Indian Institute of Technology Kanpur

Centre for Nanosciences

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ATOMIC FORCE MICROSCOPE SPECIFICATIONS

Sealed Quotations are invited in two bid system (technical and financial bid separately in sealed envelopes) for a High Performance **Atomic Force Microscope (AFM)**. All the essential and optional features (modes) should be quoted for a wide range of experimental flexibility requirement in the centre. The instrument must have a robust design having specifications mentioned below.

Detailed specifications are mentioned below:

Scanner:

- System must include a closed-loop XY scanner with a XY range of 90µm or more and with XY sensor noise <0.5nm Adev in a 0.1Hz to 1 kHz bandwidth and Z scanner with a minimum range of 15µm that is capable of both open-loop and closed-loop operation. Noise on the Z sensor must be <0.25nm Adev in a 0.1Hz to 1kHz bandwidth Scanner noise specifications and representative high resolution imaging examples must be available for inspection in publicly available brochures, datasheets or websites. The scanner must be compatible with all supplied scan modes and in both air and liquid environments.
- System must include or optionally support (specify which) a Z range of at least 40µm. It must be possible to obtain atomic lattice resolution while imaging with this scanner.
- System must scan the sample in XY and the tip in Z. Alternate approaches using exclusively tip-scanning or sample-scanning are not acceptable. System must use a flexure-guided XY piezo scanner to effectively decouple crosstalk between X, Y and Z scan directions. Scanners based on piezo tubes are not acceptable substitutes.
- Integrated LVDT position sensors in all three axes to provide seamless closed loop operation
- System must accommodate sample sizes 80mm or more in diameter and 10mm or more in height without any modifications to the standard configuration.
- System must include a single probe holder that supports all of the included, standard operating modes and supports operation in both air and liquid for those modes where liquid operation is possible.

Operating Modes

The microscope must be capable of the following scanning modes, each of which requires at minimum that the signals noted in the corresponding parentheses be

recordable simultaneously. Each of these signals must be recorded in both trace and retrace scan directions:

a) Contact (lateral force, topography, deflection, feedback error, one auxiliary) with 10 contact mode tips
b) Lateral Force Mode (LFM)
c) AC Mode (Tapping Mode)
d) Phase Imaging
e) Nanolithography/ Nanomanipulation
f) Electric Force Microscopy (EFM)
g) Kelvin Probe Force Microscopy (KPFM)
h) Magnetic Force Microscopy (MFM)
i) Piezoresponse Force Microscopy (PFM)
j) Dual AC Resonance Tracking (DART)
k) AC Mode with Q-control
l) Force Curve Mode
m) Force Mapping Mode (Force Volume)

n) Conductive AFM:

- The system must allow conductive measurements while scanning as well as at user specified locations (I-V curves).
- A sample bias of -10V to 10V must be possible.
- The bandwidth of the transimpedance amplifier must be at least 17 kHz.
- The software must allow user-specified wave forms for I/V spectroscopy (square, sine, triangle, pulse, or user defined).
- The software must allow user-specified wave forms for loading and unloading, including multiple user-specified trigger-points, while simultaneously monitoring current.
- The system must include automated spiral “in” for reducing contact resistance due to surface contamination in I/V curves.
- The current sensing range must be 1pA to 20nA.

o) System must include an imaging mode that is capable of generating quantitative nanoscale maps of storage and loss modulus, and loss tangent (loss modulus divided by storage modulus), at high pixel resolution (at least 1024x1024 pixels). Data capture must occur during normal AC mode imaging of topography at normal scan rates (<20 minutes per scan). Proposals for techniques that map storage modulus only are insufficient and will be rejected.
p) Must include a fluid dish that provides an economical apparatus for simple, static, partly-sealed AFM experiments in fluid. Should have a port less dish, Viton membrane to limit evaporation, stainless steel retaining rings, spanner, glass disk, adapter for 25mm cover slip, and spare O-rings.System must

include a single probe holder that supports operation in both air and liquid for those modes where liquid operation is possible.

q) Should provide tunneling current imaging capability at constant current or constant height, and point spectroscopy (I/V) plots at user selected points.
Accessories should include:
- STM probe holder with integral pre-amp (gain is 1x10e9 volts/amp).
- Should include a box of 20 mechanically formed PtIr STM probes, premounted HOPG sample, bias voltage connection leads, silver paint for sample prep, and a 500M Ohm test resistor.

r) Please clearly list AFM tips provisioned in the standard kit for each mode. For each mode at least 10 compatible tips (with reflex coating whereever applicable) should be quoted optionally if not included in the kit. For AC mode separate 10 tips for hard and soft samples, 10 bio-sample compatible tips for scanning in air and fluid, for MFM mode separate 10 tips with high and low coerceivity should be quoted optionally if not included in the standard kit.

Optical Lever Arm: Light Source and Photodetector

- The instrument optical lever arm must use a low coherence light source (for example, a super luminescent diode, SLD) to reduce artifacts from optical interference effects.
- The instrument must use an infrared SLD (or equivalent) for the optical lever arm to eliminate optical crosstalk with epi- and transmission- fluorescence measurements.

System Optics

- The instrument must include Kohler illumination and a view of the cantilever and sample from above. It must have at least two, software selectable magnifications (720µm and 240µm field of view – with the standard ¼" CCD camera).

Controller and Electronics

System must use at least 24-bit digital-to-analog converters (DACs) in order to generate the XY and Z piezo scan signals. At both 90-micron and 10-nm scan sizes, the corresponding bit resolution must be sub-Angstrom (<0.1nm). Note that this specification applies to the generation of the scanner drive signals, not the sampling of the scanner position sensors.

- The system must provide thermal tunes of the cantilever up to at least 2 MHz.
- The instrument must allow digital Q-control in the range 2 kHz – 2 MHz.
- The instrument must include software controlled relays for the X, Y and Z high voltage supplies and the laser power.
- The electronics must provide access to all major signals on BNC connectors on the controller front panel including deflection (A-B), sum (A+B), amplitude,

phase, lateral force, X, Y and Z sensors, three user inputs, three user outputs, X,Y and Z piezo drive voltages, and user X, Y and Z modulation voltage inputs compatible with external hardware. There must also be an audio-out for ear phone.

- The instrument must include auto-configuration of external hardware and accessories. Device parameters must be stored in non-volatile RAM on the device itself and read into the software when the device is plugged in. This eliminates the need for parameter files.
- The instrument must include a user programmable control knob that can be used to fine tune and adjust all scan parameters.
- System must be able to support multifrequency AC mode (tapping mode) operation where two specific frequencies are driven simultaneously and detected simultaneously by lockin amplifiers to measure the amplitude and phase response at each frequency. Lockin detection alone at two frequencies is not sufficient, as both frequencies must be driven simultaneously with a mixed drive signal.

Software

System must use at least 24-bit digital-to-analog converters (DACs) in order to generate the XY and Z piezo scan signals. At both 90-micron and 10-nm scan sizes, the corresponding bit resolution must be sub-Angstrom (<0.1nm). Note that this specification applies to the generation of the scanner drive signals, not the sampling of the scanner position sensors.

- Control and analysis must be user-programmable natively in an entirely open-source software programming language.
- The system's software must include a one-click configuration tool that sets up the software for standard and user-defined operation modes, such as AC imaging in air and liquid, contact mode, EFM, KPFM, PFM, force measurements, etc.
- The data acquisition system must be capable of recording individual image sizes of 8000x8000 pixels2 or greater.
- AFM control software environment must include 3D rendering technology for advanced image display. This feature must allow the user to generate, display and visualize 3 & 4D real-time scan images, as well as off-line processing.
- Must include drift compensation software. Software must allow a region of interest to be tracked in real time to within 1nm of precision while eliminating any scan distortion in the image. Drift compensation must be able to be applied to any imaging, spectroscopy or advanced characterization mode, and in conjunction with sample heating and cooling options.
- The software must have a quick, push-button non-destructive determination of cantilever spring constant using thermal noise and Sader hydrodynamic methods. Thermal tune measurements on cantilevers up to 2.5MHz.Technique must be entirely contained within the AFM hardware and software, proposals requiring external or third-party hardware and/or software are not acceptable.

- Heads, scanners, probe holders and optional environmental control cells must be "plug and play", meaning that the software automatically recognizes them and configures the software appropriately (e.g. calibration parameters).
- System must include a feature that automatically calibrates the cantilever sensitivity (deflection sensitivity/INVOLS) and spring constant by simply selecting the probe type and clicking a button. To avoid tip damage, at no point during the calibration may the tip touch the sample. The feature must actually calibrate the probe. It must not use nominal tabulated values for the sensitivity and spring constant.
- Generate, display, and visualize 3D images in real-time while you scan as well as off-line processing.
- Multiple images and channels of a single scan such as phase, amplitude, topography, MFM, conductivity may be opened and viewed simultaneously, or overlaid on a primary channel for signal correlation .
- View images in 3D by simply clicking and dragging on the image to pan, rotate, tilt and zoom into specific areas of the image.
- All imaging processing and analysis tools like FFT, power spectral density, particle or feature size distribution, flattening and various parameter measurement etc should be readily available.
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Computer and hardware:

PC running Windows 7 (64 bit) with quadcore or better processor, minimum 6 GB RAM, dual 500 GB hard drives, DVD +/- RW, compatible high end video card and dual 24” LED/LCD monitors

Instrument Isolation

System must include an enclosure that provides isolation from both vibrational and acoustic noise. The entire AFM, including the top-view optics (but not the control station), must be contained within this enclosure. The vibration isolation platform must not require compressed gas.

- The system must include a thermally- and acoustically-isolating enclosure. The enclosure must provide at least 20dB of acoustic isolation.
- The system must include an active vibration isolation table.

Instrument Isolation enclosure Options:

- The enclosure must be actively temperature-controlled to 0.10C.

Guarantee, Warranty, Support and Service

- Must include three years warranty on all parts and labour.
- Must include free AFM software upgrades for the life of the instrument.
- Please clearly specify space and other on-site facilities requirements of the system
- Company must have a local application scientist along with service support in India from the manufacturer with a commitment that support would be made

available within 48 hrs on request.

- Complete training for all the modes at the time of installation of the system and maximum three training sessions in the first year for users on request at mutual convenience at no additional cost to IITK.
- The instrument must be upgradable to additional advanced modes at a later stage.

General Terms and conditions:

- Quote should be made in two parts: Technical bid and financial bid separately in sealed envelopes.
- Technical Bid should contain compliance statement of specifications with supporting documents.
- Quotes should have a minimum validity of 60 days
- Financial bids for the product whose technical bid is not acceptable will not be opened. Any quote with the financial bid included in the technical bid will be rejected.
- The sealed envelopes with the quotes should be super-scribed with the Inquiry number and whether it is a technical or financial bid.
- The delivery period should be specifically stated. Preferably 4-8 weeks from the date of purchase order.
- Port of Delivery: FOR Destination for Indian Manufacturers and CIF New Delhi in case of foreign manufacturers.
- Maximum educational discounts should be provided.
- Actual numbers of the components may be increased or decrease.
- Installation: Installation within 10 days after receiving the system at IIT Kanpur The price should be inclusive of full installation on site with full functionality demonstration.
- Standard comprehensive warranty and support should be provided for three years after installation.
- Foreign vendors should have service centers and service engineers employed by them or their subsidiaries in India. Services provided through agents/authorized dealers are not acceptable.

The quotations must reach to us latest by February 4, 2015 at the following address:

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