



INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
MATERIALS MANAGEMENT DIVISION
Powai, Mumbai 400076.

Specifications for “Raman spectrometer” to be established as a central facility at IITB

Rfx No. 610000686 (Reference No :1000016797)

Note 1: All components are necessary. Some suggestions for the suitable option are provided based on previous experience.

Note 2: In the technical bid, point by point list should be furnished to demonstrate requirements have been met.

Other important terms:

1. The Raman spectrometer system should come with a five-year warranty except for lasers, which should be for two years. The heating stage and UPS should come with a warranty of three years. Vibrational isolation table and dehumidifying dry storage should come with a warranty of one year. During warranty, all spare parts should be included free of cost, and at least three maintenance/breakdown service per year should be provided.
2. The authorization letter should be furnished along with the quotation.
3. **It is mandatory to quote price on DDP basis in the bidding engine. Bidders have to select FCA/ FOB as the system won't allow bidders to select DDP in online bidding engine. The compliance statement should be enclosed with the quotation.**
4. The vendor should furnish a letter of authorization from the manufacturer along with the quotation. Also, the manufacturer should have ISO9001 or similar certifications.
5. The vendor should have trained service personnel to provide efficient after-sales service support. Names of three personnel, along with their training certificates, should be furnished along with the quotation.
6. The vendor must have done installation of at least five similar (with four lasers including UV) Raman spectrometers during the last 10 years in the government academic institutions and R&D labs in India to be supported with installation reports obtained from the Institutions. The names and contact details of the Institutions where the instruments are supplied and installed should be given so that the technical Committee can ascertain the veracity of the information provided.
7. The installation should be done free of cost for all equipment. Training to operate the instrument must be given to our research scholars free of charge.
8. Trained Service engineers in India or directly from OEM must be available to resolve technical problems within a week.

9. The vendor should take total responsibility to install the Raman spectrometer with the heating stage and cryostat and demonstrate the performance.
10. All power supplies should be Indian type 230+/-10% Volts, 50 Hz, with Indian standard plugs. If Indian plugs are not available, suitable converters must be provided.
11. In the technical bid, technical specifications described below should be substantiated with data measurement of 5 user-supplied samples. The inability to do so will lead to disqualification from the tender process.

Confocal Laser Raman and PL spectrometer

Fully integrated and computer-controlled confocal Raman spectrometer with a research-grade microscope and all necessary optics and accessories. The specifications are below.

1. Spectrograph equipped with a research-grade microscope capable of producing Raman (wavenumber transfer 50 to 4000 cm^{-1}) and PL (330 nm to 1.7 microns).
2. Spectral Range of spectrometer: 200 nm – 2200 nm
3. Autofocusing of a laser beam on non-planar samples for 2D mapping.
4. High throughput: 1x1 mm^2 area with 10 micro meter resolution in less than 60 minutes.
5. Scanning step size for 2D mapping to be better than 50 nm.
6. See the table for the minimum specification requirement for each laser wavelength. Laser switching must be computer-controlled without any need for realignment.

| Laser wavelength | HeCd 325 nm | Diode 532 nm | HeNe 633 nm | Diode 830 nm |
|--|---|---|--|---|
| Power | > 25 mW | > 50 mW | > 17 mW | > 200 mW |
| Spectral resolution (FWHM) | 2 cm^{-1} with 2400 gr/mm | 0.5 cm^{-1} with 2400 gr/mm | 1 cm^{-1} with 1800 gr/mm | 0.75 cm^{-1} with 1200 gr/mm |
| Gratings (on a computer-controlled stage, easy switching without realignment) | 600/1200/1800/2400 gr/mm | 600/1200/1800/2400 gr/mm | 600/1200/1800/2400 gr/mm | 600/1200/1800/2400 gr/mm |
| PL | 330 nm to 1100 nm | -- | -- | 830 nm to 1600 nm |
| Minimum Raman wavenumber required | 200 cm^{-1} for routine measurements | 50 cm^{-1} for routine measurements, 10 cm^{-1} for low wavenumber measurements | 50 cm^{-1} for routine measurements | 100 cm^{-1} for routine measurements |

| | | | | |
|------------------|-------------------------------|--|--|--|
| Remote probe | -- | Fiber optic, motorized switching option fully controlled by software, hands-free alignment, 100 to 4000 cm ⁻¹ , 2 optical fibers of 5 m length each, white light illumination system and video viewer, motorized visualization system to view both sample and laser spot, optics for injecting the laser beam in a fiber, achromatic focusing and collecting lens of 40 to 50 mm focal length, and any other necessary interface kit. | -- | -- |
| Objectives | 15x (minimum of 8 mm WD), 40X | 5x, 20 X, 50 X (LWD, minimum of 8 mm), 100 X | 5x, 20 X, 50 X (LWD, minimum of 8 mm), 100 X | 5x, 20 X, 50 X (LWD, minimum of 8 mm), 100 X |
| Polarization kit | -- | Continuous laser polarization rotator (>180 degrees rotation) for outgoing beam (analyzer), and quarter and half | -- | -- |

| | | | | |
|---|---|---|---|---|
| | | waveplate for incoming laser beam before the sample | | |
| Detector (spectrometer should support two detectors to be mounted simultaneously) | A fully automated multichannel high efficiency thermoelectrically (-60 deg C Peltier cooled) cooled back-illuminated CCD, pixel size: 1024x256, Quantum efficiency > 80% between Spectral Range 400 and 850 nm, overall spectral range 200 to 1060 nm | A fully automated multichannel high efficiency thermoelectrically (-60 deg C Peltier cooled) cooled back-illuminated CCD, pixel size: 1024x256, Quantum efficiency > 80% between Spectral Range 400 and 850 nm, overall spectral range 200 to 1060 nm | A fully automated multichannel high efficiency thermoelectrically (-60 deg C Peltier cooled) cooled back-illuminated CCD, pixel size: 1024x256, Quantum efficiency > 80% between Spectral Range 400 and 850 nm, overall spectral range 200 to 1060 nm | A fully automated multichannel high efficiency thermoelectrically (-60 deg C Peltier cooled) cooled back-illuminated CCD, pixel size: 1024x256, Quantum efficiency > 80% between Spectral Range 400 and 850 nm, overall spectral range 200 to 1060 nm, and InGaAs array detector, 512x1 pixels, spectral Range: 800 to 1700 nm (-90 deg C Peltier cooled), Quantum efficiency > 80% between Spectral Range 1000 and 1500 nm |
| Fast imaging | | | | High resolution (250 nm) fast imaging, imaging speed > 1000 spectra/second |

7. Grating efficiency (efficiency curve should be provided with the technical specifications):

- a. 600gr/mm should have >50% efficiency between 250 and 430 nm for the unpolarized light. It can be less and more for S and P polarization.
 - b. 1200gr/mm should have >50% efficiency between 650 and 1000 nm for the unpolarized light. It can be less and more for S and P polarization.
 - c. 1800gr/mm should have >50% efficiency between 530 and 730 nm for the unpolarized light. It can be less and more for S and P polarization.
 - d. 2400gr/mm should have >40% efficiency between 400 and 700 nm, and >30% efficiency between 200 and 400 nm for the unpolarized light. It can be less and more for S and P polarization.
8. Spatial resolution: better than 2 microns for both axial and lateral directions
 9. Spectrograph should allow continuous acquisition for the entire spectral Range to avoid any discontinuities at any given wavenumber. Measurement resolution, as specified in the above table, should be maintained during the acquisition.
 10. Minimum of 12 power levels in neutral density filters going from 0.0001 to 100%
 11. High stability research-grade microscope with color camera and directly coupled to the spectrometer. Reflected light illumination must be available. A video camera must be attached to the microscope for viewing the specimen.
 12. XYZ motorized and computer-controlled mapping stage with a minimum travel distance of 110x75x25 mm with a resolution of 50x50x10 nm. It should come with a joystick.
 13. Sampling arm or open space microscope: For bigger samples or samples in an external cryostat/heating stage, which cannot be fitted under the microscope. It should be coupled to the XYZ motorized stage, so we do not need to move the samples.
 14. Calibration: Automatic calibration on single crystal silicon sample and neon light. Motorized switching between laser and white light sample.
 15. Power meter: should measure 100 micro Watt to 2 Watt with 10 micro Watt resolution, capable of measuring from 190 to 1060 nm.
 16. Computer: Minimum of the dual-core 10 Gen processor, 16 GB RAM, Graphics card for 3D viewing, DVD-RW, 2 TB HDD, 2 USB 3 ports, Windows 10 (64 bit), 24-inch LED color monitor.
 17. Software: Should be available on a minimum of 6 computers for remote analysis of data. Capable of collecting and performing full Raman and PL data analysis, including background removal, peak fitting, averaging, etc., fully integrated with all motorized stages of the spectrometer and XYZ mapping stage.
 18. Libraries: Inorganic and minerals, polymeric materials, biochemicals. Minimum of 5000 entries in the libraries. Libraries should be permanent. Mention the company name where an additional library can be acquired.

To ensure the above requirements have been met, we will:

- I. Evaluate data on five user-supplied samples.
- II. Demonstration of 2D mapping in pharmaceutical tablet of typical dimension 12.5x12.5 mm² with 100-micron resolution in less than 60 minutes.

- III. Check the spectral resolution of the neon line. It should meet the requirement listed in the table.
- IV. Check the reproducibility of the spectra. It should be better than 0.02 cm^{-1} when repeated over a minimum of 25 acquisitions.
- V. Check higher harmonics of silicon at 1440 and 1940 cm^{-1} . The minimum expected signal to noise ratio must be 25:1 and 4:1 for 1440 and 1940 cm^{-1} , respectively.
- VI. Check for long exposures of more than 10 minutes. The Raman shift must not shift by more than 0.02 cm^{-1} , thus ensuring phonon linewidths do not broaden.
- VII. Check the L-cysteine sample to make sure the 14.9 cm^{-1} peak is visible including full shoulder. The vendor should supply the L-cysteine sample.
- VIII. Check for any discontinuity in the measured Raman spectrum for extended scanning range (Raman shift of 50 to 4000 cm^{-1} measured with 532 nm laser).
- IX. Testing of bigger samples which cannot be accommodated under the microscope.

UPS

1. Uninterrupted power supply battery back-up of the entire Raman system (including all motorized stages) must be more than 2 hours.

Vibration isolation table

A. Specifications for Table Top

- Size: $2400\text{mm(L)} \times 1200\text{mm(B)} \times 200\text{mm(T)}$
- Construction: Honeycomb core
- Core Design: Honeycomb core made of 0.3 mm aluminum sheet
- Top Skin: 5.0mm thickness 410 series magnetic stainless-steel plate, smooth sanded finish
- Core cell size: 6 sq.cm
- Sidewalls: Compressed wooden particle boards with lack mat finish
- Bottom skin: 5mm thickness epoxy coated MS
- Surface flatness: $\pm 0.1\text{mm}$ over $300\text{mm} \times 300\text{mm}$ area
- Mounting holes: Metric: M6-1.0 holes on 25mm grid, 37.5mm borders, nylon cups under each tapped hole for the protection of the core.
- Damping: Broadband standard damping
- Bonding: Preferably semi-solid epoxy

B. Specifications of Isolator

- Isolate the optical table from vertical and horizontal vibrations in 3 to 50 Hz frequency range

C. Performance Specifications

- >90% at 5 Hz (both horizontal and vertical)
- >97% at 10 Hz (both horizontal and vertical)
- Maximum load capacity > 1000 kg
- Vertical resonant frequency ≤ 1.25 Hz, transmissibility at resonance should be less than 10dB
- Horizontal resonant frequency ≤ 1.0 Hz, transmissibility at resonance should be less than 10dB
- Self-leveling repeatability < ± 0.5 mm
- Height > 600 mm and less than < 800 mm
- Height adjustment range: -10 mm to +5 mm

D. Air Compressor

- Appropriate air compressor should come with the table for filling the air up to 80 psi

Heating Stage for Raman spectrometer

Full kit for Micro thermometric cell working from ambient temperature up to 1500 °C controlled by software, with the following specifications:

1. Sample crucible/cup size: ≥ 7 mm diameter and minimum of 3mm deep
2. Suitable for transmitted and reflected light
3. Gas-tight chamber for atmospheric control
4. Water cooling connections for stage lid and body
5. Should come with water circulation unit and touch screen temperature controller
6. Should be integrated with the Raman system computer
7. Heating rate should be between 0.1 degC/min to 200 degC/min.
8. Temperature stability < 1 degC
9. Objective lens working distance < 8 mm

Dehumidifying dry storage cabinet

1. Capacity: 80 liters or more
2. Toughened Glass Windows
3. LED Display for Temperature and Humidity
4. Humidity Controller maintains stable RH Level within accuracy: $\pm 5\%$ RH or better

5. Humidity Range: 25 - 60 %RH (should reach 25%RH in less than 2 hours initially, and recovery time should be better than 30 minutes)
6. Humidity Technique: As suitable, preferably -- Semi-permanent dry Desiccant
7. Minimum Doors/Shelves: 2 Doors/3 Shelves
8. Input Supply: 220V ~ 240V, 50Hz

Closed cycle cryostat for Raman spectrometer (not to be quoted)

The cryostat with the below specifications must be compatible with the Raman spectrometer. The vendor must take responsibility for their integration. A separate tender is being floated for the cryostat.

1. The temperature at the sample mount (not the second stage) should be controllable at least from 10 to 325 K.
2. Temperature stability should be better than 50 mK.
3. If required for operation, the unit should come with a chiller unit with minimum of 10m piping length and water reservoir tank.
4. Temperature controller unit (preferably Lakeshore 335)
 - Two independent diode / resistor input channels;
 - Two independent heater output loops (1st loop 25 W max banana plug output, 2nd loop 2 W max detachable terminal block)
 - Autotuning PID, audible and visual alarms, and relays;
 - GPIB (IEEE-488) parallel computer interfaces;
 - Cable to connect to cryostat.
5. Dry turbo pumping station with dry diaphragm backing pump from reputed suppliers only
 - a. Suitable vacuum gauge, vent valve, SS bellows, all necessary connections to be supplied.
 - b. Turbo Pumping speed for N₂ with NW40 should be at least 40 liter/sec.
6. Maintenance interval: minimum of 30,000 hours for compressor and 12,000 hours of the cold head.
7. Exchange-gas low vibration design with flexible rubber bellows.
8. Cryostat should have 10-pin feedthrough with 10 PhBr wires running to sample holder for user experimentation (exclude all other standard cryostat wires)
9. The system should come with a microscopy extension to be used under a microscope.
 - a. The length of microscopy extension from center of vacuum shroud should be ≥ 200 mm, and length of microscopy extension rod should be ≥ 80 mm.
 - b. Microscopy extension top & bottom flange diameter should less than 120 mm.
 - c. Microscopy extension height should be less than 40 mm.

- d. Microscopy extension top flange height should be less than 75mm when measured from base of cryostat.
10. Window material should be made from UV-grade fused silica windows. Windows should be epoxy sealed. Windows should be both on the top and bottom flanges and at least 1-inch diameter. Optical windows must have more than 90% transmission for 300nm to 1700nm.
11. Working distance: the sample position to outer quartz window distance must be less than 7 mm.
12. Vibrations at the sample position in the laboratory working condition must be less than 120 nm when measured from 0 to 100 Hz. Vibration data to be provided in the same range with the technical bid measured using the same parts that are going to be supplied. Vibration test reports to be submitted prior to shipment.
13. Cooling power of bare cryocooler should be more than 7.5 W @ 20 K (second stage), 1.5 Watts @ 10 K (second stage), and 15 W @ 40 K (first stage). Initial cooldown time should be less than 2.5 hrs @ 50 Hz to reach 10 K from ambient.
14. The water-cooled compressor with a full charge of high-purity helium gas
15. Cryostat vacuum shroud base should not occupy more than 130 mm diameter space on optical table.
16. Cryostat drawing & product brochure with detail specifications to be submitted along with technical bid
17. The system should come with all necessary flex lines (minimum 10 feet long) and cold head control cable (minimum 10 feet long), exchange gas valve manifold with pressure relief valve, hose adaptor, flanges, evacuation valve, safety pressure relief valve, calibrated temperature sensor.
18. The system should come with a gold plated OFHC copper optical sample holder. Sample holder should have space to accommodate samples of 10 mm diameter or more.
19. Appropriate mounting stand arrangement with castors & lock for mounting cold head to be included.

