



INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

MATERIALS MANAGEMENT DIVISION

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Raman Frequency (RF)/Optical (PL) Characterization System Upgrade [RF/Optical Characterization System Upgrade] Technical Specifications

IIT Bombay wants upgrade the recently purchased optical table and laser to a complete characterization set up for Raman Frequency (RF) and Optical (PL) measurements. In regards to the above requirement, IIT Bombay wants to procure an automated and fully integrated computer controlled confocal Raman frequency measurement set up/spectrometer with the capabilities of recording Raman Frequency spectrum, Raman Imaging and Optical/Photo-luminescence (PL) measurements on all kind of solids (crystalline and ceramics), glassy, polymer, thin films and liquids of micro and macro samples. The “RF/Optical Characterization System Upgrade” should be inclusive of confocal microscope with objectives, detector, Lasers, optics and other necessary accessories for all components of the machine, along with computers & software for data acquisition and data analysis.

The system capabilities should include

1. Raman frequency measurements in the wavelength range of 200 nm to 2100 nm with suitable achromatic optics.
2. A focal length of 800 mm or better.
3. Multiple output ports to incorporate at least two (preferably three) detectors simultaneously for a broad spectral range coverage.
4. Performing optical photo-luminescence measurements up to 2100 nm with a resolution better than 0.1 nm.
5. Capability to measure the optical signal in the entire spectral range (200 – 2100 nm) without any change in optics.
6. Performing temperature dependent Raman frequency and optical PL measurements
7. Perform light polarization dependent Raman frequency and optical PL measurements
8. To apply electrical signals to the sample (signal source is not required)
9. Additionally, the system operation should be extendable to perform UV Raman frequency spectroscopy with 266 nm wavelength or lower.
10. Also, the system should be upgradable for AFM and TERS measurements with appropriate connecting ports.

Technical Specification

The vendor should quote for supply, delivery, installation, testing and commissioning with a list of other accessories required for complete and smooth installation and uninterrupted operation of the equipment. The technical offer should also include make and model number of facilities such as microscope, LASERS, optical components (objectives, filters, polarizers, mirrors, and others), optics for interfacing with heating and cooling stages etc.

The complete RF/ Optical Characterization System Upgrade should include the mentioned items with proposed technical specifications.

ITEM 1: Raman Spectrometer for Raman frequency measurements, PL measurements and Raman Imaging

ITEM 2: 532 nm LASERS for Raman and PL Spectroscopy

ITEM 3: Software controlled temperature dependent measurement set up

ITEM 4: Research Grade optical accessories (objective, gratings)

ITEM 5: Detectors – CCD and NIR detector

A. Raman spectrometer

A Czerny-Turner type achromatic spectrograph equipped with confocal microscope and reflective optics to cover wide spectral range.

- Spectral Range (Excitation wavelengths): 200 nm – 2100 nm,
- Focal length: 800 mm or better.
- Spectral resolution: $\sim 0.5 \text{ cm}^{-1}$ (or better) with suitable optics. The Vendor should specify with suitable optics and gratings to achieve best spectral resolution for various excitation lasers.
- Spatial resolution: 500 nm or better
- Multiple output ports to incorporate 2-3 detectors simultaneously without any change in the optics.
- Gratings: 300, 600, and 1800 gr/mm (at least two of the gratings) mounted on a motorized turret driven and controlled by software. The grating mount should be capable of holding at least two or more gratings at a time. The gratings should be quickly and easily interchangeable without realignment.
- Include Rayleigh scattering filters
- The cut-off for the laser should be 50 cm^{-1} or lower with suitable optics.
- Appropriate ports for future upgrade to AFM and TERS measurements.

B. Laser:

The laser should be air cooled for maximal confocal performance.

The LASER should be extremely stable for the long time Raman experiments (at least 48 hours continuously). Vendors also provides the information and data sheet about sensitivity (signal to noise ratio) for each LASER.

- Excitation LASER 532 nm (100 mW or more),
- Lasers switching preferably software controlled.
- Laser Power Control: The spectrometer should be fitted with a filter wheel with 9 neutral density filters (100%, 50%, 25%, 10%, 5%, 3%, 1%, 0.1%, 0.01%) controlled by software to control the LASER power on the sample.

- Laser line filters should be provided if required for specific excitation laser.
- Digital laser power meter: To measure the power on the sample
- A set of visible half wave plate should be provided for 90° rotation of the incoming laser polarization and a Vis analyzer to analyse the Raman signal for 532nm laser
- Safety equipment and protective eye-glasses for LASERS (2 numbers)

C. Temperature measurements: 4-probe cryo stage should be provided with the following specification

- Temperature range -196° to 600°C
- Up to 150°C/min heating or better
- Temperature stability <0.1°C
- Sample area 22 mm diameter or better
- Quick-release gas valves for atmospheric control
- 100 ohm platinum resistor sensor or better. 1/10th Din Class A to 0.1°C
- Light aperture ~ 2.4mm Ø
- Silver heating block for high thermal conductivity
- Direct injection of the coolant into the silver block
- Single ultra-thin lid window ~ 0.17mm
- Objective lens working distance ~ 4.5mm
- Water cooled stage body for high temperature work (>300°C) with water circulation pump
- 4 electrical probes with suitable connections for applying electrical bias

D. Optics accessories

I. Confocal Microscope:

A high stability open space research grade microscope

- Microscope should be branded research grade microscope (for instance Olympus/Nikon/Zeiss/Leica or specify) with USB-PC controlled high-resolution camera for viewing and white light polarization option. The vendor should clearly specify the geometry, model and make of the microscope.
- Objectives: Infinity corrected objectives suitable for Raman frequency and Optical PL Measurements. Normal function: Magnification 5X, 10X, 100X (NA~0.9) and 50XLWD (WD ~ 10.6 mm)
- The microscope should have provision for large free space under the objective turret to accommodate large sample holders like cryostat, high temperature and high-pressure cells.

II. Confocal Raman Imaging

- XYZ motorized stage with 100 nm (or better) step size in XY & 16 nm (or better) in Z direction. A detachable sample holder XYZ Mapping Stage with manual (with Joy Stick) as well as computer-controlled, XY-Z movements. The same should also be compatible with applied electrical bias or temperature-dependent measurements.
- Additionally, an integrated polarizer-analyzer assembly for light polarization dependent measurements

E. Detectors

I. A multichannel air cooled (-60°C) CCD detector:

- High efficiency thermoelectrically cooled CCD: A fully automated multichannel detectors suitable for both Raman and PL measurements with active pixels 1024 X 256 pixels and pixel size of 26 μm X 26 μm (or better). Quantum efficiency must be 30 % or more (in the required spectral range).

II. NIR detector

- LN₂ cooled Linear InGaAs array detector of 512 pixels.
- Working from 1050 to 2050 nm. Including a 3l LN₂ Dewar for 72hr autonomy.
- Includes motorized detector exit and Multichannel adaptation
- 50X LWD NIR objective, NA = 0.55, WD = 8 mm
- 300gr/mm ruled grating blazed at 1000 nm with pre-aligned holder, calibration and tests
- 600gr/mm ruled grating blazed at 750 nm with pre-aligned holder, calibration and tests

F. Computer and software:

- The state-of-the-art computer control system compatible with and optimized for the application software to perform the various measurement options automatically.
- The data acquisition and analysis software should be compatible with Windows 7/8/10 or latest version of computer environment. Enough number of software licenses should be supplied for control of the instrument, data acquisition and data analysis for Raman, photoluminescence and Raman mapping with storage options. The software should have automatic spectral intensity corrections. The data file should be compatible for plotting in different data plotting and analyzing software.
- The vendor should provide at least 5 number of the latest software licenses for data/spectrum analysis.
- A latest library of Raman spectra for inorganic and organics materials should be provided.

G. Other Requirements:

The vendor should provide declaration certificates for following

- Vendor should provide the standard samples for testing and calibrating the instruments at any time for the demonstration of the performance of equipment.
- Manuals (both electronic and hard copy) – technical aspects with required service details
- Installation – The satisfactory installation to the full specifications of the machine with all accessories at IIT Bombay campus. Any additional equipment/accessory for the installation of the system should be quoted invariably.
- Training – Free training to the operators and students/staffs to the satisfaction of IIT Bombay.
- Warranty – 2-year on-site warranty (give details including scope, no. of visits, etc.) and at least one year on the laser. Any part(s) that are not covered under warranty should be mentioned clearly.
- The complete system should be compatible to 220-230 VAC 50Hz, single phase power supply. The vendor should specify the power requirements for all the components in the technical quotation.
- Vendor should provide the tools and spare parts for smooth functioning of the machine for atleast 2 years.