

## 6-Meter Path in Contact Mode AFM

Scanning large surface areas in AFM may require durable probe tips to maintain constant image quality over the scan. This is also valid for imaging processes evolving in time, when multiple reproducible scanning of the same area is needed.

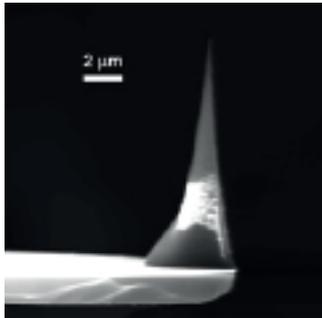
An example of such a long-time, large-area scanning is shown above. The image is a mosaic of 121 scan obtained automatically in Contact mode. Cantilever spring constant is 5 N/m. The procedure of automatic panoramic scanning was performed on SmartSPM microscope (AIST-NT). The sample is a test structure consisting of CoCr stripes of 60-nm height on Si surface. Each scan has 100x100  $\mu\text{m}$  size, the total mosaic size is more than 1x1 mm; the total path the probe made in Contact mode is about 6 meters long.

The scan was made by ART™ single crystal diamond (SCD) probe. Image courtesy of Alexei Temiryazev, IRE RAS. Sample courtesy of A.N. Shokin, NIIFP.

## SCD Probe

ART™ tips are specially grown in CVD process and attached to silicon cantilevers for use in AFM. The probes have high aspect ratio and small tip radius.

The probe is highly resistant to wear, which is useful when fast scanning speed is needed, or when the surface contains sharp and rigid edges. For instance, there is no visible wear of the SCD tip in the mosaic image above.



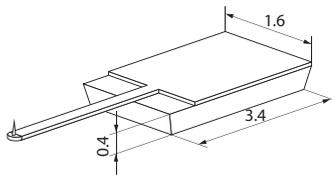
SEM image of the SCD probe tip.



SEM image of the SCD tip end.

<b>Tip material</b>	Single Crystal Diamond (SCD)
<b>Tip aspect ratio</b>	about 5:1
<b>Tip radius</b>	5-10 nm

## Cantilevers



ART™ diamond probes are glued onto rectangular (diving-board) silicon etched cantilevers. The range of spring constants and resonant frequencies of cantilevers available covers the Contact mode, Force Modulation, Non-Contact and Tapping mode. Cantilever backside is coated by Aluminium.

The chip holder size is 1.6 mm x 3.4 mm x 0.4 mm.

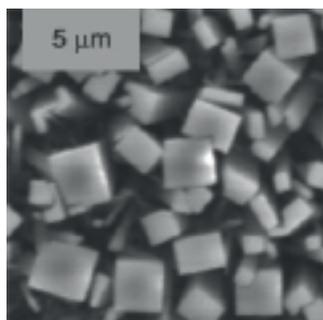
Part Number	Resonant Frequency, kHz	Spring Constant, N/m	AFM mode
D10	<b>10</b>	0.15	Contact mode
D80	<b>80</b>	3.5	Tapping mode. Force modulation. Contact mode.
D160	<b>160</b>	5	Tapping mode. Contact mode on hard surfaces.
D300	<b>300</b>	40	Tapping mode. Non-contact mode. Contact mode on hard surfaces. Nanoindentation. Force nanolithography.

**Note:** The glue used to attach the tip to the cantilever is not conducting, so the probe is not applicable for conductive AFM measurements. Values for resonant frequencies and spring constants are typical.

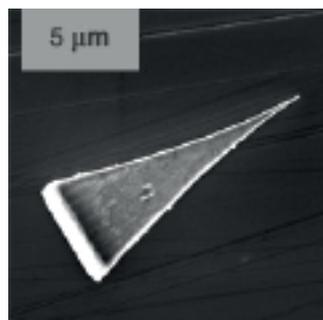
# bAatch™ gRowth & aTtachment

ART™ stands for bAatch gRowth and aTtachment technology. ART™ probe for AFM consists of two parts that are manufactured separately: a cantilever on a chip-holder and a tip. The tips grow in batch in a specially designed process and then glued onto the cantilevers using a micromanipulation equipment and procedure.

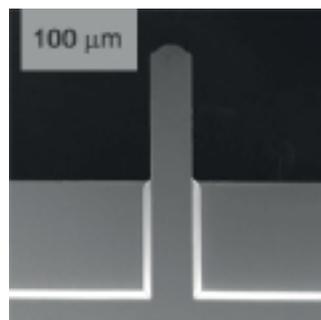
ART™ technique provides highly reproducible production at reasonable costs. Images below illustrate some of the key stages of the technology.



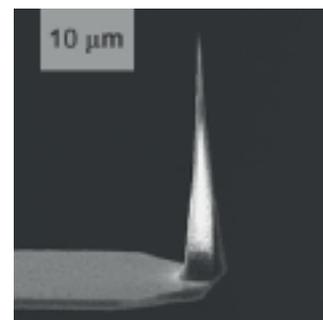
Film of diamond crystals.  
SEM image.



Single crystal diamond tip of the needed size and shape separated from others.  
SEM image.



Tipless silicon cantilever.  
SEM image.



SCD tip mounted on silicon cantilever.  
SEM image.

## Diamond Tips

Diamond is a very promising material for making AFM tips because of its durability, hardness, outstanding chemical stability, high temperature conductivity and potential ability to conduct electric current. Besides application in AFM as a probes or indentors, the diamond tips can also be used as nanosized temperature sensors and X-ray detectors.

The tips are monocrystal diamond pyramids with the {001} facet in the basis having a controllable shape along the  $\langle 001 \rangle$  axis.

## Attachment

Attachment consists in positioning and gluing a the micro-sized object on a cantilever with high precision. This manipulation technique can be used to attach not only diamond tips and not only on silicon cantilevers. Our experience shows that other objects like carbon fibers or micro-sized particles can be handled the same way. For AFM, the objects can also be glued to silicon nitride cantilevers, piezo cantilevers or tuning forks.

**Contact us if you have an idea how the diamond tips or micromanipulation technique can be used to make something special for your research.**