INDIAN INSTITUTE OF TECHNOLOGY GOA

Goa College of Engineering Campus, Farmagudi, Ponda -403401, Goa

Enquiry No. IITGOA/2018-19/074 Date: 15/02/2019

Corrigendum to the Tender for supply of Atomic Force Microscope vide Enquiry No. IITGOA/2018-19/074 dtd. 16/01/2019.

For the tender for supply of Atomic Force Microscope at IIT Goa, the following clauses / paragraphs have been modified:

I) Updated Specifications of Atomic Force Microscope:

1. Mandatory Requirements: Appropriate Quotation sought.	
1.1	Delivery and Installation at IIT Goa. Reinstallation at permanent campus after 3-5 years
1.2	5 years comprehensive warranty, service and application support
1.3	10 years spare parts, accessories, free software upgrade availability including necessary training and support.
2. Special Requirements	
2.1	Appropriate UPS system with greater than 1 hour backup must be quoted.
2.2	Suitable vibration isolation table/platform (imported brand) for the microscope system and computer workstation/accessories should be provided. All AFMs are sensitive to vibration and acoustic noise, especially in busy lab environments. An integrated enclosure providing both acoustic and vibration isolation will be required to achieve the performance is required.
2.3	List of complete safety regulations should be specified.
2.4	User list of the quoted model in India (preferably) and record of after sales services must be provided.
2.5	At least 3 references must be provided from reputed Indian institute/ that has purchased the equipment recently and preferably from western India.
2.6	Complete installation.
2.7	Demonstration of all the applications and facilities as per the demand of the users. Complete training to at least two persons. Training on specialty applications:

	a)Demonstration for AFM, with non-contact AFM, and AFM facilities b) Calibration, testing, and force measurement of standard and unknown samples. c) Training on the AFM software for operations. d)Demonstration of capabilities like for AFM nanolithography, LFM, MFM, PFM, KPFM e)Polymer imaging and characterization. f)Colloid probe microscopy etc.
2.8	A complete list of consumable with price should be quoted.
2.9	The power requirement for the main facility and for the accessories is 230-240V and 50 Hz.
2.10	Requirements of space, electricity and other auxiliaries (e.g., gas lines, water, chiller, solvent sources, etc., if applicable) for the equipment should be specified.
3.	**Basic Configuration**
3.1	Modes of Operation: Basic module should be capable of doing measurement in following modes, a) Contact Mode and Non-contact mode * b) Two frequency mode:* Amplitude and phase response at a second frequency (often a higher mode) can provide useful additional image contrast while the primary topographic feedback loop runs at the fundamental frequency. In order to optimize signal-to-noise the second frequency must be driven simultaneously along with the fundamental resonance. c)Resonance tracking mode:* Operating on resonance dramatically improves the measurement signal to noise for operating modes like piezo response force microscopy and contact resonance imaging. d)Force Curve Mode * e) Lateral Force Microscopy(LFM) * f) Electrostatic Force Microscopy(EFM) * g) Force Mapping Mode (Force Volume)* h) Force Modulation* i)Frequency Modulation* j) Kelvin Probe Force Microscopy (KPFM)*

	Also known as Surface Potential microscopy is a non contact type measurement mode capable of generating work function of surfaces at nm scales. k) Magnetic Force Microscopy (MFM) (quote separately) System must be capable of supporting an accessory that allows application for Variable in-plane and out-of-plane magnetic fields, with field strength controlled from within the software. The in-plane magnetic field should range from at least +/-5,000 G or more and the out-of-plane field strength should range from at least +/- 1200 Gauss. Model compatible with higher magnetic field will be given higher preference. The accessory may be purchased in future as up gradation. However, the vendors must state/certify that the AFM system provided will be compatible with these attachments in case these are purchased separately now or in the future. l) Nanolithography and Nano manipulation* m) Phase Imaging* n) Piezo response Force Microscopy (PFM) * The system must include demonstrated spectroscopy modes including simultaneous remnant and applied voltage hysteresis loops on ferroelectric materials and switching spectroscopy mapping (while measuring contact resonance frequency, PFM drive amplitude, PFM phase and tip-sample dissipation/Q-factor). In addition, the system must include or able to support the ability to perform PFM and Conductive AFM simultaneously. We anticipate the need to evaluate a variety of piezoelectric and ferroelectric materials. o) Tapping Mode (AC Mode) and Tapping mode with digital Q control* p) High resolution mode for imaging delicate soft samples in both air & liquid environments while maintaining resolution & clarity is must. * q) The AFM system must be able to image samples and perform measurements in air and in liquid using the same cantilever holder. The cantilever holder must be compatible with most commercial cantilevers. * r) Colloid Probe Microscopy: AFM system should be capable of measuring adhesion between colloid particles, between particles and surfaces, between cell and surfaces etc. Any new technology which allows video based interactive and automatic particle/cell attachment with probes and automatic force measurement techniques will be preferable* s) Scanning Tunnelling microscopy (quote separately) t) Viscoelastic Mapping mode* Quantitative Nano Mechanical Maps including mechanical properties such as adhesion, elasticity, stiffness, deformation, etc. Mode should be capable of quickly and gently image viscoelastic properties including storage modulus and loss tangent with nanoscale spatial resolution. Operating range, from less than 60 kPa to 300 GPa or more. A pixel resolution of 1024x1024 pixels with

	data capture during normal AC mode imaging of topography at normal scan must be achieved in less than 25 minutes/scan. u)Scanning thermal microscopy (quote separately) v) Conductive AFM* w)Electrochemistry Cell (quote separately) x)Nano indentation * with hard material probes like diamond etc. * Marked modes must be quoted within base quotation and rest of the mode must be quoted separately.
3.2	Single scanner for low and high resolution imaging
3.3	Facilities for Electrical conductivity measurements
3.3	Nano indentation for AFM
3.4	General Purpose camera with microscope with
4.	**Details of Required Specifications**
4.1	**Scanners:** a) System must scan the sample in XY and the tip in Z. Equivalent tip scanning system is also acceptable. b) The XY & Z scanner should be decoupled. A combination of Flexure / Piezo type scanners would be acceptable as long as they are able to demonstrate the intended capabilities listed here in with all modes of operation c)Each axis of motion is independently actuated using its own piezo stack and flexure stage. d)Should have Integrated LVDT position sensors in all three axes provide seamless closed loop operation. e) System must include a closed-loop XY scanner with a minimum range of 90 µm (closed loop) and with XY sensor noise <0.5 nm Adev/RMS in a 0.1Hz to 1 kHz bandwidth and sensor nonlinearity <0.5% (max deviation/full travel) at full scan. Open loop noise: should be ~21pm in XY or better. Higher scanner size will be given more weightage 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. The scanner must be compatible with all supplied scan modes and in both air and liquid environments. Closed loop sensor Noise numbers should be mandatorily demonstrated during installation at site. f) System must include a 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/RMS in a 0.1Hz to 1 kHz bandwidth and sensor non-

	linearity less than 0.05% (max deviation/full travel) at full scan. Open Loop: ~3.5 pm in Z. The System should have Z height noise < 0.06 nm Adev/RMS. 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. **Scan head of higher Z range 30 µm or more must be quoted as optional item.** g) The scanner must be closed-loop and independently actuated in X, Y and Z with dedicated piezo stacks.
4.2	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 120-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. a) The system must provide thermal tunes of the cantilever up to at least 2 MHz. b) The instrument must allow digital Q-control in the range 2 kHz – 2 MHz. c) The instrument must include software controlled relays for the X, Y and Z high voltage supplies and the laser power. d) 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. e) 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. f) The instrument must include a user programmable control knob that can be used to fine tune and adjust all scan parameters.
4.3	**Samples Types:** opaque, transparent, insulating, conducting, and biological. The instrument must accommodate samples sizes up to 80mm (dia) and 10mm thick. There should be an option for samples of 25mm thick and above.
4.4	**Upright Microscope** for sample observation with objectives – 10x, Kohler illumination and view of the cantilever and sample through a 10X 0.28 NA Mitutoyo objective. The base should contain a port for inserting fiber guide illumination and built-in cameras with differing magnifications (720and 240 micron field of view for 1/4" CCD cameras). Camera with 5 MP or more is preferable.

	The instrument must use an infrared SLD (or equivalent) for the optical lever arm to eliminate optical crosstalk with epi- and transmission- fluorescence measurements
4.5	**Force sensitivity** < 30 pN or better (proof of force sensitivity is must).
4.6	**Software** a) System must include the ability to track a changing resonance frequency during operating modes like piezoresponse force microscopy contact resonance imaging. Phase locked loops (PLL) do not offer sufficient stability to satisfy this specification. b) 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. c) Control and analysis must be user-programmable natively in an entirely open source software programming language. d) 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. e) The data acquisition system must be capable of recording individual image sizes of at least 5000 pixel by 5000 pixel. Image size with greater pixels will be given higher priority. f) 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. g) 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. **h)** Software must include a feature that automatically optimizes the imaging gain and set point for tapping mode operation. The feature must use a predictive algorithm such that operation is stable and producing high quality data within the first few scan lines.
4.7	**Computer:** Latest computer with OS and dual 24″ monitors a) Preferably Intel i7 or higher / equivalent processor b) 8 GB RAM or higher c) Internal hard drive space of 1 TB or higher capacity d) Multiple USB drive and CD/DVD burner for backup-storage of image data

4.8	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.
4.9	The system must allow conductive measurements while scanning as well as at user specified locations (I-V curves). 1. A sample bias of -10V to 10V must be possible. 2. The bandwidth of the trans-impedance amplifier must be close to 20 kHz. Better bandwidth will be given higher weightage. 3. The software must allow user-specified wave forms for I/V spectroscopy (square, sine, triangle, pulse, or user defined). 4. The software must allow user-specified wave forms for loading and unloading, including multiple user-specified trigger-points, while simultaneously monitoring current. 5. The system must include automated spiral “in” for reducing contact resistance due to surface contamination in I/V curves. 6. The current sensing range must be 1pA to 20nA. 7. The system must include or optionally support (specify which) current measurements from <1pA to 10μA. The full dynamic range of current sensing must be recorded simultaneously. Solutions that provide this, or similar, dynamic ranges sequentially, are not acceptable.
4.10	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.
4.11	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).
4.12	**3D Nanolithography/nanomanipulation/ nanoindentation Package** a) Should have the lowest noise and highest precision with closed loop position control in all three axes. b) Lithography should be operated in either vector based or bit-mapped modes.

	c) All data types should be available for plotting during lithography, including deflection, lateral force, amplitude, phase and all user-available analog- to-digital converters (ADCs) and digital-to- analog converters (DACs). d) Lithographic contrast to be controlled by modulating cantilever set-point (both contact and AC modes), cantilever drive voltage, cantilever potential and/or any other channel including the user-available DACs.
4.13	Probes/Tips (for AFM Contact Mode / Non- Contact Mode /CAFM /PFM MFM/Colloid Probe etc) and other consumable items for running the equipment for at least 5 years.
5. Additional Features must be offered separately: These add-ons will be purchased only if the price falls within the budget available. However, the vendors must state/certify that the AFM system provided will be compatible with these attachments in case these are purchased separately now or in the future and the priced offer should be made including the price of these optional modules / capabilities.	
5.1	System must include an accessory that enables application of a variable high voltage (+/- 150 V) bias between the tip and sample. Voltage must be software controlled and capable of high frequency (>100kHz) operation. Accessory must include features and training to help ensure safe operation.
5.2	The AFM should have an option to upgrade and integrate an Inverted Optical Microscope and allow simultaneous AFM and optical measurements (i.e. bright field, epifluorescence) and optional phase contrast illumination. This option alone only needs a confirmation that compatibility is possible with specific mention of the brands of optical microscopes. No price is required at this time for an optical microscope.
5.3	Temperature control stage/stages for variable temperature studies from -20°C or less to to 120°C and ambient to 250°C or more should be provided optionally. This should be compatible with the system and have the capability to be used in special gaseous environment. This stage should support samples up to 8 mm in diameter. The kit to include all necessary accessories for sealed operation. This should include special cantilever holder if required for refined results. Ability of humidity control along with temperature is highly desirable.
5.4	Different Accessories /fluid cells required for fluid environment measurement must be quoted as optional items. These accessories must be able to hold liquid or gases either fully sealed configuration or by perfusion through configurable inlet outlet ports.

Miscellaneous:

6. **Acceptance of Tender**: The Authority of IIT Goa does not bind itself to accept the lowest priced bid and reserves the right to reject any or the entire tender bids received without assigning any reason thereof.

7. **Extra Features:** If the bidder provides any other extra features which are not mentioned in the tender product specifications, then that shall be highlighted in clear terms, with documentary evidence/literature.

8. **Compliance List**: The proposal be properly indexed and a compliance list against the technical specifications should be provided.
9. **Service:** Response to ensure quality of services, the deputed Engineer from the OEM/Vendor shall have a minimum of 3 years of experience in the relevant field and must be in the payroll of the OEM/Vendor.
10. **Re-installation:** The equipment will be temporarily installed in IIT Goa's temporary campus just after the procurement. However, the equipment will be shifted to permanent campus within 5 years. OEM/Vendor shall support the shifting the equipment and reinstallation of it.
11. Relevant documents of the OEM shall be enclosed, along with the Technical Bid. Any explanation on this account shall be supported with documentary evidence from the principals.

12. **Conditional Offer** will not be accepted.
13. **Past Performance** of the Vendors will be judged at the time of Technical Evaluation.
14. The Institute does not bind itself to offer any explanation to those bidders whose technical bids have not been found acceptable by the Technical Evaluation Committee of the Institute.
15. Quoted model must be supplied to IITs or IISc within last 3 years.

16. **List of users** of the quoted model within India and preferably from IIT, IISC and national research organizations must be submitted.
17. **A bid submitted with false information** will not only be rejected but also the OEM/ vendor will be debarred from participation in future tendering process.

II) <u>The last day for submission of bids has been extended to 25/02/2019 till 17:00 Hrs.</u>

All other terms will remain same.

Sd/-
Assistant Registrar