact (NSC) silicon probes



SEM image of the magnetic silicon tip

Two HQ:NSC probe* models are available with a special coating for Magnetic Force Microscopy. The coating consists of a 60 nm cobalt layer on both the tipside and backside and is protected from oxidation with a 20 nm chromium film. The cantilever parameters are optimized for stable measurements of topography and magnetic properties.

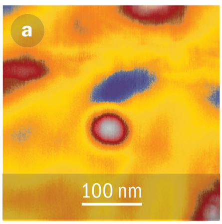
Co-Cr coated tip . . . . **< 60 nm**
Co tipside coating . . . . 60 nm
Cr tipside coating . . . . 20 nm
Backside Al coating. . . . . 30 nm
Coercitivity . . . . .300—400 Oe

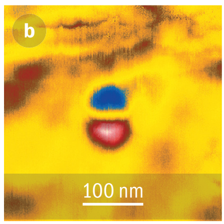
Cantilever Series	Available Coatings	Length l, ±5 µm	Width w, ±3 µm	Thickness ±0.5 µm	Resonance Frequency kHz (typical)	(range)	Force Constant N/m (typical)	(range)
HQ:NSC18	/Co-Cr/Al BS	225	27.5	3.0	**75**	60 - 90	**2.8**	1.2 - 5.5
HQ:NSC36								
lever A	/Co-Cr/Al BS	110	32.5	1.0	**90**	30 - 160	**1.0**	0.1 - 4.6
lever B		90	32.5	1.0	**130**	45 - 240	**2**	0.2 - 9
lever C		130	32.5	1.0	**65**	25 - 115	**0.6**	0.06 - 2.7

** See specifications on page 5*

APPLICATION

Topography (a) and magnetic (b) images of a Co mono domain particle obtained in Lift Mode using a NSC36 series cantilever with Co-Cr coating (now upgraded to HQ:NSC36/Co-Cr/Al BS). Image courtesy of Prof. V. Shevyakov, MIET.

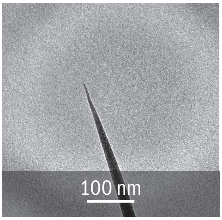




PART NUMBER	HQ: NSC * / Co-Cr / Al BS / *	18,36	series
		15, 50	quantity

Hi'Res-C

High Resolution silicon probes



SEM image of the Hi'Res-C spike

The Hi'Res-C probes* suffer less contamination than silicon probes and are capable of obtaining many high-resolution scans, although they do require special care in use. Due to the small tip curvature radius, the tip-sample attraction force is minimized.

Advantages of Hi'Res-C are noticeable when scanning small areas (< 250 nm) and flat samples (R_a < 20 nm). On larger images, the resolution is similar to that of General Purpose probes.

Spike radius . . . . **< 1 nm**
Spike height . . . . 100 - 200 nm
Spike material . . . . diamond-like

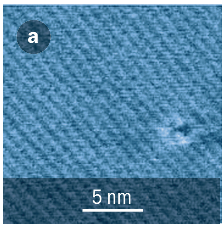
Overall coating:
Au overall coating . . . . 30 nm
Cr overall sublayer . . . . 20 nm
The coating does not cover the spike!

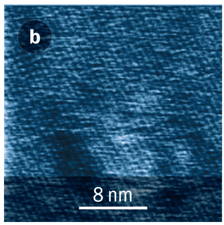
Cantilever Series	Available Coatings	Length l, ±5 μm	Width w, ±3 μm	Thickness ±0.5 μm	Resonance Frequency kHz (typical)	Resonance Frequency kHz (range)	Force Constant N/m (typical)	Force Constant N/m (range)
Hi'Res-C14	/Cr-Au	125	25	2.1	**160**	110 - 220	**5.0**	1.8 - 13
Hi'Res-C15	/Cr-Au	125	30	4.0	**325**	265 - 410	**40**	20 - 80
Hi'Res-C19	/Cr-Au	125	22.5	1.0	**65**	25 - 120	**0.5**	0.05 - 2.3

** See specifications on page 5*

APPLICATION

The advantages of the Hi'Res-C probes are noticeable on scans less than 250 nm in size. The tip radius of 1 nm allows high resolution imaging of nanometer-sized objects like single molecules, ultrathin films, and porous materials in air.



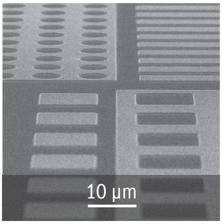


(a) Height image of polydiacetylene crystal obtained with Dimension 5000 SPM microscope and Hi'Res-C probe. Scan size 15 nm. A single defect in the molecular lattice of PDA crystal is visible. (b) Height image of PDA crystal obtained with Agilent 5500 SPM microscope and Hi'Res-C14 probe. Scan size 23 nm. Molecular lattice of PDA is observed only.

Images courtesy of Dr. S. Magonov, Agilent Technologies.

PART NUMBER	Hi'Res - C * / Cr-Au / *		
		14, 15, 19	series
		5, 15	quantity

TGXYZ Series



SEM image of a TGXYZ02 grating

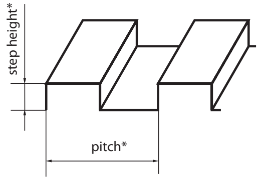
Calibration gratings from the TGXYZ series are arrays of different structures comprising rectangular silicon dioxide steps on a silicon wafer. The small square in the center with dimensions 500 µm by 500 µm includes circular pillars and holes, as well as lines in the X- and Y-direction with a pitch of 5 µm. The large square with dimensions 1 mm by 1 mm contains square pillars and holes with a pitch of 10 µm.

Active area . . . . 1 x 1 mm

Chip dimensions . . . . .5 x 5 x 0.3 mm

Part number	Step height*	Height accuracy	Pitch	Accuracy
TGXYZ01	20 nm	2%	5 and 10 µm	0.1 µm
TGXYZ02	100 nm	3%	5 and 10 µm	0 .1 µm
TGXYZ03	500 nm	3%	5 and 10 µm	0.1 µm

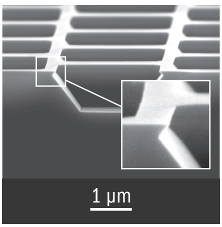
*The dimensions marked * are given for reference only. The actual step height, shown on the label of the individual grating box may differ slightly from the nominal value.*



APPLICATION

The TGXYZ calibration gratings are intended for vertical and lateral calibration of SPM scanners. The vertical non-linearity can be compensated for by using several calibration gratings with different nominal step heights.

TGX Series



SEM image of a TGX01 grating

The silicon calibration grating TGX is an array of square holes with sharp undercut edges formed by the (110) crystallographic planes of silicon. The typical radius of the edges is less than 5 nm.

Part number . . . . TGX

Active area . . . . 1 x 1 mm

Chip dimensions . . . . 5 x 5 x 0.3 mm

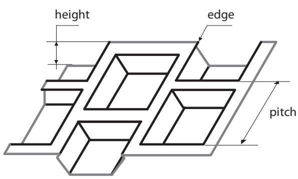
Edge radii . . . . < 5 nm

Pitch . . . . 3 µm

Pitch accuracy . . . . 0.1 µm

Step height* . . . . 1 µm

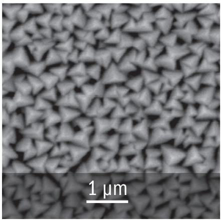
*The dimensions marked * are given for reference only.*



APPLICATION

TGX calibration gratings are intended for determination of the tip aspect ratio and for lateral calibration of SPM scanners. The gratings can also be used for detection of lateral non-linearity, hysteresis, creep, and cross-coupling effects.

PA Series



SEM image of a PA01 structure
Scan size 1 µm

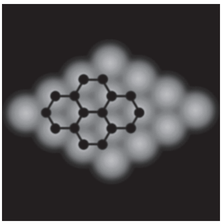
Sample for characterization of tip shape with hard sharp pyramidal nanostructures. The structures are covered by a highly wear-resistant layer.

Part number	**PA01**
Pyramid base	50 - 100 nm
Pyramid height	50 - 150 nm
Smallest edge radii	< 5 nm
Active area	5 x 5 mm
Chip dimensions	5 x 5 x 0.3 mm

APPLICATION

The exact shape of the scanning probe tip is very important for obtaining AFM images of high quality and accuracy. As new AFM tips with nanometer radii of curvature become widespread, periodic structures that have surface features of similar or greater sharpness should be used to estimate the parameters of the tip.

HOPG



Typical STM image of HOPG with superimposed graphene structure

Highly ordered pyrolytic graphite (HOPG) is a lamellar material and consists of stacked planes. Carbon atoms within a single plane interact more strongly than with those in adjacent planes. Each atom within a plane has three nearest neighbors, resulting in a honeycomb-like structure. This two-dimensional single-atom thick plane is called graphene.

Density	2.266 g/cm^3
Thermal conductivities:	
thermal conductivity parallel (002)	1700 ± 100 W/(m·K)
thermal conductivity perpendicular (002)	8 ± 1 W/(m·K)
electrical conductivity parallel (002)	2.1 ± 0.1 x 10^6 [(Ω·m)$^{-1}$]
electrical conductivity perpendicular (002)	5 x 10^2 [(Ω·m)$^{-1}$]

There are several grades of single - or doublesided HOPG with thickness 1 mm or more:

	ZYA Grades ▼	**ZYB Grades** ▼	**ZYH Grades** ▼
Mosaic spread	0.4° ± 0.1°	0.8° ± 0.2°	3.5° ± 0.5°

APPLICATION

HOPG terminated with a graphene layer can serve as an ideal atomically flat surface to be used as a substrate or standard for SPM investigations. This is also an easily “cleavable” material with a smooth surface, which is vital for SPM measurements that require a uniform, flat and clean substrate.

	Probe Type	Characteristics	f_o, N/m	*k*, kHz	Tip Material, Coating	R_{tip}, nm
Materials characterization	HQ:NSC18	Force modulation	~2.8	~75	Silicon, Al or no Al backside coating	~8
	HQ:NSC14	Phase imaging	~5.0	~150	Silicon, Al or no Al backside coating	~8
General topology imaging	HQ:NSC17	Contact imaging	~0.18	~13	Silicon, Al or no Al backside coating	~8
	HQ:NSC15	Intermittent/non-contact Imaging	~40	~325	Silicon, Al or no Al backside coating	~8
	HQ:NSC14	Intermittent contact imaging	~5.0	~150	Silicon, Al or no Al backside coating	~8
Topology imaging for life science	HQ:NSC14	Intermittent contact imaging	~5.0	~150	Silicon, Al or no Al backside coating	~8
	HQ:NSC18/ Cr-AuBS	Intermittent contact imaging in fluid	~2.8	~75	Silicon, Au backside coating	~8
	HQ:NSC18/Cr-AuBS	Contact imaging in fluid	~2.8	~75	Silicon, Au backside coating	~8
	HQ:CSC17	Contact imaging	~0.18	~13	Silicon, Al or no Al backside coating	~8
	HQ:CSC38 (three lever)	Contact imaging	~0.09 ~0.03 ~0.05	~20 ~10 ~14	Silicon, Al or no Al backside coating	~8
	Hi'Res-C14/Cr-Au	High resolution Imaging	~5.0	~160	Carbon spike, Al backside coating	~1
	HQ:NSC36 (three lever)	Intermittent contact imaging	~1.0 ~2.0 ~0.6	~90 ~130 ~65	Silicon, Al or no Al backside coating	~8
Probes for mechanical property measurements in Life Science	HQ:NSC14/Hard	Specially coated for durability	~5.0	~160	DLC coating, Al back-side coating	<20
	HQ:NSC18	Force modulation	~2.8	~75	Silicon, Al or no Al backside coating	~8
	HQ:CSC17/Cr-Au	Chemical inertness, functionalization	~0.18	~13	Cr-Au coating on both sides	<35
Probes for high resolution imaging	Hi'Res-C14/Cr-Au	Nanometer-sized objects like single molecules, ultrathin films, and porous materials in air	~5.0	~160	Carbon spike, Cr-Au coating on both sides (spike not coated)	~1
Electrical applicatons in vacuum	HQ:DPER/XS11, Cantilever A	High resolution	~0.2	~15	Pt coating on both sides	<20
	HQ:DPE/XSC11, Cantilever A	High sensitivity, low wear	~0.2	~15	Pt coating on both sides	<40

f_o – Force constant; *k* – Resonance frequency

	Probe Type	Characteristics	f_o, N/m	*k*, kHz	Tip Material, Coating	R_{tip}, nm
Electrical applications for PFM, TUNA, SCM, SSRM	HQ:DPER/XSC11, Cantilever C	High resolution	~7	~155	Pt coating on both sides	<20
	HQ:DPE/XSC11, Cantilever C	Dynamic/contact electrical mode, high sensitivity, low wear	~7	~155	Pt coating on both sides	<40
	HQ:CSC17/Cr-Au	Chemical inertness, functionalization	~0.15	~12	Cr-Au coating on both sides	<35
	HQ:NSC19/Pt	Dynamic/contact electrical mode	~0.5	~65	Pt coating on both sides	<30
Electrical applications for EFM, SKPM, Voltage Modulation, Scanning Impedance Microscopy, SGM	HQ:DPER/XSC11, Cantilever C	High resolution	~7	~155	Pt coating on both sides	<20
	HQ:DPE/XSC11, Cantilever C	Dynamic/contact electrical mode, high sensitivity, low wear	~7	~155	Pt coating on both sides	<40
	NSC14/Pt	General stability in conductive modes	~7	~155	Pt coating on both sides	<30
	NSC14/Cr-Au	Chemical inertness, functionalization	~7	~155	Cr-Au coating on both sides	<35
	HQ:DPER/XSC11, Cantilever B	High resolution	~2.7	~80	Pt coating on both sides	<20
	HQ:DPE/XSC11, Cantilever B	High sensitivity, low wear	~2.7	~80	Pt coating on both sides	<40
	NSC18/Pt	General stability in conductive modes	~2.8	~75	Pt coating on both sides	<30
	NSC18/Cr-Au	Chemical inertness, functionalization	~2.8	~75	Cr-Au coating on both sides	<35
Magnetic force microscopy	HQ:NSC18/Co-Cr/Al BS	Magnetic coating	~2.8	~75	Co-Cr coating, Al backside coating	<90

f_o – Force constant; *k* – Resonance frequency

Contacts

Toll Free (US): +1 866 SPMTIPS (776-8477)
Toll Free (EU): +8000 SPMTIPS (776-8477)
Headquarters: +359 2 865-8629
E-mail: sales@mikromasch.com
Skype: mikromaschsupport

www.mikromasch.com

www.spmtips.com

MikroMasch® Headquarters
Innovative Solutions Bulgaria Ltd.
48, Joliot Curie Str.
1113 Sofia, Bulgaria
phone: +359 2 865-8629
fax: +359 2 963-0732
sales@mikromasch.com
info@mikromasch.com

MikroMasch® Europe
NanoAndMore GmbH
Spilburg Bld. A1,Steinbühlstrasse 7
D-35578 Wetzlar, Germany
Toll Free (EU): +8000 SPMTIPS (776-8477)
phone: + 49 6441-870-6272
fax: + 49 6441-870-6274
europe@mikromasch.com

MikroMasch® USA
NanoAndMore USA Corp.
9 James F. Byrnes Street
Lady's Island, SC 29907, USA
Toll Free (US): +1 866 SPMTIPS (776-8477)
phone: +1 843-521-1108
fax: +1 843-521-1148
usa@mikromasch.com