The Anfatec Level AFM – a short description

Atomic Force Microscopy - approved devices for affordable prices

Our system is complete for almost all typical applications. It provides all basic modes as:

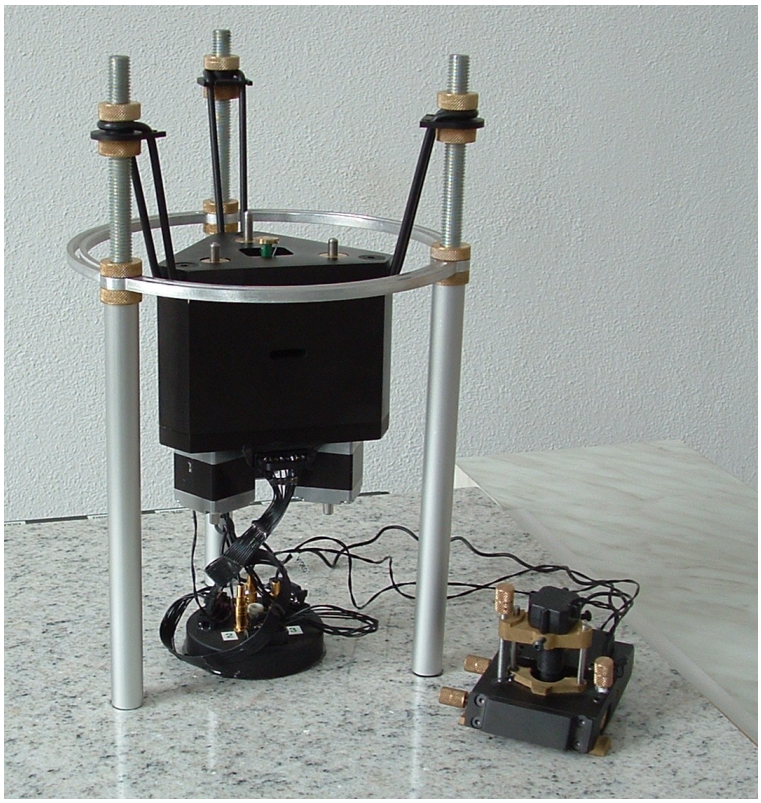
- contact mode
- dynamic mode (vibrating cantilever)
- lateral force mode
- force spectroscopy
- Magnetic Force Microscopy (2nd trace imaging)

and can be ordered with options for EFM (2nd lock-in amplifier and conduction AFM).

The price is so affordable ... because the conception is the most effective we found useful for this type of instrumentation. The price includes a complete working AFM with full support and service! It is as easy to handle, as a laser deflection AFM can be. We provide a fast and uncomplicated support for our systems. With all systems, we give a personal 8 h introduction. The operation modes are demonstrated at your samples to make the start-up easy for you.

System parameters:

lateral resolution:	< 5 nm (practical resolution limit under ambient pressure)
height resolution:	< 0,2 nm (atomic steps and layers)
maximum scan range:	30 µm (standard, others possible on request)
maximum sample size:	4 cm x 4 cm
manual positioning range:	5 mm x 5 mm
accessories:	15 cantilevers; 1 calibration grating UMG01
	20 sample holders; 2 sample boxes, tweezers



The system consists of:

- a base plate made from stone with wiring,
- vibration isolation
- microscope base:
  - ☑ 3 integrated miniaturized stepper motors for head levelling
  - ☑ lateral coarse positioning with 6 mm travel range
  - ☑ self-adjustable grooves (head is always in same position)
  - ☑ calibrated scanner (about 30 µm range)
  - ☑ electrical contact to sample (can be used for Electrical Force Microscopy)
- standard AFM-head
  - ☑ laser diode maximum 3 mW, 670 nm with lens system
  - ☑ laser adjustment in three axis
  - ☑ integrated 4-quadrant photo-detector with amplifier electronics
  - ☑ adjustment of the laser beam onto the photo detector in two directions (X, Y)
  - ☑ built-in dither piezo for acoustical excitation in dynamic mode
  - ☑ integrated illumination
  - ☑ color-camera with microscope optic with a direct view onto the cantilever
  - ☑ uncomplicated mounting of the cantilever chips
- high voltage amplifier V45C
  - ☑ DS4L-Modul with Interface to the AMU 2.x
  - ☑ control of the level station
  - ☑ 8 x 24-bit D/A and 8 x 24-bit A/D channels
- control computer:
  - ☑ 64-bit AMD processor
  - ☑ 17“ TFT monitor
  - ☑ video card
  - ☑ installed software: Windows XP, Anfatec Scan with GNU GPL, Anfatec Present
- Anfatec Measurement Interface AMU 2.x (PCI bus board with integrated LockIn amplifier)
- tools: 1 calibration grating UMG01, 1 start-up set of cantilevers (15 pcs.), connection cables
- English or German manual, certain tutorials for NC AFM, contact AFM, Scanner calibration

News in 2006:

- Hardware:
  - ➢ software- or hardware-linearisation and calibration of the scanner
  - ➢ AMU2.2 instead of AMU2.1 with better signal to noise ratio
  - ➢ 2nd trace imaging for MFM
  - ➢ 2nd internal LockIn amplifier for integrated Kelvin feedback and EFM imaging
- Software: much more scan mode options / 3D view / unit cell correction for molecular grids / .
- Mechanics/ Head: improved observability of the sample in the camera and sample illumination.

Microscope Mechanics

The mechanics consists of three main parts: the base plate, the “body” and the “head”.
The head holds the cantilever simply by a spring loaded mechanism. It needs no glue or cantilever holder. All electronic components for laser and photo diode, a specialized lens and mirror system and fine mechanics are integrated in the head.

Additionally, a small CCD camera is mounted on the head. The camera image shows directly the cantilever from the top. LED light, whose intensity is adjustable, illuminates the tip and the sample.

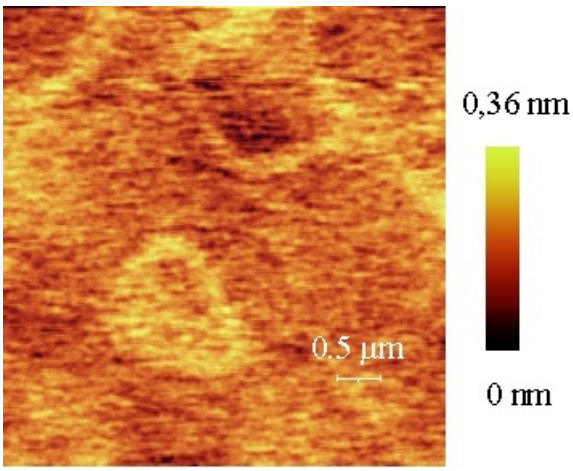
The base plate provides the electrical connections and allows to bring the whole system under a vacuum bell jar. This can minimize acoustical coupling from the environment and enables to work under protection gas.

The body is heavy and hangs vibration damped above the base plate. It includes all tools for coarse positioning and the scanner. Usually, the x and y coarse movement is done manually with a travel range of 5 mm. Three stepper motors allow to position the head in three degrees of freedom.

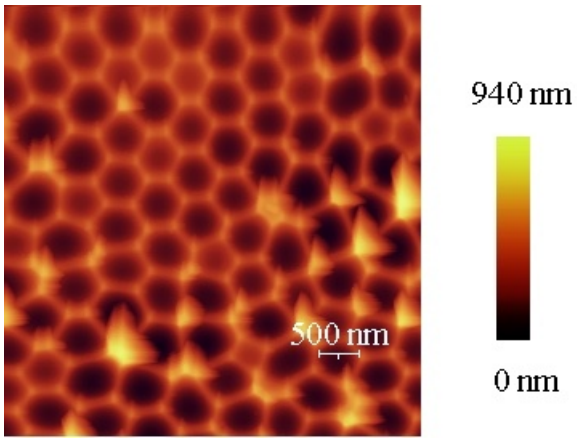
Sample holder and Scanner

The scanner is a tripod-type and scans the sample, while the tip is mounted in the head. The sample is mounted on a steel plate on three small magnets. Possible samples sizes are up to 2 cm by 2 cm, however, bigger samples are possible, too. There are two new linearisation modes for the scanners available: a software-mode and a hardware mode. The maximum scan range is 30 µm.

Applications



← Atomic steps on a mica surface.
Scan range: 5 µm.
Sample: TU Chemnitz.



Porous alumina →
Image range: 3 µm x 3 µm
Mode: dynamic non-contact
Sample: MPI Halle

Control System

- up-to-date PC with Windows XP UK English Home Edition
- high-quality and high-speed LockIn-amplifier on PCI-board
- fast data interface to the SPM-control unit

Electronic control

The system is provided with a HV amplifier V45B and a high performance SPM control unit:

- 8 channel – 24 Bit A/D (4 used for AFM, 2 additional used for hardware linearisation option)
- 8 channel – 24 Bit D/A (4 pre-specified for AFM)
- motor control, head control, fast digital interface to the PC

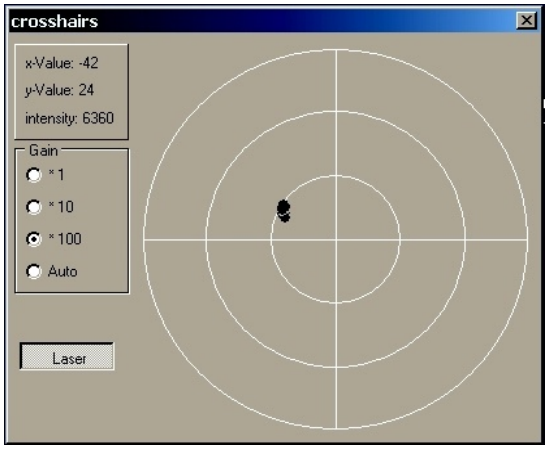
SOFTWARE

The Software works under NT based Windows systems.

- Scan software "Anfatec Scan" (GPL licence)
- Image software "Anfatec Present"

Anfatec Scan

- ☑ Simultaneous acquisition of up to 8 external channels + height image + LockIn channels + 8 external channels from a second basis module
- ☑ software feedback (PI type) with 6 different feedback modes
- ☑ free parameter input during scan
- ☑ images saved in Anfatec file format (read by Anfatec Present and SPIP[(1)]) and unscaled as Bitmap
- ☑ distance spectroscopy / voltage spectroscopy
- ☑ coarse positioning
- ☑ automatic approach



- ☑ adaptable to almost every hardware due to
  - ☑ free scalability of all channels in physical units
  - ☑ software offset correction
  - ☑ invert-channel-option
- ☑ user settings are saved in an initialization file

All functions are easy to select by menu buttons. A time-scaled oscilloscope provides observation of all input channels. A *Crosshairs* window (see figure) makes the adjustment of the laser for AFM easy.

Anfatec Present

- diverse filter functions (high pass, low pass, Fourier, noise, ..)
- enhanced line and plane correction with various selection options
- data import and export
- shows image information
- histogram for brightness /contrast
- colour palette variable
- **3D view**
- line and roughness analysis, FFT
- copy function to other windows tools

Lock-In-Amplifier on the AMU2.3

Signal Input

Voltage Input	SMB
Input Impedance	1 MΩ
Damage Threshold	> +/- 12 V
Bandwidth	dc to > 1 MHz (3 dB bandwidth)
Full Scale Sensitivity	7 V, 0.7 V, 70 mV
Input Noise:	
@ 100 kHz, high dynamic	< 2 $\mu V/\sqrt{Hz}$
@ 100 kHz, normal dynamic	< 0,4 $\mu V/\sqrt{Hz}$
@ 100 kHz, low dynamic	< 10 $nV/\sqrt{Hz}$

Reference Output

Internal Oscillator	3 mHz .. 1 MHz
Frequency Resolution	3 mHz
Frequency Accuracy	+/- 50 ppm from 0°C to 70 °C
Reference Output Voltage	< 1 mVpp ... max. 20 Vpp
Output Noise @ 100 kHz for 7 V_{rms} output	160 $nV/\sqrt{Hz}$

Scanner:

Maximum range in z-direction:	5.1 µm +/- 0.3 µm / 150V
Maximum range in x- and y-direction:	25 µm ... 60 µm(mit Eichkurve)
technical resolution in x- und y-direction:	0,9 nm
technical resolution in z-direction:	0,034 nm
achieved resolution:	about 5 nm
achieved resolution z-direction:	< 0.2 nm

Optional features (not necessary for standard applications):

- Vibration isolation table under the microscope
- hardware scanner linearisation
- glass bell jar for acoustic protection
- additional cantilever packages and gratings
- enhanced LFM mode sensitivity due to a spot-like laser diode
- additional LockIn amplifier for dynamic EFM or MFM
- implemented Kelvin feedback
- current amplifier for conductance AFM incl. power supply
- SPIP(1) – with all costumer specific modules
- 2nd TFT monitor