Specifications for UV Micro-Raman set-up integrated with Multimode AFM system

Scope of the supply: The package (Integrated Confocal Raman spectroscopy (UV-VIS)/micro–Raman Mapping - Multimode high resolution AFM system with accessories) should be capable of performing various measurements/imaging [confocal Raman spectroscopy/micro–Raman Mapping, reflectance mapping, PL spectroscopy/imaging, multimode AFM, and optical imaging and bright field from the same area/point (co-localization) of the same sample with a minimal uncertainty. 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. System must have compatibility to integrate JANIS ST-500 cryostat (available with the user).

The package should include the following items with mentioned specifications:

S. No	Item	Description
Hardware		
A	**Confocal UV micro-Raman set-up capable of Raman mapping:**	
1.	Spectrometer	➢ High throughput (≥ 60% @532 nm) single spectrometer with focal length ≥ 400 mm ➢ Spectral resolution ≤ 0.5 cm^{-1} ➢ Scan to scan repeatability ≤ 0.04cm^{-1} ➢ Raman Spectral range: 50 cm^{-1} to 4000 cm^{-1} (with suitable cut-off filters for 50 cm^{-1}) and 10cm^{-1} to 4000 cm^{-1} (with suitable cutoff filter for 10 cm^{-1}) at 532 nm and ≤150 cm^{-1} to 4000 cm^{-1} for 355 nm UV range. ➢ Motorized Grating Stage having a minimum of three gratings – 600 gr/mm, 1200 gr/mm, 2400 gr/mm, and 3600 gr/mm. ➢ The same System should have appropriate filters for complimentary Photoluminescence (PL) spectroscopy/imaging with a 365 - 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).
2.	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 UV-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 three excitation wavelengths.
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 continuously variable option. ➢ Excitation Diode LASER 532 nm, LASER power ≥ 25 mW ➢ Excitation LASER 355 nm, LASER power ≥ 10 mW ➢ Laser power meter to measure actual power before the objective.
4.	High QE CCD detector	➢ ≥ 1024x255 pixel format with Peltier cooling down to ≤ -55 ^{0}C ➢ ≤ 26 x 26 microns pixel size ➢ Peak QE ≥ 90% at 400 nm range ➢ 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: ➢ 6X Objective turret, color video camera ➢ Objectives: 10x with numerical aperture (NA) ≥ 0.25, 50x LWD (>9 mm) with NA ≥ 0.5 (compatible with 355 nm and 532 nm lasers), 100x with NA ≥ 0.9. ➢ Objectives should be fluorescence measurement compatible. ➢ LED white-light source for Köhler illumination ➢ Auto-focus and auto-contrast of BF image ➢ Automatic White light imaging saving with data. ➢ 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 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	**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, ➢ 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 (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 ~ 20 µm, 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
3	Controller	➢ Latest generation ➢ The controller should enable all modes of operation as listed above. ➢ The same controller, Peizo stage and microscope should be used for both Raman and AFM.
4	Beam deflection module	The instrument must use an infrared Laser / SLD with a wavelength ≥ 900 nm for beam deflection or feedback.
5	Active/passive vibration isolation system	Active range: 0.7 – 1000 Hz, Passive range >1000 Hz suitable dimensions to house the Raman-AFM setup.
C	**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 be acceptable.)	➢ A single software is preferable for doing Raman, AFM, PL, optical imaging. 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 (3rd party/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 ➢ 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) and Spectroscopy Images (PL, RAMAN etc.) and AFM (Topography, phase) 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 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. ➢ Base Software license for five offline workstations.
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 11 (64 bit) or next generation Operating System, 32" or higher display.
D	**Accessories**	
1	Accessories for cryostat	Necessary attachments for integration of Janis ST-500 cryostat stage (now lake Shore) (details (physical dimensions etc.) of the existing ST-500 set-up can be provided)
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)
E	**Essential upgrades 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 one more LASER sources (in the visible range) in addition to the already included lasers. ➢ Suitable documentation should be provided to prove the possibility of this upgrade.
4.	AFM Modes	➢ Lift mode for 2 pass technique for MFM, EFM and KPFM. ➢ EFM mode with appropriate standard sample and set of cantilevers. ➢ KPFM mode with appropriate standard sample and set of cantilevers. ➢ MFM mode with appropriate standard sample and set of cantilevers. ➢ Nano lithography and nanomanipulation tools for surface restructuring.
5.	**Optical Techniques**	➢ Darkfield with condenser. The objectives in the main configuration must support Darkfield imaging. ➢ DIC microscopy.
E	**Warranty**	1 Year standard onsite warranty for the full system + 2 Years additional (optional) onsite warranty except for LASER
F	**Installations**	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.
G	**User Training**	Complete installation and hands on training for 2 users. Training will be given at UGC-DAE CSR, Indore Centre.
H	**Service support**	A principal company service facility in India is desired. At least two factory-trained service engineers should be available in India.
I	**Pre-installation advice**	Necessary pre-installation advice including space and power requirement should be enclosed along with the offer.
J	**Spares**	All essential and recommended spares should be informed and should be quoted separately. Parts should be available for at least next 10 years.
K	**Published results**	Attach at least 5-10 papers in reputed international journal where the quoted system is primarily used for data collection.