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From: Director, CSIR-NPL
Tender No. 14-VI/AKS(1139)23PB/T-136 Dated: 28.11.2023

CORRIGENDUM

With reference to NPL's Global Tender ID: **2023_CSIR_732824_1**, Pre-Bid Conference (PBC) was concluded on 21.11.2023 for "**Integrated Confocal Raman Spectroscopy/Micro-Raman Mapping – Multimode AFM System with Accessories**". Consequent upon the outcome of PBC, **some changes have been made in the technical specification of captioned tender. Revised specifications are as follows:**

Specifications for Integrated Confocal Raman spectroscopy/micro–Raman Mapping - Multimode AFM system with accessories

Scope of the supply: The package (Integrated Confocal Raman spectroscopy/micro–Raman Mapping - Multimode AFM system with accessories) should be capable of performing various measurements/imaging [confocal Raman spectroscopy/micro–Raman Mapping, reflectance mapping, PL spectroscopy/imaging, multimode (topography, phase, KPFM, EFM and MFM) AFM, and optical imaging (DIC, dark field and bright field)] from the same area/point (co-localization) of the same sample with a defined uncertainty in finding the same point/area of the sample while doing all the above-mentioned measurements/imaging. This capability of co-localized measurements/imaging is a must to deliver the most critical functionality of the system: correlative information generated by multi-technique measurements/imaging on the same point/area of a given sample without moving the sample between different techniques.

The package should include the following items with mentioned specifications:

S. No	Item	Description
Hardware		
A	**Confocal Raman spectroscopy/micro–Raman Mapping:**	
1.	Confocal Scanning Raman Microscopy Mode	➢ Raman imaging with error correction based on a closed feedback loop of the scanner. ➢ 3D imaging and depth profile based on confocal configuration with Raman Depth resolution ≤ 1 μm with 532 nm laser. ➢ 2D mapping/imaging with diffraction-limited spatial resolution ≤ 250 nm with 532 nm laser

		➢ It should have an option to accommodate a minimum of three excitation lasers (in the visible range) that can be automatically selected. An appropriate multiwavelength coupler should be provided. ➢ Automatic alignment of all necessary optical components without any manual intervention in the optical beam path for switching between there or more excitation wavelengths. Rayleigh rejection filter can have automatic or manual alignment.
2.	Spectrometer	➢ High throughput spectrometer with focal length ≥ 250 mm ➢ Spectrometer throughput (from sample to detector) ≥ 64% ➢ Spectral resolution ≤ 0.5 cm^{-1} ➢ Scan to scan repeatability ≤ 0.04cm^{-1} ➢ Raman Spectral range: 50 cm^{-1} to 4000 cm^{-1} ➢ Motorized Grating Stage having a minimum of three gratings. It should be equipped with 300 gr/mm, 1200 gr/mm, and 2400 gr/mm. Blazed wavelength range: 300 – 600 nm. ➢ The same System should have appropriate filters for complimentary Photoluminescence (PL) spectroscopy/imaging with a 550- to 1050 nm spectral range. ➢ Built-in Neon or Mercury Argon source in the beam path for spectrometer calibration (intensity, resolution, and spectral position calibrations). ➢ Reflectance mapping (intensity mapping of part of backscattered Raman signal) should be possible with the Spectrometer and CCD camera and with an additional photomultiplier tube (PMT) module (either independently or simultaneously reflectance mapping should be possible). The output unit should have provision to mount appropriate, rapidly exchangeable filters. ➢ Counting PMT: TTL output, typical Quantum Efficiency (QE) ≥ 15% @450 nm, typical dark count rates ≤ 150 cps.
3	Excitation Laser	LASER should be air-cooled for maximal confocal performance and TEM00 mode. The laser intensity should be controllable to change the intensity from 0 to 100 % using neutral density filters or another mechanism with a minimum of 9 steps or more. ➢ Excitation Diode LASER 532 nm, LASER power ≥ 75 mW ➢ A slim Power meter (400 – 1100 nm, ≥ 100 mW) with the required software should be included for actual laser power measurement on the sample.
4.	High QE CCD detector	➢ ≥ 1024x127 pixel format with Peltier cooling down to ≤ -50^{0}C ➢ ≥ 26 x 26 microns pixel size ➢ Peak QE ≥ 95% for the 532 to 700 nm range ➢ Very low noise levels ≤ 7.0 electrons ➢ USB interface
5	Microscope	Confocal Microscope platform – branded research grade for both, Raman and AFM. The microscope should contain a colour camera or/and Binocular for viewing the sample. The vendor should specify the model and make of the microscope. The microscope should include: ➢ ≥ 5X Objective turret, color video camera ➢ Objectives: 10x with numerical aperture (NA)≥ 0.25, 20x with NA ≥ 0.5, 50x with NA ≥ 0.75, 100x with NA ≥ 0.9. The working

		distance for all the objectives ≥ 1.0 mm. ➢ Objectives (10x, 20X, 50x, 100X) should be compatible with differential interference contrast (DIC) microscopy, bright field (BF), and dark field (DF). ➢ DIC microscopy optics should include an appropriate reflector module with circular polarized DIC and a circular DIC slider with an adjustable and rotatable DIC prism. DIC should work optimally with offered objectives (10 – 100 X). ➢ Should be equipped with compatible DF condensers. ➢ Objectives (20X/100X) should be fluorescence measurement compatible. ➢ LED white-light source for Köhler illumination ➢ Auto-focus and auto-contrast of BF image ➢ Additional LED source from the below for transmitted light provision ➢ Automatic White light imaging saving with data ➢ Auto-focus for corrections on tilted/spherical surfaces ➢ Optical Image stitching with Vignetting mode correction ➢ Remote / Joystick for Microscope Control should be provided. ➢ The microscope should be equipped with circular polarized DIC microscopy-compatible optics ➢ Software should be included for acquiring, processing, and exporting optical (BF, DF)/DIC/fluorescence images.
6.	XYZ Mapping Stage	• XY Motorized stage: travel range ≥ 25 mm, step size ≤ 25 nm, reproducibility ≤ 0.01% over the full range. • Z Motorized stage: travel range ≥ 25 mm, step size ≤ 10 nm. • Software controlled.
B	**Multimode AFM**	
1	AFM Modes	Following AFM modes should be possible with AFM: ➢ Contact Mode ➢ Lateral Force Microscopy (LFM), ➢ AC Mode/Tapping mode/Intermittent mode ➢ Amplitude & Phase Imaging, ➢ Acquisition of force-distance curves, ➢ Magnetic Force Microscopy (MFM) ➢ Electrostatic Force Microscopy (EFM) ➢ Kelvin Probe Force Microscopy (KPFM) ➢ Lift Modes (two-pass measurement technique for KPFM, EFM and MFM) ➢ 10 tips for each mode need to be included. ➢ If simultaneous AFM and Raman measurements are possible and special tips are needed for this purpose, then 10 such tips should be provided.
2	Positioning Device, Scanner, and sample stage	Piezo-driven scan platform (flexure-based technology: three independent piezo for x, y, and z or equivalent technology) for diffraction-limited confocal Raman imaging and multimode AFM with the following specifications: ➢ Continuous scans range in x- and y-direction ≥ 100µm, z-direction ≥ 10µm, and closed-loop control to ensure positioning accuracy

		and high resolution. ➢ Scan hardware linearized with closed-loop feedback. ➢ Scan resolution in x- and y-direction ≤ 0.3nm and ≤ 0.2nm in z-direction ➢ Bi-directional position accuracy/repeatability ≤ 5nm in x- and y-direction over the full range (100 x 100µm, going from one corner to another and returning at the starting point). ➢ Linearity ≤ 0.03% ➢ Motorized and software-controlled automatic tip-sample approach ➢ The stage should accommodate a sample size ≥ 150mm in diameter
3	Controller	➢ Latest generation ➢ The controller should enable all modes of operation as listed above ➢ Pixel density ≥ 4000 x 4000
4	Beam deflection module	The instrument must use an infrared Laser / SLD with a wavelength ≥ 850 nm for beam deflection or feedback.
5	Active/passive vibration isolation system	Active range: 0.7 – 1000 Hz, Passive range >1000 Hz
Software and system for instrument control, data acquisition, analysis, and display		
1	Software (All the features should be mentioned in the Catalogue/ /website/manual/brochure and proven with attached relevant documentation. (Just quoting without attaching relevant, above-mentioned, documentation will not beacceptable.)	➢ A single software is preferable for doing Raman, AFM, PL, optical imaging, DIC, and Reflectance Mapping. If more than one software is offered for all the measurements mentioned above, then the OEM/supplier will be responsible for efficiently patching different software. All the software must be licensed. No freeware will be accepted. ➢ All software for Raman & AFM to operate on a single computing system to enable all modes of operation. Required integration of software (3rdparty/home built) will be the responsibility of the OEM/supplier to allow smooth workflow for all modes of operation. ➢ Software Wizard for guidance through the complete investigation, from initial settings and acquisition through data and image post-processing ➢ Raman Analysis Software should also be quoted, which can cover: Cluster Analysis (automatic identification of similar spectra and classification of multi-spectrum data into a user-defined number of clusters, Color-coded image generation of user-selected clusters, automatic average-spectra generation of cluster areas for further processing, Principal Component Analysis (multivariate analysis method that produces an optimized reduction of a spectral data set to its principal components), Graph De-mixer (subtraction or addition of spectral information from/to other spectra with a free adjustable weighting factor-weight per spectrum and immediate preview function), Image overlay (image overlay of any combination of two images/bitmaps, both images may have different sizes, positions or number of pixels), Advanced Fitting tools (Extensive curve fitting tool for single spectra and 1D and 2D multi-spectral data sets, combinations of various fitting functions ,

		generation of individual fitting functions), Various filters (anisotropic, edge, sharpen, Fourier, user defined filters etc.), Non-Negative Matrix Factorization (automatic unmixing of spectral components and correlation with their distribution),Graph and image repair (data substitution algorithms such as simple interpolations or texture analysis to remove pixel failures-e.g. extreme cosmic rays, hot/dark CCD pixels), Data cropping and reducer (data Cropping and Reduction Selection of image regions and 1D/2D spectral data sets to crop, cut, or combine the data included in these regions), Image Correlation (easy matching of two or more image objects in a correlation plot and correlative comparison of various object characteristics). Any other features of supplied software (acquisition/plotting/analysis) should be mentioned. ➢ Data Export to ASCII, Matlab, etc for Raman and different formats of images (JPEG, PNG, BMP etc.) for various modes of AFM, Raman maps, reflectance mapping, and optical microscopy. ➢ Multiple Algorithms for background subtraction &and curve fitting for Raman data ➢ Filter Viewer – Fast and unlimited image preview generation of filters (Peak intensity, width, position) applied to a Raman data set. These features should also be applicable during running measurements. ➢ Provision for saving and cataloguing optical properties with individual measurements to facilitate comparison and reproducibility - Correlative Microscopy for optical Images (Brightfield, DIC etc.) and Spectroscopy Images (PL, RAMAN etc.) and AFM (Topography, phase, EFM, KPFM) images ➢ Image post-processing possibilities include, among others, 3D imaging and volume visualizations. ➢ Multiple algorithms for background subtraction and Curve-fitting tool for single spectra and multiple Raman spectrums: Different types of fitting functions: Gaussian, Lorentzian, Pseudo Voigt, and custom fitting functions, Exponential fitting for time-dependent studies, Multiple peak selection. ➢ Various statistical data evaluation options for Raman: Image as a function of peak intensity, Image as a function of peak position, Image as a function of peak width, and data normalization. ➢ Raman Image generation through visualization of corresponding spectra (basis analysis) ➢ Data Representation: high-speed movie-like image presentation of spectral datasets, also functional as a preview option simultaneously with data acquisition ▪ Fast determination of position, time, and/or spectral correlation between various data objects ▪ 2D and 3D color-coded representation of any image datasets (AFM, Raman, etc.) in selectable color schemes. ▪ 2D/3D overlay of any two images at a time should be possible: e.g. AFM (all modes) image with Raman chemical information, optical (including DIC), and reflectance mapping image. ▪ Spectrum peak finder and labelling

		▪ Principal Component Analysis for Raman imaging to automatically establish the number of components in a sample, locate them in the image, and differentiate their individual Raman spectra ➢ Image Stitching for large-area (≥ 25 x 25 mm) overview, Focus Stacking for sharp and defined particle outlines ➢ Vignetting correction for uniform brightness ➢ Region of interest selection (including multiple regions) ➢ Co-localization (acquiring data at the same given point/area on the sample) uncertainty for Raman (1D, 2D) and AFM (all required modes) should be better than ≤ 250 nm over the scan range of≥ 25 x 25 mm. ➢ Raman mapping capability example: A large Raman map (≤ 225 x 225 µm) should have ≥ 1000 x 1000 data points (individual Raman spectrum) with automatic focus stabilization (maintaining diffraction-limited spatial resolution over full scan range). ➢ It should allow the stitching of multiple AFM images using an XY motorized stage with a travel of ≥25 mm x 25 mm and a step size of ≤ 25 nm. ➢ It should facilitate Raman and AFM imaging up to 25 mm (X, Y) without moving samples from one scanner to another. ➢ Dynamic position correction software to correct the position of the beam spot on the sample from capacitive feedback from the piezo stage of AFM. ➢ Motorized and software-controlled automatic tip-sample approach for AFM. ➢ AFM software should have features like Baseline correction, Shape correction (polynomial), Image FFT, Line profile, step height calculation, Image smoothening (average, median etc.), Image cross-section, Image threshold, Image roughness and other statistics, Image repair for jumps in the scan, Image stitching of numerous AFM images, Image overlay of AFM data on Optical image, AFM Image overlay on Raman data. ➢ Software license (data collection and data analysis) for five offline workstations and its free upgrade till compatible upgrade versions are available. ➢ Two licenses of any additional offered advanced data analysis software and its upgrade free of cost till the warranty period.
2	Instrument control, data acquisition, analysis, and display system	The state-of-the-art control system should be compatible with and optimized for the application (control, acquisition, and analysis) software to automatically perform the various measurement options. The desktop system with a current generation processor (similar or better than i9), 16 GB RAM, 512GB SSD (Solid State Drive), Two 4 TB HDDs, Windows 10 (64 bit) or next generation Operating System, 32" or higher display. Two display screens should be provided.
C	**Accessories**	
1	Acoustic Hood/enclosure for AFM	Acoustic Hood/enclosure for AFM with appropriate rigid support frame/platform for reducing air currents and acoustic noises
2	Calibration/Test/Tip checker samples	➢ A mounted XYZ calibration standard grid suitable for both, lateral and vertical AFM scanner calibration: silicon dioxide structures on a 5x5mm silicon chip, structure step height range: 20nm, square pillars and holes with a ≤ 10µm pitch, circular pillars, holes and lines with ≤ 5µm pitch, circular holes with ≤ 500nm pitch, Vertical

		accuracy ≤ 2% of the actual value, lateral pitch accuracy (5µm and 10µm/500 nm pitch regions ≤ 0.1µm/10nm) ➢ Tip checker for AFM probes: A mounted 5x5mm silicon chip completely coated with wear-resistant thin film (granular, sharply peaked nanostructure) ideal for reversely imaging an AFM probe's apex ➢ Test sample for KPFM and EFM: arrays with alternating Al and Au lines deposited on an oxide-covered silicon substrate, line array pitches of 8, 20, and 40 µm, line height ~ 35nm, mounted on glass disc - metal disc stack, thin copper wires connected to the Al and Au contact pads. ➢ Test sample for MFM
3	Online Uninterrupted power supply (UPS)	An appropriate online UPS (≥ 3 KVA), isolation transformer, and minimum 30-minute backup time should be provided.
D	**Upgradation for the Future: - Appropriate catalogue/website/manual/brochure/scientific publications need to be attached to prove that required future upgradation is possible with the offered system**	
1	Scanning Near Field Optical Microscopy	➢ The system should be upgradable to do SNOM ➢ Should be able to do Nearfield Raman, Nearfield PL Correlative Microscopy SNOM- AFM-Raman spectroscopy/mapping-PL on the same area without moving the sample. ➢ Suitable application note/notes should be provided to prove the possibility of this upgrade.
2.	Time-resolved PL	➢ The system should be upgradable to perform time-resolved PL spectroscopy ➢ Suitable application note/notes should be provided to prove the possibility of this upgrade.
3.	Additional LASER excitations	➢ The system should be upgradeable to accommodate two more LASER sources (in the visible range) in addition to the already included 532 nm LASER. ➢ Suitable documentation should be provided to prove the possibility of this upgrade.
4.	Lower Raman spectral range	➢ The system should be upgradeable for Raman Spectral range: 10 cm^{-1} to 4000 $cm^{-1,}$ and additional filters/optics should be provided without altering existing filters/optics. ➢ Suitable documentation should be provided to prove the possibility of this upgrade.
E	**Warranty**	1 Year standard onsite warranty for the full system+ 2 Years additional onsite warranty except for LASER
F	**Installations**	Minimum one previous installation in India in the last five years should be proved for core functionalities [AFM (contact mode/tapping mode topography and phase imaging), Raman spectroscopy, and micro-Raman mapping)] of the quoted (similar model/type as in quotation) integrated Raman-AFM system.
G	**User Training**	Total 9 days of onsite training for three persons over the 3-year warranty period (four days of basic training of operation, maintenance, and software during installation + two days of advanced training within six months of installation + three days of advanced training within the remainder of the total warranty period). Training will be given at CSIR-NPL.

H	**Pre-shipment inspection**	Provision for pre-shipment instrument inspection and acceptance of the complete system at the factory by the CSIR-National Physical Laboratory, New Delhi. The CSIR-National Physical Laboratory shall bear the expenditure Acceptance criteria: The firm/OEM should demonstrate the following: Raman Spectral resolution ≤ 0.5 cm^{-1} Raman Scan to scan repeatability ≤ 0.04cm^{-1} Raman mapping capability: A large Raman map (≤ 225 x 225 µm) should have ≥ 1000 x 1000 data points Demonstration of all AFM modes on the mentioned standard samples Demonstration of DIC capability of microscope Demonstration of correlated information capability by through measurements (Raman, AFM topography, EFM, KPFM, optical image) on the same area of sample supplied by us. Overlaying of any of these two measurements should be demonstrated.
I	**Service support**	A principal company service facility in India is desired. At least two factory-trained service engineers should be available in India, preferably near Delhi, for quoted system.
J	**Pre-installation advice**	Necessary pre-installation advice including power requirement should be enclosed along with the offer.

All other terms & conditions of said tender will remain the same.

Sr. Controller of Stores & Purchase

Minutes of the Pre-bid Conference (PBC) Meeting

Date: 21st November 2023

Tender No.: 14-VI/AKS(1139)23PB/T-136

Item Description: Integrated Confocal Raman spectroscopy/micro–Raman Mapping - Multimode AFM system with accessories

Venue: 2nd Floor Conference Room, Main Building, CSIR-NPL

Date and Time: Tuesday 21st November 2023

Sub: Minutes of Pre-bid conference (PBC) meeting

The PBC/TSC meeting was held to finalize the technical specifications of "Integrated Confocal Raman spectroscopy/micro–Raman Mapping – Multimode AFM system with accessories".

PBC meeting was attended by all the TSC members and Sh. Suresh Pant, Sr. COSP, CSIR-NPL.

The following firms/OEMs attended the PBC meeting:

Firm /OEM	**Name & Designation**	**Mode of attendance**
(A) M/s Laser-Spectra Services India Pvt. Ltd./Horiba	Mr. T. D. Balaji	Online
(B) M/s Oxford Instruments India Pvt. Ltd./Andor-Asylum	Mr. Sanjay Chavan	Online
(C) M/s Toshniwal Brothers (SR) Pvt. Ltd./WITec	Mr. Mohit Gautam	Offline
	Mr. P. Roy	Offline
	Mr. Hitesh Mamgain	Online
(D) M/s Forevision Instruments	Mr. Sai Kamaraju	Online
	Mr. S. Nagendra	Online
	Ms. Jayeeta	Online

Based on the feedback from participating firms/OEMs and I/O recommendation, the following changes have been made to the specifications to make them generic and broad-based:

Original Specifications and its number	**Final Specifications and its number**
A.1	**A.1**

Automatic alignment of all necessary optical components without any manual intervention in the optical beam path for switching between there or more excitation wavelengths.	Automatic alignment of all necessary optical components without any manual intervention in the optical beam path for switching between there or more excitation wavelengths. Rayleigh rejection filter can have automatic or manual alignment.
A.2 Spectrometer throughput (from sample to detector) ≥ 70%	**A.2** Spectrometer throughput (from sample to detector) ≥ 64%
A.2 Motorized Grating Stage having a minimum of three gratings. It should be equipped with 300 gr/mm, 1200 gr/mm, and 2400 gr/mm.	**A.2** Motorized Grating Stage having a minimum of three gratings. It should be equipped with 300 gr/mm, 1200 gr/mm, and 2400 gr/mm. Blazed wavelength range: 300 – 600 nm.
A.3 The laser intensity should be controllable to change the intensity from 0 to 100 % using neutral density filters or another mechanism with a minimum of 16 steps or more.	**A.3** The laser intensity should be controllable to change the intensity from 0 to 100 % using neutral density filters or another mechanism with ≥ 9 steps.
A.5 6X Objective turret, color video camera	**A.5** ≥ 5X Objective turret, color video camera
B.2 Continuous scans range in x- and y-direction ≥ 100µm, z-direction ≥ 15 µm, and closed-loop control to ensure positioning accuracy and high resolution.	**B.2** Continuous scans range in x- and y-direction ≥ 100µm, z-direction ≥ 10µm, and closed-loop control to ensure positioning accuracy and high resolution.
B.4 The instrument must use an infrared Laser / SLD with a wavelength ≥ 900 nm for beam deflection or feedback.	**B.4** The instrument must use an infrared Laser / SLD with a wavelength ≥ 850 nm for beam deflection or feedback.
Software and system for instrument control, data acquisition, analysis, and display **1.** Software license for five offline workstations. Any software update should be free of cost for the next 10 years from the date of installation/acceptance of the system.	**Software and system for instrument control, data acquisition, analysis, and display** **1.** Software license (data collection and data analysis) for five offline workstations and its free upgrade till compatible upgrade versions are available. Two licenses of any additional offered advanced data analysis software and its upgrade free of cost till the warranty period.
F Minimum three previous installations in India in the last five years should be proved for core functionalities [AFM (contact mode/tapping mode topography and phase imaging), Raman spectroscopy, and micro-Raman mapping)] of the quoted (similar model/type as in quotation) integrated Raman-AFM system.	**F** Minimum one previous installation in India in the last five years should be proved for core functionalities [AFM (contact mode/tapping mode topography and phase imaging), Raman spectroscopy, and micro-Raman mapping)] of the quoted (similar model/type as in quotation) integrated Raman-AFM system.
H Provision for pre-shipment instrument inspection and acceptance of the complete system at the factory by the CSIR-National Physical Laboratory,	**H** Provision for pre-shipment instrument inspection and acceptance of the complete system at the factory by the CSIR-National Physical Laboratory, New Delhi.

New Delhi. The CSIR-National Physical Laboratory shall bear the expenditure	The CSIR-National Physical Laboratory shall bear the expenditure Acceptance criteria: The firm/OEM should demonstrate the following: Raman Spectral resolution ≤ 0.5 cm^{-1} Raman Scan to scan repeatability $\leq 0.04 cm^{-1}$ Raman mapping capability: A large Raman map ($\leq$ 225 x 225 μm) should have $\geq$ 1000 x 1000 data points Demonstration of all AFM modes on the mentioned standard samples Demonstration of DIC capability of microscope Demonstration of correlated information capability by through measurements (Raman, AFM topography, EFM, KPFM, optical image) on the same area of sample supplied by us. Overlaying of any of these two measurements should be demonstrated.

After incorporating the above-listed modifications, the finalized specifications recommended by the TSC are attached as an annexure.The meeting ended with a vote of thanks to the chair.

Declaration: We hereby declare that we have no conflict of interest with any of the bidders in this tender