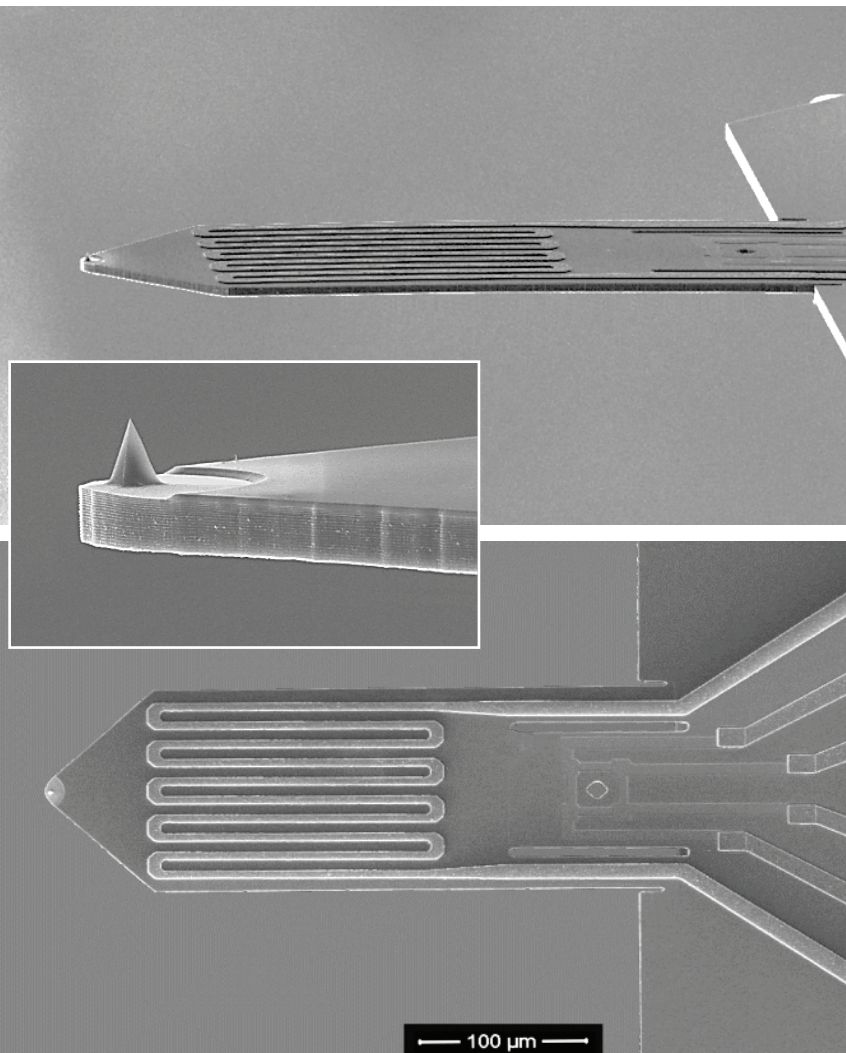


Silicon probes with integrated piezoresistive read-out and thermomechanical actuation



Probes with piezoresistive read-out enable reproducible atomic-resolution imaging. The thermomechanical actuator* integrated “on the probe” is suitable for excitation of the cantilever in its resonance frequency actuation and a static displacement without interference to the mechanical AFM-setup. An integration of on-probe force delivery based on thermomechanical excitation makes up to seven or more eigen-modes operation possible.

The piezoresistive Wheatstone bridge configuration of the read-out and the unique design enable effective temperature and actuator crosstalk compensation.

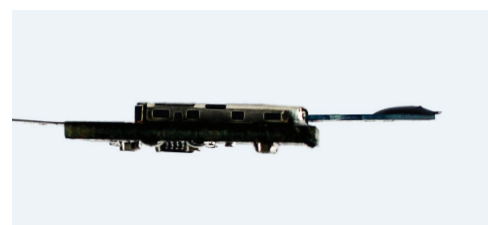
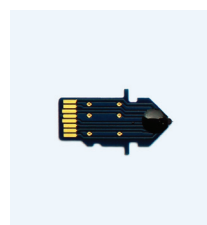
Thermomechanical actuation is based on multi-layer structures composed of diverse thin film layers. Different coefficients of thermal expansion between the layers result in bending of the cantilever by means of differential extension of composite layers. In the context, the displacement of the cantilever tip can be precisely controlled by the dissipated electrical power in the embedded thin-film metallic resistor.

nano analytik GmbH developed for its customers a series of small form-factor preamplifiers with high-bandwidth and low-noise performance, suitable for fast AFM applications. The preamplifier module has a small mass and can be integrated in any AFM-head in sample- and cantilever-scanning configuration.

Patent: US2005225011 – 2005-10-13*

Patent: 202014004190.3**

Cantilever* holder** with analog-front-end



Cantilever holder with integrated first-stage amplifier and flat-cable:
 Type AFM 26 (120mm length)
 Type AFM 27 (90mm length)
 PCB dimensions (mm) 23 x 22

Cantilever on PCB

Cantilever holder side view.
 Thickness of preamplifier 4.5mm



Cantilever

Parameter	RS3AP 1	RS3AP 2	RS3AP 3
	Contact Mode Non- Contact or Tapping Mode	Non- Contact or Tapping Mode	Non- Contact / Tapping Mode (high frequency)
Integrated piezoresistive Wheatstone bridge	■	■	■
Thermomechanical actuation	■	■	■
Resonance frequency [KHz]	50 +/-12%	70 +/-10%	90 +/-8%
Spring constant [N/m]	10 +/-15%	28 +/-20%	60 +/-20%
Deflection sensitivity (Bridge voltage 2.5V)	3µV/nm	5µV/nm	10µV/nm
Force responsivity [µV/nN]	0.36 +/-20%	0.27 +/-20%	0.15 +/-20%
Probe length/width [µm]	350+/-3; 140+/-2	350+/-3; 140+/-2	350+/-3; 140+/-2
Probe thickness [µm]	4 +/-1	6 +/-1	7 +/-1
Silicon tip height [µm]	4.5 +/-10%	4.5 +/-10%	4.5 +/-10%
Silicon tip radius (guaranteed) [nm]	<10	<10	<10
Distance of tip to the cantilever edge [µm]	3 +/- 0.5	3 +/- 0.5	3 +/- 0.5
Chip-size [mm]	3 x 1.5	3 x 1.5	3 x 1.5
Electrical connections via PCB-board	■	■	■
PCB-board dimensions [mm]	25 x 15 x 0.6	25 x 15 x 0.6	25 x 15 x 0.6
Quick probe exchange kit	■	■	■

standard features
 available on request
 - not available

First-stage amplifier

Second-stage amplifier

Electrical parameters	Value / description
Gain	10, 100, 1000 (fixed, selectable by the customer)
Bandwidth	4 MHz @ Gain = 10 500 kHz @ Gain = 100 60 kHz @ Gain = 1000
Input voltage noise density	12 nV / Hz ^{1/2} @ Gain = 10 11 nV / Hz ^{1/2} @ Gain = 100
Input current noise density	5pA / Hz ^{1/2}
Total input RMS voltage noise	26 uV @ Gain = 10, BW 4 MHz 9 uV @ Gain = 100, BW 500 kHz
Total input RMS noise with 2.5kOhm cantilever bridge connected	39 uV @ Gain = 10, BW 4 MHz 14 uV @ Gain = 100, BW 500kHz
Power supply	+ / - 5V DC

Electrical parameters	Value / description
AC Amplifier	Fixed gain 10 Bandwidth 10 MHz
DC amplifier	Fixed gain 10 Bandwidth 7 kHz
Bridge supply	Programmable current source 0 ... -1mA, 12-bit resolution
Bridge supply feedback	12 bits (10 bits optional)
DC offset compensation	- 0.5 Vref ... + 0.5 Vref 12-bit resolution Programmable Vref 0 ... 2.5V
Interface	RS232, mod-bus protocol Programming JTAG interface
Power supply	+/- 7.5V DC ... +/- 12V DC

AFM starter set

nano analytik GmbH can supply you with all needed components to set up your own active cantilever AFM.

The AFM starter set contains:

- 10 active cantilever on interface PCB
- 1 analog-front-end AFM26

Optional:

2nd stage amplifier for providing separate amplification paths for DC and AC working modes; regulated cantilever bridge supply from 0 to -1 mA and DC offset compensation for the preamplifier