Sr. No. 98 / Reference No. : 101

Detailed Description of Item : Gas & Solvent Sorption Analyzer :

1. **Gas sorption system with physisorption and chemisorption capabilities for Microporous and Mesoporous samples.**

1. **Low Pressure:**

Sr. No.	Parameter	Expected performance
1	Operating pressure range	~10^{-6} kPa to ambient pressure (~ 1 bar)
2	Pressure transducers	Multiple pressure (at least 3) transducers working at suitable pressure range for accurate pressure measurements
3	Pressure resolution	~0.005 kPa
4	Accuracy	<± 0.15% of full scale over entire operating pressure range
5	Manifold	Thermostatted manifold
6	Gas Inlet Ports	At least 3, Dedicated port for He
7	Number of Sample analysis ports	3 or more (all capable of micropore analysis)
8	Adsorptive Gases	N_2, Ar, CO_2, CH_4, H_2, O_2, Kr, CO, Ethane (C_2H_6), Butane (C_4H_{10}), Acetylene (C_2H_2), and other non-corrosive gases.
9	Gas sorption Measurement Temperature Range	77 K to at least 323 K Dewar vessel should hold Liq. N_2 at least for 60 h. Re-circulated bath for ambient and above ambient temperature measurements

10	Analysis Software Capabilities:	1) Adsorption and Desorption Isotherm, 2) PCT Curve 3) BET plot (single point, Multi point) 4) Langmuir plot, 5) Mesopore size distribution Analysis (DH, BJH, CI, INNES plot) 6) Micropore size distribution (MP, HK, SF plot) (range 0.35 to ~ 500 nm), 7) Total Pore volume (detectable within 0.0001 cc/g) 8) t plot 9) α_s plot 10) DA plot 11) Metal dispersion analysis 12) Isosteric heat of adsorption 13) Difference of Adsorption Isotherm 14) Molecular probe plot 15) NLDFT/ GCMC pore size distribution and other standard software features
11	Sample Pretreatment unit:	Separate unit capable of treating at least 3 samples at a time. Pre-treatment temperature range 40 to 550 ^{o}C. Programmable heating/cooling sample pre-treatment parameters
12	Reference Material	Suitable reference material for calibra-tion/check (Carbon, Zeolite, Silica based)

- **<u>High Pressure</u>:**

Sr. No.	Parameter	Expected performance
1	Operating pressure range	Ambient to at least 50 bars
2	Pressure resolution	<±0.1%
3	Accuracy	<±0.05% f.s
4	Pressure transducers	Multiple pressure (at least 3) transducers working at suitable pressure range for accurate pressure measurements
5	Gas Inlet Ports	Multiport gas inlet system (at least 2)
6	Adsorptive Gases:	N_2, Ar, CO_2, CH_4, H_2, O_2, Kr, Water vapour, CO, Ethane (C_2H_6), Butane (C_4H_{10}), Acetylene (C_2H_2), and other non-corrosive gases.
7	Measurement Temperature Range	77 K to at least 323 K
8	Software capabilities	Isotherm: Surface excess or amount adsorbed, storage capacity, Kinetics of Gas sorption, Heat of Adsorption, Isotherm overlay Etc.
9	Sample Pretreatment unit:	1)Separate unit capable of treating at least 3 samples at a time. 2) Pre-treatment temperature range 40 to 550 ^oC. 3) Programmable heating/cooling pretreatment parameters

3. **<u>Chemisorption</u>:**

Sr. No.	**Parameter**	**Expected performance**
1	Chemisorption/ Reactive gas adsorption	Capable of studying NH_3, CO_2, and F containing molecules
2	Chemisorption Furnace	1) Sample activation and measurement facility 2) Operating temperature 40 °C to 1100 °C 3) Programable heating/cooling pretreatment parameters

2. **Solvent sorption Analyzer:**

Sr. No.	**Parameter**	**Expected performance**
1	Adsorptive Solvents	H_2O, MeOH, EtOH, butanol, Iso-propanol, Benzene, Cyclohexane, Toluene and other non-corrosive solvents.
2	Measurement Temperature Range	77 K to at least 323 K (50 ^oC)
3	Required Sample amount	~20 to 200 mg
4	Solvent Degassing Facility	In-situ solvent degassing facility

*Other parameters would be similar to that of low-pressure sorption system.

3. Easy switching between gas to solvent vapor adsorption measurement preferably by software controlled manifold purging or adsorbate exchange program.

4. Appropriate computer station with good configuration, UPS, batteries to run the system for at least 60 minutes in the event of a power failure.

5. Appropriate Gas cylinders with regulators, SS tubing, nuts, Ferrules & connectors for gas connections etc. should be provided.

6. Comprehensive warranty with all the consumable and spare parts required for 5 years. This includes replacement of damaged parts and engineering/service support at the cost of the supplier. In case, the machine is down for more than 1 week during the warranty period, number of days accordingly should be compensated by providing additional extended warranty free of cost.

7. Optional:

Sr. No.	**Parameter**	**Expected performance**
1	Coating on inner walls of gas/solvent vapor transporting metal tubes and sealing	Special coating to handle the corrosive gasses.
2	Chemisorption	Temperature programmed desorption, oxidation and reduction (TPD, TPO and TPR) and pulse titration (automatic loop injection.
3	Gas switching	Software controlled multi-gas port switching unit
4	Hydrophobicity Measurement	Hydrophobicity and hydrophilicity measurement

Sr. No. 99 / Reference No. : 102
Detailed Description of Item :

N2 GAS GENERATOR :

- Technology used: pressure swing adsorption (CMS) to produce N2 gas
- Nitrogen flowrate: 10 L/min @6 bar , purity 99.9995%
- N2 dew point < -55°C
- CO2, CO < 1 ppm
- Supply with oil free compressor
- Noise level < 55 dB
- LCD display with indication of the model, inlet/outlet pressure, N2 flow tate, hours run meter and PC status LED and service maintenance indication

- Fan Exchanger with forced ventilation: The exchanger allows to cool the compressed air to allow a better separation of water and to avoid a contamination in water
- Efficiency of the filtration with water separator filter and coalescing filter: The water separator filter removes 99.9% water before the coalescing filter which protects the CMS columns
- Efficiency of the compressor cooling: 4 fans (2 side fans and 2 fans below the compressor
- Outlet Connexion: ¼ G (BSP) Female
- Electrical supply: 230V / 1 ph / 50 Hz or 110 V / 1 ph / 50-60 Hz
- Auto start
- Visual maintenance indication
- Outflow indicator
- Energy saving mode: enables the compressors to switch off when N2 supply is not required
- Alarm display with help menu
- Audible alarm sounder
- Remote access for maintenance
- Fit with wheels
- After the 1st year warranty (labour + parts), system should come with 4 years of comprehensive maintenance contract/warranty including parts and labour. The defects, if any, shall be attended to on immediate basis but in no case any defect should prolong for more than 24 hours. The comprehensive warranty includes onsite warranty with parts.

Sr. No. 100 / Reference No. : 103
Detailed Description of Item :

Digital processing confocal scanning violet laser microscope with ultra-high temperature infrared heating furnace system.

- Temperature range: Room temperature – 1700^{o}C.
- Heating rate: upto 50^{o}C/sec, cooling rate: upto 100^{o}C/sec
- Gas atmosphere: controllable from air to oxidizing, reducing and inert
- Resolution: 0.5 μm at the highest temperature

Sr. No. 101 / Reference No. : 104 (Revised)
Detailed Description of Item : A network-attached storage facility with high storage space, server to host, necessary backup/RAID tools, and UPS.

Section - A: Storage facility with a capacity of 500 TB or above. It should have the following components:

Hardware Details:-

- Intel Xeon processor (10 cores, 2.4G)
- 128GB DDR4 ECC memory
- 1+1 Redundant power supplies
- 4U form factor

STORAGE CAPACITY: -

- MAIN BOX & JBOD:- RAW Capacity = 744TB
- 21 x 12000GB SATA ENT HDD = 252TB
- 41 x 12000GB SATA ENT HDD = 492TB
- MAIN BOX & JBOD:- Usable Capacity RAID 60(8D + 2P) + 1 Hot-Spare = 517TB
- 2 SETS RAID60 (8D +2P) = 172TB
- 4 SETS RAID60 (8D +2P) = 345TB

Technical Specifications:-

- Should support up to 44 hot-swap SAS/SATA LFF/SFF HDDs/SSDs
- Should be populated with at least 41 x 12000GB, 7200RPM SATA ENT, hot-plug HDDs
- Should have sufficient (N+1) Redundant power supplies (2 x 1280W, 80Plus Platinum)
- 4U form factor [437.0 x 669.0 x 178.3 mm (W x D x H)]
- Interconnecting cable bundled

Following Features are preferred:

- Single-Controller Unified Storage (File & block)
- Should support both Block (iSCSI, FCP, SRP) & File (SMB, NFS, FTP, AFP) protocols
- Host Interface: 2 10G (SFP+) Ethernet ports, 1 x Management port
- Supports RAID 0,1,0+1,5,6,50 & 60
- Supports up to 24 hot-swap SAS/SATA LFF/SFF HDDs/SSDs in same enclosure and up to 204 HDDs/SSDs using add-on JBODs
- Populated with 21 x 12TB , SATA ENT 7200 RPM, hot-plug HDDs
- Supports SSD Caching (Optional upgrade)
- Built-in Snapshot with rollback

● WebUI for setup and configuration

Section - B :- UPS

- Please quote for appropriate UPS and batteries necessary for 60 minutes backup at full load. Please specify calculations of power consumption.

Sr. No. 102 / Reference No. : 105 (Revised)
Detailed Description of Item : High-performance computing (HPC) facility with online UPS, networking switch, and software.

Item name	**Item Description**
HPC cluster with one master and multiple compute nodes, Infiniband Switch, rack, and UPS	• **Master node** (quantity 1 no) with the following specifications: • **Processor:** 2x Intel Xeon S-4210R (10C/20T, 2.4GHz, 13.75M, 100W) (Total 20 Cores) • **Chipset:** Intel® C621 chipset • **RAM :** 4x 16 GB (Total 64 GB) DDR4-2933 ECC RDIMM (Max 12 DIMM Slots) • **HDDs:** 4x 8 TB (Total RAW 32 TB) SATA Ent. 7200 RPM 3.5" HDD • **SSD:** 1x 480 GB SSD 2.5" • **RAID:** SAS Gen-3 (12 Gbps) H/W Controller for RAID 0, 1, 5, 6, 10, 50 and 60 • **NIC:** 2x 1G Ethernet LAN ports (1x Port shared with IPMI) • **Management:** IPMI 2.0 with virtual media over LAN and KVM-over-LAN Support • **Exp. Slots:** 4x PCI-E 3.0 x16, 3x PCI-E 3.0 x8 • **VGA:** ASPEED AST 2500 BMC (onboard) • **Ports:** 4x USB 3.0 (rear), 1x VGA • **Interconnect:** 1x Infiniband (IB-EDR) 100 Gbps HBA + Cable of suitable

	length • **Chassis:** 2U Rackmountable (8x 3.5" Hot-Swap SAS3/SATA3 drive bays) • **P. Supply:** 740W High-Efficiency Platinum Level 80 PLUS Certified Power Supplies • **OS:** Open Source Linux • **Warranty:** 3 Years Comprehensive On-site Warranty • **Compute Nodes*** with the following specifications: • **Processor:** 2x Intel Xeon G-6226R (16C/32T, 2.9GHz, 22M, 150W) (Total 32 Cores) • **Chipset:** Intel® C621 chipset • **RAM :**12x 32 GB (Total 384 GB) DDR4-2933 ECC RDIMM (Max 16 DIMM Slots) • **SSD:** 1x 960 GB 2.5" SSD (Total 3x 3.5" HDD bays per hot-swap node) • **RAID:** Onboard SATA Controller for RAID 0,1 and 10 • **NIC:** 2x 1G Ethernet LAN ports (via SIOM) • **Management:** IPMI 2.0 with virtual media over LAN and KVM-over-LAN Support • **Exp. Slots:** 2x PCI-E 3.0 x16 (LP) • **VGA:** ASPEED AST 2500 BMC (onboard) • **Interconnect:** 1x Infiniband (IB-EDR) 100 Gbps HBA + Cable of suitable length • **Ports:** 2x USB 3.0 (rear), 1x VGA, 1x RJ-45 Management • **Chassis:** 2U Rackmountable (4 hot-swappable server nodes in a single 2U Chassis) • **P. Supply:** 2200W Redundant Titanium Level 80 PLUS Certified Power Supplies • **OS:** Open Source Linux • **Warranty:** 3 Years Comprehensive On-site Warranty **Please describe the software packages and compilers provided with the system.**

	• **Switches:** **Primary Interconnect (IB-EDR 100Gbps Infiniband):**- Description: 36-Ports Externally Managed IB-EDR 100 Gbps Switch **Warranty:**- 3 Years On-site **Secondary Interconnect (Gigabit Ethernet) (Quantity required: 2):**- Description: 48-Ports Gigabit Ethernet Switch using Dlink DGS-1210-52 **Warranty:**- 3 Years On-site • **UPS** • Please quote for appropriate UPS and batteries necessary for 60 minutes backup at full load. Please specify calculations of power consumption. • **Server Rack with PDU** • 42U Server Rack (800x1000 mm) with 2 PDU's each with sufficient Ports

Sr. No. 103 / Reference No. : 106 (Revised-II)
Detailed Description of Item :

Technical Specifications for Calorimetric system for characterization of molecular interactions and stability (ITC)

Applications: Measurement of heat released or absorbed during a binding interaction, characterization of molecular interactions, determination of thermodynamic parameters of interactions between ligand and receptor, assessment of the effect of molecular structure changes on binding, Enzyme kinetics, and protein stability at various temperatures.
The fully automated system must be equipped with control unit, wash module, degassing station, filling & cleaning assemblies, injection syringes, other start-up accessories necessary software's for instrument control, operation analysis of data, viewing and printing enabling accurate determination of thermodynamic parameters such as binding constants, reaction stoichiometry, enthalpy, entropy and protein stability module etc.

System discerption

- Fully-automated Microcalorimeter
- Measuring principle: Should be Direct or power compensation measurement of heat released or absorbed during a binding event with the heat compensation, detection via power feedback.

- Microcalorimetery Cell with syringe tower and Control Unit for real-time operation and post-run data analysis.
- Washing Module with detergent capability for cleaning cell and titration syringe.
  Software pack includes: ITC thermodynamic data analysis software and Microsoft Windows
- Accessory kit contains; User manuals, additional syringe, O-rings, temperature standards, fuses, plunger tips, tools,
-

Detail description :

- **Cell configuration:** It should be coin-shaped or cylindrical, Peltier elements to provide faster equilibration, faster response time, and better sensitivity.
- **Cell type:** Should be Non-capillary, enclosed in an adiabatic chamber, must be fixed in place, with active volume of the cell should be 0.2 ml or lower including dead volume. Vendors to specify the working volume and the dead volume for the offered cell.
- **Cell Material:**
  a). Should have a high-sensitivity and inert with easy cleaning and facilities efficient stirring of the solution. It must not react with non-metal and metal ions such as carboxylates, phosphate ions, silver, gold, and magnesium and also should not react with thiol compounds.
  b) Cell material should also be highly resistance to extreme pH conditions
  Vendors to specify the working detail about the resistivity of the constituent material to various possible samples. Cell material should be very high chemical resistance to extremes of pH and solvents, acid, base, and detergent based cleaning materials.

- **Samples:** In solution state including turbid samples the detectable heat range should be in between ~ 10 ncal to ~ 10.0 µcal or similar. Vendors can specify any deviations.
- **Injection syringe capacity:** The volume capacity should be in between ≤ 40 µL or ≤ 250 µL depending upon vendors instrumetation and injection syringe volumes
- **Minimum detectable heat**: ~ 50 ncal to ~10.0 µcal or similar
- **Injection syringe and wash module:** Purging options to remove air bubbles, automated washing and cleaning of cell and syringe. The injection volume should have high precision
- **Injection Volume Precision:** 0.01 µL or similar
- **Equilibration time:** Instrument should have quick re-equilibration between injections. The system should have shorter equilibration time between injections, leading to increased productivity. Movement of instrument operating temperature should be fast with short system equilibration time when moving the temperature. < 5 min (lesser will be preferred) between 35°C to 5°C.
- **User selectable Feedback Mode:** Multiple feedback mode option
- **Sample concentration range:** 10 µM or lower
- **Sensitivity:** Base line noise level measured (RMS average) must be 0.15 nano calories/s or better for coined shaped cell and for Cylindrical shaped Cell, the Baseline stability is 0.02 µWatt/hr and Low noise level is 0.002 µWatt/hr or in the similar range.
- **Response time:** The system should have response time ~ 15 seconds or lower.
- **Mixing or stirring speed:** Should have user definable mixing speed with twisted stirring paddle for increasing the mixing efficiency at slow speeds. The system should have multiple

mixing speed ~1000 rpm or more for coined shape and for cylindrical shaped cell 0 to 200 rpm.

- **Operating temperature range:** ~5°C to 80°C with temperature stability ~ ±0.0001°C at 25°C.
- **Temperature control system:** Peltier controlled system for rapid temperature equilibration.
- **Binding constants detectable range:** Should be able to detect interactions with binding constants in the range of millimolar to nano-molar for normal binding and millimolar to nano-molar for competitive binding.
- **Pipette assembly:** Automated and controlled by the software to minimize sample loss or introduction of air bubbles encountered during manual filling.
- **Temperature control system:** Solid-state thermoelectric devices with active heating and cooling to maintain accurate, precise temperature control.
- **Instrument Cleaning**: Instrument should have separate solvent access ports available on the instrument for easy cleaning. Cleaning of the stirring and injection systems should be user programmable and fully automated. No manual repositioning of the injection and stirring systems and should be Compatible with non-aqueous solvents.
- **Software:** Should be compatible with the latest model and upgradable periodically.
  Software: (a) Should be capable of running instrument, injector control, providing user- selectable binding models, and data merging like: single site, two site, sequential site, competitive site, and enzyme kinetics. Non-linear least square analysis of the data should include calculations to correct for the excluded concentrations of the macromolecules and ligands during each injection. It should be easy to export and use data in other formats. Should allow corrections for heats of dilution and blank effects, Should have experiment optimization tool for post-titration adjustments of all experimental parameters for optimizing subsequent titrations. Should have Dedicated fitting model for Enthalpy Screening data. It should generate high resolution images, which are ready to publish data like, Scatter plot, Statistical plot, Signature plot.
  (b) Analysis software: should provide copies of offline analysis software and should not require a separate software supporting license.
- **Computer**: All in one Computer and necessary software for operation, data collection and analysis, viewing should be provided. Current generation computer will be supply along with the instrument with Windows OS. Monitor High resolution with capability for extension

14. **Data processing**

Automated and manual; remote connection capabilities
Including comprehensive data analysis package with scripts. Additional licence for data analysis software

- 21. **Analysis software:** should provide unlimited copies of offline analysis software and should not require a separate software supporting license.
- 22. **Training:**
- Must include an intense training by a company expert for all mode of data recording and analysis after installation
- Periodic training by local engineers for usage of the instrument
- There should be at least one service engineer and one application scientist based in India for easy servicing of the instrument.
- **UPS:** 10 KVA or appropriate for the instrument (
- **Warranty: 5 Years of CMC (all parts, all electronic boards should be covered)**

- A user-list should be provided highlighting installation of similar equipment in other research institutes in India in the recent past. Preferably in any IIT's.

Sr. No. 104 / Reference No. : 110 (Revised)
Detailed Description of Item :

Cameras and Accessories for Motion Capture System :

Specifications for Additional Cameras and Accessories for a Augmenting/Upgrading and existing Motion Capture System

Line Item 1: Camera for Motion Capture System (Qty. 2)

Two additional cameras are required to augment a four-camera Motion Capture System already installed at our facility. This motion capture system is used for providing measurements of 3D Positions and Orientations of at least two rigid bodies (each having a typical dimension of 1.5 feet) where these two rigid bodies are connected to each other by means of a joint (e.g. a revolute/pin joint) and hence constrained to stay close to each other. The system should be able to track this combination of rigid bodies in a volume of 15 feet X 15 feet X 10 feet. In order to increase the number of rigid bodies that this system can capture we wish to add two more cameras to this system along with all associated accessories such as cables (at least 30 m for each camera) and mounting clamps and heads. Detailed specifications are given below.

Camera Output:

- Optical Motion Capture Camera must provide Full 256 grayscale output for marker centroid identification.
- Imaging Sensor:
- The camera must provide a custom-designed imaging sensor with a full frame resolution of atleast 5 million pixels at atleast 420Hz.
- The custom designed imaging sensor must provide 256 subpixel resolution for the highest centroid identification accuracy.
- The custom designed imaging sensor must possess an electronic freeze frame shutter / global shutter that records the entire sensor image at the same exact point in time. Allows for sharp and accurate data when captured at high speed.

1. On-Board Processing:
    - The Camera must contain dedicated on-board processors for maximizing data accuracy and throughput.
    - On-board processors must be able to resolve partially overlapped markers with separate centroids.
2. 2D On-Board Processing:
    - Camera must transmit additional 2D tracking information to host PC for superior labeling and reconstruction.
3. Camera Lens Field of View:
    - Camera must be available in 56 and 70 degree Lens and Strobe FoV combinations using high power IR wave length (850nm), resulting in superior volume coverage and illumination of lens FoV.
    - IR waves emitted from strobe must directed and focused with secondary optics.
    - Camera Sensing and Feedback:
    - Camera must be equipped with an accelerometer to enable camera selection for simple system set-up (Tap to Select). Accelerometers also monitor camera position in real time and provide notice if camera is bumped or moved after system calibration.
    - Camera must be equipped with Thermal Sensors to detect changes in camera temperature which could affect system status.
    - Camera must be equipped with front facing OLED display to provide camera identification, information and system status.
        - Data Transmission:
        - Data communication and motion capture system power must be transmitted to the camera in a single cable - for easier and faster system set up.
        - Data must be communicated throughout motion capture system with Gigabit Ethernet speed (1Gigabit/second).
        - Interference Free:
        - The Camera must be able to operate without interference from normally existing magnetic and electronic fields within the capture environment.
        - The Camera must be able to operate out-of-doors in direct sunlight and with dynamic lighting conditions.

- Software Integration and Control:

    - Camera and software must allow a native (not 3rd party) control application to provide real-time control functionality for system set-up, calibration and operation on a mobile device; facilitating single user operation.

4. Software & Hardware Compatibility:

    - These cameras should be compatible with the existing motion capture system currently installed at our facility which comprises of Vicon Vantage V5 Cameras (Qty. 4) & Vicon Tracker Software.

5. Cables & Mounting Accessories:

    - Please also include mounting clamps, heads and cables (at least 30m) for each camera i.e. Qty. 2.

Line Item 2: Reflective Markers (Qty. 30)

14 mm IR reflective markers on hard plastic base compatible with the cameras.

General Mandatory Requirements for all Line Items

1. This cameras and associated accessories described above working in a compatibility mode with Vicon Vantage V5 Cameras and Vicon Tracker Software must be installed in India at least at one site, please give detailed contact details. Proof i.e. purchase order and satisfactory certificate from the user must be provided.

2. Installation on site by a factory trained engineer must be provided and this engineer must demonstrate proper operation of the camera in compatibility mode with our motion capture system (Vicon Vantage V5 Cameras & Vicon Tracker Software) already installed at our facility.

3. The datasheet and user's manual of the specific quoted cameras and accessories should be submitted with the bid from which determination of compliance with the specifications mentioned above is possible. These documents should also be available on the website of the OEM.

4. Detailed point wise compliance document must be submitted and must be certified by the OEM. Any vague remarks will disqualify the bid.

Sr. No. 105 / Reference No. : 111
Detailed Description of Item :

Equipment name: 3D printer for cement concrete

Target application: To build a full-scale structural elements (walls, columns) of houses conforming to affordable housing segment (Economical Weaker Section) with engineered cementitious mixtures using 3D printing technology.

Specifications:

The research project requirement demands minimum concrete print envelope or build volume (without changing the location of printer) to be 10 m^2 area with height of 3.5 m in open field. Since the printing will be done at construction site, the 3 D printer should have the capability of automatic moving capabilities with crawlers in open field application. In addition, the printer should have automatic levelling legs at open fields with undulations and variable print speed (50 mm/s to 500 mm/s) for desirable productivity. Further, the 3 D printer should have adequate capabilities to print structural elements with Portland cement based materials including aggregates having a maximum size of 8 mm.

In this regard, 3 D printer should include all the following items.

1. Integrated mixing and pumping unit
2. Crawler unit with auto levelling legs
3. Control unit
4. Dedicated software
5. Robotic arm (7 axis) with reach of 3.5 m height
6. Print head, hoses and nozzles should be customisable/modular (different shapes (circular, square, rectangle) and sizes (20 mm - 40 mm)
7. Other electrical accessories viz., connectors, cables etc.

Installation of 3D printer and training at IIT Bombay

Sr. No. 106 / Reference No. : 112 (Revised)
Detailed Description of Item : X-ray Photoelectron Spectroscopy (XPS)

Technical specifications for upgrades for x-ray photoelectron spectroscopy (XPS)

1. **Key Generic Requirements:**
    a. The tenderer must provide an installation scheme showing the physical space (footprint) of the item(s) as well as space required for routine access and all installations including related accessories
    b. The vendor should have installed similar types of systems in centrally funded technical institutes or government research labs. Purchase order (PO) and user list should be provided as supporting evidence

c. The compliance sheet should be provided by the vendor. The absence of the compliance sheet may result in the cancellation of the purchase order
d. For each compliance, supporting evidence such as manuals and other necessary and supporting documents needs to be provided
e. The vendor should have an Indian representative which can take care of the urgent troubleshooting or any queries on an urgent basis
f. Installation and training of the system should be demonstrated

2. Technical Specifications (Generic):

a. The primary purpose of the upgrade to the XPS system (Versaprobe-II from Physical Electronics) is to measure the unoccupied electronic states of solid materials to obtain the entire band structure of semiconductor films
b. The system should have the ability to measure the kinetic energy of the Auger electrons emitted from the sample surface and provide quantitative elemental and chemical state information from surfaces of solid materials
c. The system should have a heater and thermocouple-integrated sample holder for temperature control, and also contain 4 contacts for in-situ electro-chemical experiments
d. The system should have the latest instrument control software and upgraded versions of the analysis software

3. Technical Specifications (Specific):

A. Low Energy Inverse Photoemission Spectroscopy (LEIPS)

a. The LEIPS option should allow for in-situ characterization of the unoccupied electronic states of solid materials analysis
b. A low energy electron source to preserve sample chemical structure during analysis
c. Two optical filters 254 + 300 nm (4.88 pv) and 260 nm (4.78 pv)
d. New electron neutralizer assembly with BaO cathode
e. New CCD camera for analysis chamber

B. Scanning Auger Electron Spectroscopy

a. 10 keV electron gun for Auger Electron Spectroscopy (AES) and imaging with better spatial resolution than XPS
b. Scanning secondary electron detection and imaging
c. Scanning Auger spectra, images, line scans, depth profiles and maps
d. Digitally controlled and fully integrated into SmartSoft
e. Beam size performance (≤ 100 nm)
f. REELS capability In FAT mode, Elastic Peak spectrometer resolution < 0.5 eV FWHM at 1 kV electron beam on a clean gold standard sample
g. Relocation and rework of the UV lamp

C. 4 Contacts Hot and Cold Stage

a. Temperature range of -120 °C to 500 °C with a single 25 mm 4 contacts sample holder
b. Heater and thermocouple integrated in the sample holder for enhanced reliability and temperature control
c. 4 contacts with sample holder for in-situ electrochemical experiments
d. All stage motions maintained including compucentric Zalar Rotation and compucentric tilt

D. Heating Sample Holder

a. Temperature range − ambient to 800 °C

E. Vacuum Transfer Vessel

a. Compatible with the sample holders
b. Inert gas transfer from controlled atmosphere glove box to PHI analytical systems
c. Enable sample transfer between PHI analytical systems

F. Intro Ion Gauge

a. Pirani/BA hot cathode gauge with pressure measurement up to 4 x 10^{-8} Pa
b. Pressure readout on instrument computer
c. User selectable pressure setting software option for sample introduction

G. Computer and Software

1. Windows 10 for VersaProbe II

a. State-of-the-art 64-bit computer with Windows 10 O.S. with 24" Color LCD Monitor
b. New hardware including USB 3.0, COMM 16 PORT, and PCI card
c. Latest SmartSoft-VP instrument control software for Windows 10 64-bits

- Enhanced queuing for automated analysis functionality:
  - Create automated analysis queues combining survey, high resolution scans, depth profiles, maps and more
  - View and modify existing queue items while queue is running
  - Queue validation feature before starting the queue
- New sidebar dashboard for easy access to common acquisition control functions and settings
- Supports all options on VersaProbe II and III

d. New intro camera Windows 10 compatible

2. StrataPHI Thin Film Structure Analysis Software (2 nos.)

a. Software to allow for the structure estimation ofthin film stacks using single angle spectral dataand angle dependent profile data
b. To calculate thickness for thin film structures composed of discrete layers

3. Latest version of Multi-pak Software (2 copies)

H. Other components

a. Filter for LEIPS (280nm, 10nm)
b. Filter for LEIPS (285 nm,14nm)
c. Filter for LEIPS (355nm, 7nm)

I. Acceptance criterion

a. Complete on-site installation, training of all upgrades
b. Demonstration of LEIPS and Auger data measurement on standard samples as per specs
c. Demonstrate 4 contact stage operation over entire temperature range, with rotation and electrical bias
d. Demonstrate functional intro ion gauge

J. Spares, installation, training, warranty & maintenance

a. Supplier should complete installation on-site, provide a minimum of 1 year warranty post installation and on-site training of upto 4 people
b. AMC for 5 years by local Indian vendor beyond the warranty period should be included in the quotation that includes at least one maintenance visit and two emergency visits within 48 hours per year
c. Necessary spare/consumables parts for 5 years beyond the warranty period should be quoted with the system (see list below)

d. Supplier should demonstrate measurement and analysis techniques of the upgraded system
e. Cost of travel, lodging and boarding for pre-shipment inspection for the required number of days should be included on a per person basis
f. Include standards to be used for calibration of tool parameters
g. A set of basic tools required for performing routine maintenance. A tool cart that can be locked and that can accommodate these tools should be provided
h. The payment terms will be specified in the commercial proposal and is subject to negotiation
i. Please provide details of the number of trained personnel in India, number in the western region or in Mumbai who can service the machine
j. Please provide references both in India and abroad
k. The cost of shipping up to IIT Bombay should be included. IIT Bombay will help with customs clearance at Mumbai Airport. Please include your payment option. IIT Bombay would prefer to retain at least 20% of payment till instruments have been commissioned and successfully demonstrated
l. Please list a set of acceptance tests for on-site (vendor) inspection and after installation at IIT Bombay
m. All facilities requirements such as compressed air/N_2/He and chilled water should be specified

K. Consumables

a. PLATE-CHANNEL, 50MMOD, T0.48MM (2 Nos.)
b. ASSY-PCB, ANODE 32CH, VP3 (1 No.)
c. ASSY-IONIZER, MOD 06-350, Q2K (3 Nos.)
d. ASSY-FIL, LAB6, Q2K (1 No.)
e. KIT-ANODE, SERVICE FXS (1 No.)
f. ASSY-NEUT, BAO CATH, VPIII (1 No.)
g. GASKET-CU, 4.62 FLG, CLN (3 Nos.)
h. GASKET-2VCR, CU-2-VCR-2 (10 Nos.)
i. GASKET-CU 362MM OD FLANGE (10 Nos.)
j. KIT-GASKET, 1.33 OD FLG, (10) (10 Nos.)
k. KIT-GASKET, 4.50 OD FLG, (10) (10 Nos.)
l. GASKET RET ASSY-SS4VCR2GR (10 Nos.)
m. GASKET RET ASSY-CU4VCR2GR (10 Nos.)
n. FILTER-OIL MIST, KF25, ALCATEL (4 Nos.)
o. Filter-Exhaust, Vac Pump, KF-16 (4 Nos.)
p. Rough Pump-Oil Mist Filter-Copper Sieve, 4" (2 Nos.)
q. Rough Pump Oil-(Ulvac Pump)-4 liter (2 Nos.)
r. OIL RSVR, HiPace80 PM143740-T (5 Nos.)
s. BaO Cath (4 Nos.)
t. OIL RSVR, HiPace 80 PM143740-T (5 Nos.)

L. Options

a. Improved Image registration software should be quoted as an option
b. Variable temperature stage without contacts (-140 C to 600 C) should be quoted as an option

Sr. No. 107 / Reference No. : 113

Detailed Description of Item :

1) **Basic plasma cleaner** capable of bonding glass-PDMS or PDMS-PDMS for fabrication of microfluidic application. It should also be able to activate and sterile PDMS surface to help different protein coatings.

a) voltage: approx. 230V

b) Compact tabletop unit

c) Adjustable RF power settings (Low, Medium, High)

d) Maximum RF power of 18W

e) Includes 3" diameter x 6.5" lengthPyrex chamber

f) Hinged door with viewing window

2) Pyrex Sample Tray

3) Economy Dry Oxygen Vacuum Pump to enable surface oxidation and create plasma by maintaining vacuum.

- voltage: 230V
- includes adaptor, centering ring, connectors and hose

Sr. No. 108 / Reference No. : 114 (Revised)

Detailed Description of Item : Refrigerated incubator shaker

Triple eccentric counter balanced drive with 9 permanently lubricated ball bearings, solid state brushless DC motor

Stackable

Hermetically-sealed compressor using CFC-free refrigerant

Temperature range : 20º C below ambient to 80º C (min setting of 4°), increments of 0.1° Accuracy : ± 0.1º C at 37º C with a uniformity of ± 0.25º C

Shaking Range: 25 to 400 rpm with 1" (2.5 cm) orbit with ± 1 rpm shaking control

Timer: 0.1 to 99.9 hours, continuous operation Capacity: up to 6 litre flasks

Ambient Conditions: Temperature 10º C to 35º C, humidity 20% - 80% non-condensing.

Platform size: 46cm x 46cm

Single adjustable stationary shelf

In chamber moisture proof receptacle Multifunction reservoir with built in drain Low watt-density, resistance-type heaters with high temperature safety thermostat cut off

Program modes: constant speed and temperature, timed shaking, programmable multi-steps and RS-232 control

- Multistep programming with 4 programs and 15 steps per program
- Audible and visual alarms
- Chamber Illumination: 2 internal 12 V, 100 Watt halogen lights
- Safety Features: out of balance sensor, acceleration and deceleration circuit, open door/lid cut out switch, thermostat fail safe and non-volatile memory for automatic restart after power interrupt and set point retention
- Certificate: Meets CSA, UL & CE standards
- Power: 1500 VA Dimensions (W x D x H) : 62 x 75.4 x 82.5 cm
- Weight: <125 Kgs

In addition, the following must also be provided.

- **Universal Platform:** For use with shaker
- **250mL Erlenmeyer clamps with spring retainer**: For use with the Universal platform in Shakers
- **500mL Erlenmeyer clamps with spring retainer**: For use with the Universal platform in Shakers
- **Stacking Kit**

Sr. No. 109 / Reference No. : 115
Detailed Description of Item :
Multi Mode Reader with Accessories :

The reader should be capable of Measuring Absorbance, Fluorescence Intensity Top, Bottom, reading of TRF and flash/glow Luminescence with two injectors' future upgradable to Alpha screen, automated cell Imaging, TR-FRET, FP and reagent heater and stirrer module in Injectors.
The Reader should have 2 Monochromator across Excitation and 2 Monochromator across Emission also should have provision for filter selection simultaneously across excitation & emission and vice-versa to select different wavelengths.

The Reader should be able to Perform following parameters in absorbance mode:

a. Wavelength Range from 200 nm to 1000 nm with 1nm Increment
b. Full absorbance spectrum data from 200–1,000 nm in less than 5 seconds
c. Provision for Vertical/Up right Cuvette port facility
d. Temperature control ambient plus 4 to 40 deg C

The Reader should be able to perform following parameters in Fluorescence mode:

a. Wavelength Range from 250 nm to 900 nm across excitation and 280 to 900 nm emission for Fluorescence reading.
b. Facility of Bandwidth adjustment between 5 to 50 nm

The reader should be able to perform following parameters in Luminescence mode:

a. Wavelength Range from 380 nm to 700 nm
b. Reader should have option for wavelength scanning and multicolour luminescence.
c. Dynamic range should be more than 9 orders of Magnitude.
d. Detector: Photon counting low dark current PMT.
e. Reader should be able to perform BRET 1 and BRET 2 assay.
f. Dispenser should have provision for stirring and heating

Essential Accessories:

- The system should be supplied along with required laptop
- Warranty 1 year
- The software should have function for drag and drop for assay sequence and data reduction which provides an automatic export of measurement parameters into result files in a user specified formats.

Sr. No. 110 / Reference No. : 116

Detailed Description of Item :

Tetrad Dissection Microscope :

- Micromanipulator to provide a 3-dimentional X, Y, Z-axis control on a single joystick.
- The microscope stage to have a specialised index pointer and layout schematic for real-time grid location reference.
- The microscope to have an intelligent energy saving mode, automatically switching off the illumination after 15 minutes idle time.
- The microscope to have a clear acrylic holder for minimum light disruption and maximum ease of needle set up.
- A box of pre-made needles ready for dissection.
- Stage equipped with needle-protection limits to eliminate needle breakage on dish perimeter.
- Full needle change in less than 60 seconds without need for recalibration.
- Box of 10 dissection needles.
- Engineered for light-optimising transmission
- To have a light module and stage for the dissection of yeast and fungal cells and spores.
- Stage should be equipped with needle-protection limits to eliminate needle breakage on dish perimeter.
- Stage with click-stops in a grid
- The instrument to be supplied with Microzaper and the necessary power supply equipment.

Sr. No. 111 / Reference No. : 117

Detailed Description of Item :

Technical specifications for multi-material atomic layer deposition (ALD) system

1. **Key Generic Requirements:**
   a. The tenderer must provide an installation scheme showing the physical space (footprint) of the item(s) as well as space required for routine access and all installations including related accessories

b. The vendor should have installed similar types of systems in centrally funded technical institutes or government research labs. Purchase order(PO) and user list should be provided as supporting evidence
c. The compliance sheet should be provided by the vendor. The absence of the compliance sheet may result in the cancellation of the purchase order
d. For each compliance, supporting evidence such as manuals and other necessary and supporting documents needs to be provided
e. The vendor should have an Indian representative which can take care of the urgent troubleshooting or any queries on an urgent basis
f. Installation and training of the system should be demonstrated

2. Technical Specifications (Generic):

a. The primary purpose of the system is to deposit dielectric (oxide and nitride) and metal films based on sequential use of gas phase chemical process
b. The system should have the ability to deposit a wide variety of thin film materials using thermal and plasma-enhanced atomic layer deposition

3. Technical Specifications (Specific):

A. Deposition chamber

a. Flow-optimized ALD chamber for thermal and plasma depositions
b. Continuous, exposure and plasma-based operational modes
c. Deposition on substrates up to 8 inch in diameter
d. Substrate heating from RT upto minimum of 500 °C
e. <±2 % 1 sigma film uniformity for thermal and plasma Al_2O_3
f. Automated load-lock with independent turbo pumping system for low pressures
g. Film deposition on high aspect ratio features of 1 : 500 or better
h. Analytical port for in-situ ellipsometry
i. Analytical port for in-situ quartz crystal microbalance (QCM)
j. Analytical port for in-situ residual gas analyzer (RGA)
k. Analytical port for in-situ optical emission spectrometry (OES)
l. System to isolate reaction by-products from pumps
m. Easy deposition of layers and stacks of layers

B. Precursor delivery system

a. ALD reactor should be able to accommodate and function with gas, liquid, and solid precursors
b. Minimum of 6 precursor sources
c. Precursors individually heatable at least up to 200 °C
d. Heated lines and manifold (at least upto 150 °C), and valves (at least upto 200 °C)
e. High speed ALD valves(< 15ms)
f. Rapid exchange precursor cylinders with manual valves
g. Carrier gas mass flow controller
h. Spare precursor cylinders (3 nos.) should be quoted with the system

C. Plasma design

a. Pulsed plasma radical generator with auto-matching network
b. Inductively-coupled plasma (ICP) or capacitively-coupled plasma (CCP)
c. Variable RF power supply and software interfacing
d. Ability to perform thermal and plasma processes in the same recipe
e. Minimum of 6 gas inlets for plasma
f. Plasma gas inlets should be compatible with gas sources for O_2, O_3, N_2, NH_3, Ar, H_2S

D. Additional features

a. Deposition using low vapor pressure (≥ 0.01 Torr) precursors should be possible –two low vapor pressure deposition kits to enable this should be quoted in the main system
b. High concentrationozone generator (1 number) with software and MFC control (with MFC and other accessories)should be quoted
c. Chamber, precursor delivery and pump hardware should support film depositions and evacuation of by-products using metal-organic and halogen chemistries

E. Additional equipments

a. Spectroscopic ellipsometer integrated with the system from reputed manufacturer should be quoted
b. Ellipsometer should be capable of in-situ monitoring with no film deposition on its windows
c. Quartz crystal microbalance (QCM) capable of functioning upto 300 °C integrated with the system from reputed manufacturer should be quoted
d. Spare crystals (5 nos.) for QCM should be quoted

F. Computer and software

a. State-of-the-art computer system (printer, monitor, table etc.) for managing the system with data analysis/acquisition and equipment operation software
b. Ability to be controlled remotely via an internal network or the internet
c. The operating system should be Windows 10. A free upgrade if necessary should be assured
d. Monitors should be at least 19" (diagonal) LCD monitors
e. Sample recipes should be included that demonstrate different ALD modes
f. Recipe library available with the vendor must be made available
g. Automatic data logging
h. Graphing of precursor pulses versus time
i. Built-in software safety interlocks
j. Over-pressure abort
k. Over-temperature abort
l. Faulty recipe entry warnings
m. Continuous USB communication monitoring

G. Other components

a. Security features protecting the integrity of the vacuum system, in vacuum components, precursor lines and electronics in case of power failure
b. Base frame for the system chambers and rack for electronics

H. Power requirement

a. 230 VAC single phase or 440 V three phase, 50 Hz
b. Electronics control box with safety features
c. Emergency off (EMO) switch

I. Acceptance criterion

a. Vendor should agree to demonstrate film uniformity specs for 8 inch substrates: < ± 2 % 1 sigma over 150 mm for thermal Al_2O_3 and plasma Al_2O_3 measured onsite by ellipsometry after installation
b. Vendor should bring their own demo precursor for the test

J. Spares, installation, training, warranty & maintenance

a. Supplier should complete installation on-site, provide a minimum of 1 year warranty post installation and on-site training of upto4 people
b. AMC for 5 years by local Indian vendor beyond the warranty period should be included in the quotation that includes at least one maintenance visit and two emergency visits within 48 hours per year
c. Necessary spare parts for 5 years beyond the warranty period should be quoted with the system
d. Supplier should demonstrate deposition of at least one standard film (e.g. Al_2O_3) conforming to film uniformity and aspect ratio specs of the system in both thermal and plasma modes
e. Cost of travel, lodging and boarding for pre-shipment inspection for the required number of days should be included on a per person basis
f. Include standards to be used for calibration of tool parameters
g. A set of basic tools required for performing routine maintenance. A tool cart that can be locked and that can accommodate these tools should be provided
h. The payment terms will be specified in the commercial proposal and is subject to negotiation
i. Please provide details of the number of trained personnel in India, number in the western region or in Mumbai who can service the machine
j. Please provide references both in India and abroad
k. The cost of shipping up to IIT Bombay should be included. IIT Bombay will help with customs clearance at Mumbai Airport. Please include your payment option. IIT Bombay would prefer to retain at least 20% of payment till instruments have been commissioned and successfully demonstrated
l. Please list a set of acceptance tests for on-site (vendor) inspection and after installation at IIT Bombay
m. All facilities requirements such as compressed air/N_2/Ar, carrier gas and chilled water should be specified

K. Optional items

a. Please include options currently available that can be added on in the future
b. High temperature chuck (upto 800 °C) should be quoted as an option
c. Substrate bias should be included as an option
d. Spare substrate holder and gate valve shield should be quoted as an option
e. Spare vapor trap should be quoted as an option
f. Spare turbo pump for the main deposition chamber should be quoted as an option
g. Low flow pumping hardware for light samples / powders should be quoted as option
h. OES attachment from reputed manufacturer that can be easily integrated should be quoted as an option

Sr. No. 112 / Reference No. : 118

Detailed Description of Item :

Technical specifications for Profilometer

1. Key Generic Requirements:

a. The tenderer must provide an installation scheme showing the physical space (footprint) of the item(s) as well as space required for routine access and all installations including related accessories.

b. The vendor should have installedsimilar types of systems in centrally funded technical institutes or government research labs. Purchase order(PO) and user list should be provided as supporting evidence.
c. The compliance sheet should be provided by the vendor. The absence of the compliance sheet may result in the cancellation of the purchase order.
d. For each compliance, supporting evidence such as manuals and other necessary and supporting documents needs to be provided.
a. The vendor should have an Indian representative which can take care of the urgent troubleshooting or any queries on an urgent basis.
e. Installation and training of the system should be demonstrated.

2.(a) Technical Specifications (Generic):

The primary purpose of the equipment is to measure the film thickness having a "step". The measurement is to be obtained by "physical contact" method using a pointed stylus tip which scans the surface having a step etched into it. The step height provides the thickness of the deposited films. It should collect accurate step height and surface roughness measurements and should have 3D Mapping functionality. The range of thickness which is to be examined is from nanometer to millimeter with angstrom level vertical resolution. Displays of surface topography, calculation of average / mean surface roughness are required. Additionally, system also to have 2D stress measurement to calculate sample stress.The entire setup for the Profilometer should include

i. Base unit- Profilometer Set up
ii. Vibration Isolation Table
iii. Accessories

All of the above items should be from the same manufacturer.

2.(b) Technical Specifications (Specific):

A. Measurement Technique

Following are must-have features:

- contact stylus Profilometry,
- system with LVDT/LVDC sensor technology.
- All-in-one sensor that enables scans at large vertical range (up to 1 mm)

B. Power

Following are must-have features:

- In accordance with standard Indian power outlets/supply and should be supplied with an environmental enclosure.

C. Stylus

Following are must-have features:

- Stylus force: 1 to 15 mg.
- Stylus radius: Include 5 stylus of less than equal to 2 um diameter and 2 stylus of larger (> 10 um) diameter in the main system quote
- Stylus exchange and XY stage mounting

D. Sample requirements

- Sample size: Between 1 to 100mm and up to 50 mm thickness.
- Sample X/Y Stage: Motorized 150mm x 150mm or better translation with 360^{o}, rotation with 1micron XY repeatability.
- Dedicated vacuum chuck of at least 8 inch for wafer samples.

E. Camera

- Real-Time scanning window
- Viewable through high-definition >3 megapixel color video microscope.

- video microscope: Allow viewing of sample surface to enable stylus to stay in view during the scan
- Video microscope should have a minimum 0.275 to 2.2 mm vertical FOV or more.

F. Computer specs

- Latest version compatible with the set up. 64 bit Desktop Computer with Windows® 10 Pro operating system, 3.2GHz processor, 4GB RAM, 500GB hard drive or better specifications.

G. 2 D Stress Measurement

- Stress measurement capability calculates tensile and compressive stress simultaneously.

H. Measurement Software and Parameters

- The system should include automated measurement collection with analysis software which includes advanced parameters, such as S-Parameters, V-Parameters. P-Parameters, Step-Height, Surface-Area, Slope and Volume analysis. Data Analyzer tree should display all applied filters - Gaussian Regression, Fourier, Histogram, and statistical. Should be possible to load several profiles together to do the comparison. It should also be possible to extract data in Excel compatible format. It should be possible to save data and re-analyze at a later stage without actually doing the scan. The system should be capable of sub nanometer resolution with suitable stylus. The system should have live 3D visualization and stitching capability.

I. Two calibration standards

J. Vibration isolation table quoted with the system

K. Include AMC for 3 years by local Indian vendor beyond the warranty

L. Warranty: Minimum one year warranty must be included

- **Process Demonstration for onsite acceptance**

The system should include automated measurement collection with analysis software which includes advanced parameters, such as S-Parameters, V-Parameters. P-Parameters, Step-Height, Surface-Area, Slope and Volume analysis. Data Analyzer tree should display all applied filters - Gaussian Regression, Fourier, Histogram, and statistical. Should be possible to load several profiles together to do the comparison.Scan length: Scan length should be at least 50 mm. scanning should be either tip scan or stage scan, but not both.

- Step height repeatability: Step height repeatability ~ 4Angstrom or better, 1 sigma on steps ≤1μm or better.
- Data points/scan: minimum of 120,000 or higher.
- Noise: Less than 1 nm
- Vertical resolution: 1 Angstrom or lower
- Vertical measurement range: 1 nm - 1 mm
- 2 D Stress Measurement
- Save data and re-analyze at a later stage without actually doing the scan
- Capability of sub nanometer resolution with suitable stylus
- Live 3D visualization and stitching capability

Sr. No. 113 / Reference No. : 119

Detailed Description of Item : . High Performance Electron Beam Lithography System

1. General requirements

1.1. High Performance Electron Beam Lithography System for advanced Nanolithography consisting of electron optics, stage-chamber unit, vacuum control, control electronics, comprehensive control software and operating PC

1.2. System must offer high resolution SEM imaging functions for result inspection and metrology

1.3. Instrument must be delivered with temperature stabilized housing to relax site requirements down to +/-2°C
1.4. System must run factory and site acceptance
1.5. System must have small footprint of maximum 4.5m² for main system
1.6. Vendor must provide installation and initial onsite training
1.7. Vendor must have installed atleast five dedicated ebl systems in India and must have a local service & support office in India.
1.8. System must include Uninterrupted Power Supply with minimum 30 min autonomy time and automated safe shut down routine

2. Electron Optics requirement

2.1. Thermal Field Emission (TFE) Schottky Emitter
2.2. Beam energy selectable between 10 and 50 keV, in 1V step size delivered by modern and compact switch mode power supplies
2.3. Ultra fast BSE detector
2.4. Three lens optics with minimized alignment requirement
2.5. Electrostatic beam deflection capable of deflecting the beam up to 500µm x 500 µm without the need of additional subfield deflection to reduce calibrations
2.6. Zoom condenser lens arrangement for continuous beam current adjustment

3. Stage and chamber requirements

3.1. Stage travel range in XY plane 150 mm x 150 mm
3.2. Vertical stage travel range 15 mm for higher flexibility sample thickness
3.3. Stage mounted to the top chamber plate to have ONE reference for column and stage
3.4. Stage positioning by hybrid DC motor coarse and Piezo drive fine positioning with 1 nm stage movement resolution independent of working distance and beam deflection
3.5. Load lock capable of loading up to 200 mm wide samples (8" wafer, 7" mask) with automated stage transfer procedure to the kinematic – stress free – mounting on stage
3.6. Automatic on stage sample holder levelling by built in lift Piezo elements
3.7. CCD camera for sample navigation
3.8. Universal sample holder that can hold small pieces and wafers up to 4 inch diameter

4. Pattern and Scan Generator

4.1. 50MHz maximum scan speed
4.2. 18-bit analogue resolution
4.3. Future proof upgradable FPGA (Field Programmable Field Array) architecture
4.4. Pixel to pixel continuous corrections of in field astigmatism, focus and distortion in real time
4.5. 64-bit operating system with 32Gbyte memory to handle large CAD data
4.6. Water cooled circuits for highest stability and accurate DAC performance
4.7. Capable of Vector Scan lithography
4.8. Capable of exposing huge gray scale Bitmaps
4.9. Capable of Marker and SEM Image Acquisition

5. System control software

5.1. General

5.1.1. Operating software must be capable of handling multiple user at different user experience levels
5.1.2. Operating software must control all system functions and support service and maintenance routines
5.1.3. Operating software must be capable of full lithography workflow from pattern design and import, pattern postprocessing and proximity correction, result simulation, job setup and exposure execution
5.1.4. Operating software must be capable of SEM imaging for result inspection, including archiving, annotations and metrology
5.1.5. Operating software must support CAD based sample navigation for convenient revisiting sample sites of interest

5.1.6. Operating software must be capable of automated large area image acquisition
5.1.7. A second offline software license for data preparation must be made available
5.1.8. Extensive PYTHON scripting functions and remote control for operation and remote diagnostics must be available
5.1.9. An easy standalone software package that allows internal non-EBL experienced customers to create EBL jobs offline

5.2. Lithography function

5.2.1. Built in hierarchical GDSII layout editor with EBL specific shape information like exposure dose and exposure strategy
5.2.2. Built in proximity effect correction, monte carlo based proximity parameter determination, 3D resist development simulation and data post processing
5.2.3. Exposure strategy vector scan step & repeat
5.2.4. Exposure strategy Grayscale BITMAP with mosaic import and preview function must be available.
5.2.5. Exposure strategy Fixed Beam Moving Stage for writing continuous paths without stitching error must be available.
5.2.6. Exposure strategy Modulated Beam Moving Stage for writing periodic patterns without stitching error must be available.
5.2.7. Patterning direction must be completely flexible per pattern shape to ensure optimum results

5.3. SEM function

5.3.1. Image acquisition with flexible scan speed, noise reduction and archiving
5.3.2. CAD based precise relocation of point of interest
5.3.3. Annotation editor for images
5.3.4. Image archiving functions

6. Specifications

6.1. **Guaranteed** minimum line width <= 10nm
6.2. **Guaranteed** minimum grating period <= 40nm
6.3. Field stitching **guaranteed** <= 20 nm ([mean] + 3 sigma)
6.4. Overlay accuracy **guaranteed** <= 20 nm ([mean] + 3 sigma)
6.5. It is essential that the vendor provides a detailed description of measurement procedures of specification 6.1.-6.4

7. System should be offered with

7.1. Automated Height Sensing for 4" up to 8" laser based measurement and correction of working distance
7.2. Two Wafer holders for 3 inch wafer
7.3. Two Rotation and Tilt module for 6 inch system
7.4. Fixed Beam Moving Stage Writing Strategy

7.4.1. Stage should follow arbitrary curved paths at constant speed to expose elongated pattern without stitching errors
7.4.2. GDSII editor must be able to define these patterns beside conventional step and repeat pattern shapes
7.4.3. Necessary calibrations and parameter must be defined and completely integrated within the system operation software package

7.5. Modulated Beam Moving Stage Writing Strategy

7.5.1. Stage moves at constant speed while beam is deflected with low noise and user defined elementary shape arrangement to create a periodic pattern without stitching over several mm
7.5.2. GDSII editor must be able to define this pattern beside conventional step and repeat pattern shapes
7.5.3. Necessary calibrations and parameter must be defined and completely integrated within the system operation software package
7.6. Backscatter Electron Detector
7.7. Additional five off line licenses must be offered

7.8. Service contract for four years

8. System infrastructure

8.1. System must be delivered with necessary closed loop cooling system

8.2. Site survey must be performed and report submitted within 2 months after contract concluded

8.3. Possibility to install system in gray room but sample loading and operation is done from clean room

Sr. No. 114 / Reference No. : 120 (Revised)

Detailed Description of Item :

Technical specifications for LaserWriter - Maskless Lithography System

1. Key Generic Requirements:

a. The tenderer must provide an installation scheme showing the physical space (footprint) of the item(s) as well as space required for routine access and all installations including related accessories.

b. The vendor should have installed at least two similar types of systems in centrally funded technical institutes or government research labs. Purchase order (PO) and user list should be provided as supporting evidence.

c. The compliance sheet should be provided by the vendor. The absence of the compliance sheet may result in the cancellation of the purchase order.

d. For each compliance, supporting evidence such as manuals and other necessary and supporting documents needs to be provided.

a. The vendor should have an Indian representative which can take care of the urgent troubleshooting or any queries on an urgent basis.

e. Installation and training of the system should be demonstrated.

2.(a) Technical Specifications (Generic):

b. The LaserWriter system will be used as pattern generator for microstructures for applications in research areas such as MEMS, micro-fluidics, micro-optics and all other fields. The system should be an affordable, compact system with powerful pattern generator including mask less technology as a new generation table top laser lithography tool. The entire setup for the LaserWriter should include

i. Laser
ii. Optics
iii. Accessories

All of the above items should be from the same manufacturer.

c. The footprint required for the optical table-top is as following.

i. Width: 630 mm
ii. Depth: 850 mm
iii. Height: 530 mm

2.(b) Technical Specifications (Specific):

A. Diode Laser source (405)

Following are must-have features:

- Diode Laser (405nm) for Vector Mode Exposure Module
- For exposure of broadband photoresists
- laser wavelength: 405 nm
- output power: 120 mW

- typical lifetime: 20.000 hrs

B. LED Laser Source (365)

Following are must-have features:

- UV LED (365nm) for Raster Scan Exposure Module
- The standard 385nm light source for the Raster Scan Exposure Module is replaced by an UV LED for exposure of broadband and special i line photoresists, including SU-8, AZ-nLOF, TOK IP and others
- - LED wavelength: 365 nm
- - output power: 9 W
- - typical lifetime: >10,000 hrs

C. Optics

Following are must-have features:

- Optical system including highly reflective mirrors and SLM (Spatial Light Modulator) DMD.

D. Greyscale

- 128 grey levels

E. Chuck & substrate size

- Maximum substrate size: 5" x 5"
- Minimum substrate size: 5 x 5 mm²
- Maximum write area: 100 x 100 mm²
- Substrate thickness: 0.1 to 12 mm
- Encoder resolution: 20 nm

F. Write Mode's & Minimum structure size [µm]

- Raster Scan exposure Mode

Minimum feature size of 0.6 µm

- Vector Mode Exposure Module
  minimum feature size of 0.6 µm

G. Exposure time

- Raster Scan exposure Mode

10mm²/min at 0.6µm structure size
20mm²/min at 1µm structure size
25mm²/min at 2µm structure size

- Vector Scan Exposure Module
  Maximum linear write speed - 200 mm/s

H. Alignment Accuracy

- Raster Scan exposure Mode

2nd Layer alignment over 5x5mm² [3σ, nm] - 500nm
2nd Layer alignment over 50x50mm² [3σ, nm]] - 1000nm

- Vector Scan exposure Mode

2nd Layer alignment over 5x5mm² [3σ, nm] - 500nm
2nd Layer alignment over 50x50mm² [3σ, nm]] - 1000nm

I. Address grid [nm]

- Raster Scan exposure Mode - 20nm
- Vector Scan exposure Mode - 20nm

J. Edge roughness [3σ, nm]

- Raster Scan exposure Mode - 100nm
- Vector Scan exposure Mode - 30nm

K. Edge CD uniformity [3σ, nm] & Line width variation [3σ, nm]

- Raster Scan exposure Mode - Line width variation -200nm
- Vector Scan exposure M- Line width variation -70nm

L. System Dimensions

- Width: 630 mm

- Depth: 850 mm
- Height: 530 mm
- Weight: 100 kg
- Temperature Stability: ±1 ºC
- Humidity: 50% ±10% (non-condensing)
- Clean Room: Class 1000 or better
- Compressed Air: 6 - 10 bar, stability ±0.5 bar (without oil or other residue)
- Electrical: 230VAC / 6A or 110VAC / 12A

- Process Demonstration for onsite acceptance

The LaserWriter should be able to write minimum feature size for standard device and contact pad structures as lines, circles, rectangles, squares with minimum/negligible stitching error and edge roughness within acceptable tolerance values.

- Minimum structure size - 600 nm
- Minimum lines and spaces - 800 nm
- Edge Roughness - 100 nm
- Line width variation - 200 nm
- Global 2nd Layer Alignment [3σ, nm] -1000 nm
- Local 2nd Layer Alignment [3σ, nm] - 500 nm
- Write speed - 10 mm^2/min

Sr. No. 115 / Reference No. : 121 (Revised)

Detailed Description of Item :

Inter connected Dual Sputter Deposition Chambers with common load lock and other facilities.

Inter connected Dual Sputter Deposition Chamber System should have minimum following specifications:

Sputter Chamber No.1:

- Cylindrical style chamber, 304L SS, electro-polished (box-style chamber not desired)
- Chamber diameter must not exceed 14" ID (this allows for faster-pumpdown times)
- At least two 6" CF viewports with integrated shutters, capable of removing shutter drive without breaking vacuum preventing inexperienced users from operating shutter
- Three Ports available for gauge heads
- Ports available for RGA
- Ports for thickness monitor
- At least seven for periphery 2" confocal sputtering source ports and One 2" or 3" direct deposition source port on chamber center axis.
- Chamber designed to incorporate load-lock via 8" CF flange
- All chamber ports must be metal-sealed with exception of top lid
- Chamber must be designed to incorporate RHEED as future upgrade. Vendor must guarantee RHEED compatibility without the need for additional magnetic shielding.
- All unused ports must be blanked off
- Additional 8" CF port located opposite load-lock for connection to Sputter Chamber No.2
- Includes manual isolation valve between Chamber No.1 and Chamber No. 2.
- Internal and external photos of OEM's previously manufactured system with similar dual-chamber layout must be submitted along with tender.

Sputter Chamber No. 2:

- Cylindrical style chamber, 304L SS, electro-polished (box-style chamber not desired)
- Chamber diameter must not exceed 14" ID (this allows for faster-pumpdown times)
- At least Two 6" CF viewports with integrated shutters, capable of removing shutter drive without breaking vacuum preventing inexperienced users from operating shutter
- Three Ports available for gauge heads
- Ports available for RGA
- Ports for thickness monitor
- At least seven for periphery 2" confocal sputtering source ports and One 2" or 3" direct deposition source port on chamber center axis.
- Chamber designed to access load-lock via Chamber No. 1 using 8" CF flange
- Includes transfer arm support hardware to minimize transfer arm sag
- All chamber ports must be metal-sealed with exception of top lid
- Chamber must be designed to incorporate RHEED as future upgrade. Vendor must guarantee RHEED compatibility without the need for additional magnetic shielding.
- All unused ports must be blanked off
- Spare 8" CF port located opposite Chamber No. 1 for future expansion
- Internal and external photos of OEM's previously manufactured system with similar dual-chamber layout must be submitted along with tender.

Instrument Rack:

- Welded stainless steel frame with open frame work design
- Single Instrument rack must accommodate Chamber No. 1, Chamber No. 2, and load-lock in side-by-side orientation. Individual instrument racks for each chamber are not acceptable.
- Chambers must not be enclosed with panels
- Load-lock must not be enclosed with panels
- Durable powder coated table top required for available workspace
- Utilities must be located on backside of instrument rack mounted in removable boxes for ease of access (please show picture of design)
- Instrument rack must have space available to accommodate additional future power supplies (In addition to those listed in the description)
- Instrument rack must have adjustable leveling feet to allow ≥12 mm of height adjustment for future transfer alignment with adjoining vacuum chamber
- Instrument rack and electronics cabinet must be one welded assembly. Detachable instrument rack is not preferred

Vacuum Pumps:

- Two Pfeiffer Hi-Pace 700 l/s turbopump with delayed vent valves (One for each chamber)
- Two Edwards 6cfm rotary vane mechanical backing pumps
- Interconnecting plumbing and hardware
- All vacuum pumps must be controlled outside of the system software (via breaker) to ensure on/off unison, pump safety, and potential software issues do not prevent vacuum pump operation

Sputtering Guns:

- Each chamber is capable of accommodating up to (Seven) 2" UHV magnetron sputtering sources in con-focal orientation
- Each chamber is capable of accommodating (One) additional sputtering source, evaporation source, or in-situ stress measurement device on bottom center axis of chamber
- Each chamber includes (Three) 2" con-focal magnetron sputtering sources with chimney, pneumatic shutter, and individual gas injection capability.
- Pneumatic shutters for confocal sources must be flip-top style. Domed style or rotary style are not acceptable.
- 2" sputtering gun must be able to accommodate up to 0.125" thick magnetic targets, including pure iron.

- All guns must have modular magnet design to allow balanced, unbalanced, and magnetic material configurations. Dedicated gun for magnetic material sputtering is not accepted, must have versatility.
- Magnets must be located in vacuum, outside of cooling water, with Curie point of 200C.
- UHV sources must be bakeable to 200C, eliminating the need to remove magnets prior to system bakeout
- Vendors must be able to provide specialized backing plates, targets, and clamping rings for dielectric materials that are inherently brittle. In order to eliminate additional target stress, the clamping ring must not clamp down on the target material itself. Pictures of this design must be provided.

Power Supplies:

DC Generators

- Include two nos. 750W DC power supply with integral automated 4-way DC switchboxes (to be shared between chambers)
- Power supplies must allow for simultaneous display of voltage, amperage, and power on the active front panel for diagnostic purposes. Changing display between different parameters is not desired.
- Power supplies must have ability to control shutter actuation to allow manual operation outside computer control.
- Power supplies must have kW hour monitoring ability
- DC power supply must provide stable plasma under the following conditions: 1W at 2mTorr pressure

RF Generators

- Include one 300W RF power supply with auto matching network (to be shared between chambers)
- Include one automated 4-way RF switchbox (to be shared between chambers)
- Include One 100W RF power supply with auto matching network for substrate biasing for Chamber No.1
- RF power supplies must provide stable plasma under the following conditions: 3W at 3mTorr pressure

Vacuum Gauges:

- Each chamber must include a dedicated gauge package that consists of one Convectron gauge, one 0.1 Torr Baratron gauge, and one cold cathode gauge.
- Vacuum gauge controllers must have ability to display up to three gauge heads

Chamber No. 1 Substrate Holder:

- Accommodates up to 3” diameter
- 0-40 RPM rotation
- Must allow uniform heating to 850C via quartz halogen lamps
- Capable of heating in O2 environment
- 2” Z-motion for target-to-substrate height adjustability
- Must have Dual PID heater control that automatically switches between high/low temp range without manual tuning
- Overtemp protection +/- 1 degree C temp stability
- Must include RF biasing capability of ≥50W while rotating / heating / depositing with dedicated 100W RF generator and auto-matching network

Chamber No. 2 Substrate Holder:

- Accommodates up to 3” diameter
- 0-40 RPM rotation
- 2” Z-motion for target-to-substrate height adjustability

Gas Handling:

- One MFC gas line for Ar (100 sccm)
- Ar plumbed to One sputtering source in each chamber ((Two) total) via diverter valve

- MFC must include necessary plumbing/hardware to all process gas delivery to Chamber #1 or Chamber #2 sequentially

Pressure Control:

- Each deposition chamber must include One VAT Series 64 automatic pressure control for turbopump isolation and throttling (8"CF size) (total of two VAT Series 64 valves).
- Automatic venting via turbo delayed vent valve on each chamber
- Manual vent valve on each chamber
- Systems must be designed for downstream pressure control (upstream pressure control is not desirable) for maximizing turbo pump life, better gas flow resolution for reactive processing and less gas consumption.

Load Lock:

- Aluminum chamber body machined from a single billet
- Minimum Pfeiffer 80 l/s turbo molecular pump.
- Minimum 4 cfm mechanical dry backing pump
- Full range vacuum gauge
- Includes manual hand-crank actuator on transfer arm to allow user to look through viewport at any stage of transfer while actuating arm
- Transfer arm must have heavy duty aluminum shaft to minimize transfer arm sag (transfer arm thickness must be specified when submitting quotation)
- Load-lock must be located outside of electrical cabinet for easy atmospheric access (may not be enclosed)
- Load-lock must be capable of reaching base pressure of 5.0×10^{-7} Torr or better
- Includes VAT manual isolation gate valve between Chamber No. 1 and load-lock

Power Distribution system and pump control:

- System must take single phase, 30A, 208 VAC input voltage.
- Include water and vacuum interlocks
- Water and vacuum interlocks must be tied into Mains power to prevent operation of power supplies without interlocks being satisfied. This prevents users from operating power supplies without proper safety restrictions in place.
- Include breakers for vacuum pump control, allows single breaker to turn turbo and mechanical pump on/off. Ease of operation for pump safety.
- Power distribution system must be designed to power all required components from both chambers

Computer Control:

- Computer control software must be designed to control either Chamber #1 or Chamber #2 sequentially
- Computer control software must be LabVIEW based
- Must use Windows 10 OS
- Interfaces with up to (Five) DC & (Four) RF generators for control of output mode, setpoint, ramping & plasma detection
- Interfaces with (Two) 4 way DC switchboxes and (One) 4 way RF switchbox
- Interfaces directly with solenoid pneumatics manifold, for control of shutters, gas isolation valves & spares
- Interfaces with VAT valve for: open / closed / throttle position
- Interfaces with Substrate Holder closed-loop PID heater controller for: on / off / temp. setpoint / T/C temp. feedback
- Define and stack process layers to create processes
- Monitoring and data logging kW hrs. in software:
- 100+ separate password protected accounts for process layer & process security
- Auto shutdown of power supplies if: plasma not detected
- Auto abort of process if: plasma not detected / gas flow setpoint or temperature setpoint not reached

- Displays and data logs: shutter position / DC power feedback / Pulse Frequency and Reverse Time / DC bias feedback (for RF) / plasma verification / process pressure / gas flow feedback / T/C temperature feedback / target kW hours / Abort Notifications
- Pre-wired receptacles to allow ease of upgrade
- Recipe creation
- LabVIEW software must utilize analog communication

Guarantees:

- Con-Focal Deposition Uniformity: +/- 2.5% over 3" diameter wafer with 5mm edge exclusion with RF deposited SiO2 or reactively deposited TiN (measured optically with vendor's ellipsometer).
- Vendor must have in-house ellipsometry monitor to prove deposition uniformity at time of acceptance testing
- Base Vacuum: Better than or equal to 3.5 x 10-8 Torr. Alternatives for better vacuum (9 x 10-9 Torr or better) should be provided as option.

Warranty:

- System includes 1 year warranty, which includes all non-consumable parts of the system subjected to normal, proper usage

Must include photos/documentation of the following:

- Table top work space
- Viewport design
- Picture of similar sputter gun configuration to provide proof of experience. Drawings or schematics not accepted.
- Information on backing plate design for oxide targets, to ensure good cooling and target stability.
- Letter from RHEED manufacturer confirming successful integration of their product into similar equipment.
- Video of load-lock system showing actuation of transfer system
- Testing documentation on low power operation of DC and RF power supplies. Critical for ultra-thin film applications.

System Delivery:

- Vendor must complete Factory Acceptance Testing (at vendor's facility) and deliver the system to IITB within 18-22 weeks.

On-site Commissioning:

- Vendor must provide at least (3) days of on-site commissioning, installation, and training at customer's facility.

Sr. No. 116 / Reference No. : 122 (Revised)
Detailed Description of Item :

Technical specifications for Plasma Asher :

Requirements:

- List of at least 5 international semiconductor industrial customers.
- List of 5 international academic/lab customers.
- List of Indian customers (note repeat purchases if any).

Documentation:

- The complete manuals of the system, the parts of the system, and troubleshooting
- The safety features and precautions for the system to prevent errors, emergency shut down options, and procedures should be provided.
- System applications are to remove resist and their residues, ashing, and descum.
- System capabilities to be listed and the list of recipes to be provided.
- Cleaning procedure of the chamber between the process to be provided.
- The results obtained from the system (before and after ashing microscope/ SEM images, etc) and the other necessary and supporting documents to be provided
- The user manual, Maintenance, troubleshoot events, necessary and supporting documents for the system, and other parts used in the system to be provided.
- The library of recipes and other necessary and supporting information for deposited materials to be provided.

Process:

- Ashing material: resist descum and strip
- Substrate size: small pieces- Max. 4inch wafer
- Product yield: 1 wafer/run for 4inch.

Configuration (to match or exceed)

- Substrate size & load capacity: Piece-Max. 4inch wafer
- Source (gas) injection type: Showerhead type
- RF generator & Matching network: 600W (@13.56Mhz)
- Rotary pump
- PC control with Touch panel
- System body: 800mm(w)* 800mm(d)* 1,200mm(h) - indicative

Please add as an upgrade option a Substrate heater: Max. 300℃

Process Chamber Module:

- Process chamber
    - Chamber size: Φ380 mm x 250mm (H) - indicative

    - Chamber material preferably Aluminum or SS
    - Wafer loading/unloading type: Top plate open type
    - Port: Viewport, Gauge port, pumping port, Gas port
- Showerhead unit
    - Process gas injection through a showerhead
    - Uniform gas flow suitable for 4” wafer process
    - Showerhead material: Aluminum
    - RF isolator: Ceramic
    - PE (Plasma Enhanced) compatible 1-stage showerhead
- Substrate chuck
    - Substrate size: ≥ 4 inch
    - Capacity: 1(one) substrate

Power supply Module

- RF generator
    - Frequency: 13.56MHz
    - Output power: 600W in a 50Ω
    - Digital RF power meter
- RF matching network
    - Operation type: Automatic type
    - Frequency: 13.56MHz
- RF cable kit

Vacuum Module:

- Vacuum pump
    - Rotary pump: 600 L/min
    - Oil rotary pump
    - Ultimate pressure: < 5×10^{-3} Torr

- Vacuum Pressure gauge
  - Convectron gauge: 760 torr ~ 5 x 10^{-3} torr
  - Pressure readout & cable kit
  - ATM switch
- Vacuum valves & lines
  - Main valve: Pneumatic type angle valve
  - Line: Auto vent line, SUS hard line and flexible bellows line

Gas Delivery Module:

- Used gases & flow control
  - Process:
    - O_2: MFC (100-200 sccm)
    - N_2: MFC
  - Purge & Vent: N_2: Metering Valve
- Gas valves & gas line
  - Swagelok Pneumatically operated diaphragm valve, which is Air-actuated
  - The tubing of 316 L stainless steel, micro-polished
  - Metering valve for N2 purge & vent
  - All gas lines are welded with VCR fitting.
  - The gas line is helium-leak tested to 10^{-9} Torr·L/s

Control Module:

- System control
  - The system is controlled by PC automatically & manually
  - Touch panel
  - Including analog & digital input/output card
  - User-friendly screen & easy Graphic User Interface (GUI)
  - Process data logging, process control software

    - Malfunction interlock
    - Vacuum pressure, RF power, Temperature configuration
    - Recipe edit, save, download, run system control
- Electrical control panel
    - Electrical power drive panel (ON/OFF/Emergency switch)
    - RF generator control panel
    - Vacuum gauge controller panel
    - MFC controller panel

Frame Module:

    - Mild steel made system frame
    - 19-inch control panel mountable
    - Easily movable casters & leveling foots

Warranty:

Manufacturer warrants for a period of one (1) year from the final acceptance.

Process control in manual:

- Please provide flow, pressure, and temperature dependence on etch rate and uniformity.

Process Demonstration for onsite acceptance:

- Leak Check < 3mTorr/min
- Leak Rate 1e-10 Torr L/sec
- PR High Rate NU (>100 nm/min)
- PR Low Etch rate NU (10nm/min)
- Linear etch rate with time (does not saturate till 5000 um & 180s)
- Process control of power vs etch rate should be linear
- Heater uniformity < 3%
- Plasma stable at power <20W

Packaging and shipment

- Each Package should not exceed 900mm W, 1900mm D, and 1900mm H
- Pricing must include freight, insurance, and packaging to IITB as an option.

Sr. No. 117 / Reference No. : 123 (Revised)
Detailed Description of Item : Rapid thermal processing (RTP) system

Units	Requirements
General	1) Standalone system with vertical configuration for reduced foot-print. 2) Wheels for easy movement.
Process Chamber	1) Cold wall chamber with lamp on top. 2) Capability to process up to 100 mm diameter wafers. 3) Ultra-clean and contamination free environment. 4) See-through quartz window to the lamp. 5) Easy to clean.
Temperature Range	1) Temperature ranging from room temperature to 1450 °C. 2) 1450 °C for maximum step duration of > 25 s. 3) 1200 °C for maximum step duration of > 25 mins.
Ramp Rate	1) Temperature ramp rate up to 200 °C.
Temperature Control	1) Digital PID controller with PC control. 2) Accurate temperature control during ramp and stable state. 3) Process temperature accuracy up to ±1 °C.
Power Control	1) Power blocks for the lamps to control the lamps for better process reproducibility. 2) Accurate temperature control and stable power to the lamps.
Temperature Measurement	1) 2 pyrometers viewports one at the centre and one at the edge for better temperature control.
Gas Lines and Control	1) 5 gas lines with digital mass flow controller ranging up to 2000 sccm. 2) Gases: O_2, N_2, Ar, NH_3, forming gas (3% H_2 diluted in N_2)
Vacuum Capability	1) Dry base pump to avoid any oil contamination. 2) Turbo pump with capability up to 5×10^{-6}Torr.
Safety	1) Safety interlocks and alarms for the following: (a) Dangerous gas mixing, (b) Overheating, (c) Vacuum pump failure, (d) Lamp filament failure, (e) Temperature control failure, (f) Pyrometer failure, (g) Thermocouple failure, (h) Water flow failure.
Computer and Software	1) PC with windows 10 professional and ethernet port. 2) User-friendly control software with recipe creation, data logging during the process, parameters display, pyrometer calibration and manual control capabilities.
Certification	1) SEMI S2 or equivalent certification.

Shipping	1) Packaging and shipping included.

Sr. No. 118 / Reference No. : 124 (Revised)

Detailed Description of Item :

Reactive Ion Etching (RIE) based Inductively Coupled Plasma (ICP) source system is required.

Technical specifications for Reactive Ion Etching System (RIE)

1. Key Generic Requirements:

a. The tenderer must provide an installation scheme showing the physical space (footprint) of the machine(s) as well as space required for routine access and all installations including the gas lines, MFCs, and other related accessories.

b. The vendor should have installed similar types of systems in centrally funded technical institutes or government research labs. Purchase order (PO) and user list should be provided as supporting evidence.

c. The compliance sheet should be provided by the vendor. The absence of the compliance sheet may result in the cancellation of the purchase order.

d. For each compliance, supporting evidence such as manuals, SEM images, AFM results and other necessary and supporting documents needs to be provided.

e. The vendor should have an Indian representative which can take care of the urgent troubleshooting or any process related queries on an urgent basis.

f. Safety features like interlocks to prevent errors in operation, Gas leakage interlock, RF interlock, emergency shut-down options along with necessary protocols should be separately mentioned.

2.(a) Technical Specifications (Generic):

a. The system must be cleanroom compatible with all the necessary support systems such as vacuum systems, cooling systems, power supply systems, computer hardware, and software provided.

b. The machine must be software controlled with appropriate software and hardware interlocks to protect the machine from any possible operational or non-operational failure thereby ensuring the safety of the operator as well as the machine.

c. The process is required to contain all the necessary sensors and control to aid in safety monitoring, performance monitoring, automatic operation, and diagnostic of the system. A complete set of system operation and maintenance manuals must be provided.

d. A library of process recipes for materials that can be processed by the machine well documented by the company must also be included.

e. Suitable gauges calibrated as per international traceable standard must be provided for monitoring vacuum in the process chamber as well as load-lock and providing feedback for controlling process pressure in the chamber. Further, pressure gauges to monitor the lines between chamber and turbopump, and turbopump to backing pump should be included to ensure the best possible vacuum performance.

f. The process pressure control in the reactor chamber should be automatic and closed-loop through software-controlled throttle valves.

g. The control computer system/PLC should be a state-of-the-art system with a pre-loaded operating system and the software required for running the machine. The control panel must contain all the buttons required to operate the machine.

h. The software must allow for configurable user groups with different access privileges. Three different modes operator, engineer, and admin should be provided for easy and safe handling of the tool.

i. The software must allow the user to write and edit machine recipes.

j. The software must provide full system monitoring and recording of full system states in log files.

k. The system must provide access to sample process history and security protocols.

l. The system must provide system fault detection and diagnosis.

m. Automatic and manual control modes should be available in the software.

n. Installation, training, and Silicon, Diamond, SiN, SiO2 etch process demonstration.

2.(b) Technical Specifications (Specific):

a. The system is targeted towards Silicon (Si), Diamond, SiN, SiO2 etching through standard processes.

b. The system should be capable of carrying out etching on small pieces mounted on a suitable and compatible carrier wafer. The source diameter should be suitable to achieve uniformity over a 4-inch wafer diameter also. The chamber diameter and load-lock transferring mechanism should be able to accommodate 2 and 4-inches wafers

c. The wafer mounting chuck should enable mechanical/electrostatic clamping.

d. Standard MFCs controlled 8 lines CHF_3, Cl2, BCl3, Argon, O2, N2, C_4F_8/CF4 and SF6 should be closely coupled to the plasma source to enable minimum cycle time. Provisions for more gas lines to be able to hook up with the system to enable future upgradations, if any, should be provided.

e. The reaction chamber should be machined from a single metal block (preferably aluminum) with an anodized inner surface for chlorine processes. A separate air-inlet port (for by-products protection), as well as a viewing port, should be provided with the main reaction chamber.

f. The loading mechanism should be a software (recipe) driven and fully automated with a robotic transfer mechanism to move the wafer from loadlock into the process chamber and back on the execution of a process recipe. There should also be an option to manually override the transfer.

g. The substrate should be cooled using through Helium backside circulation. The helium flow rate and pressure are considered process parameters. The flow rate/pressure should be controlled through a software-controlled MFC.

h. The substrate electrode temperature should be from -20 ^{0}C to +200 ^{0}C settable with the stability of 1-2 ^{0}C or better.

i. The system should come with provisions for separate pumps for the reaction chamber (RC) and the load lock chamber (LLC). Altogether there should be 3 pumps, 1 Turbomolecular pump with a pumping speed of 1300 litres/sec or better, 2 dry pumps (one each for RC and LLC) with a pumping speed of 1500 litres/min and 600 litres/min or even better respectively.

j. The load lock chamber vacuum pumps must be able to pump the load lock chamber down to approximately 10^{-1}Torr. suitable for typical wafer transfer to the main process chamber within approximately 10 minutes. It should be able to pump down to 5×10^{-5}Torr. with overnight pumping.

k. The main chamber must be able to reach (in half an hour) and maintain a vacuum level of less than 5×10^{-6} torr during standard etching processes.

l. Oil-free dry backing pump with 1300 lpm or more rating with N2 purge standby to minimize N2 usage when no etching is in progress. The backing pump must be resistant to corrosive gases.

m. The backing pump must include a microprocessor-based diagnostic accessory for quick identification of faults that may occur from time to time.

n. The plasma should be inductively coupled with an operating frequency of standard 13.56 MHz. The plasma generator power/bias rating should be 2 KW/600 W. Suitable matching techniques should be provided to minimize reflected power (less than 5% reflected power). The vendor should also provide detail about techniques/methods.

o. The power supply cooling can be either air-cooled or water-cooled. Any specific requirements for this (ex: Chiller) should be mentioned as a mandatory item along with the system.

p. The RF coupling to plasma should be done through Alumina, AlN, or, any other suitable dielectric.

3. (a) Process demo:

The system is going to be extensively used for etching of Silicon (Si), Diamond, SiN, and SiO2. The demo process of etching on samples provided from IITB (Details of the sample mentioned below) should be carried out to develop the process. The process recipe needs to be replicated by the

installation engineers on a similar set of samples after the installation of the machine is completed at the IITB site.

Vendor should provide measurement results of factory etch profiles, like SEM images, AFM results and profilometry step height and it should later match with onsite etch and measurement profiles, using IITBBNF inhouse SEM, AFM, and profilometer for side wall angle, roughness, and etch rate parameters.

Packaging and shipment

- Each Package should not exceed 900mm W, 1900mm D and 1900mm H
- Pricing must include freight, insurance, and packaging to IITB as an option.

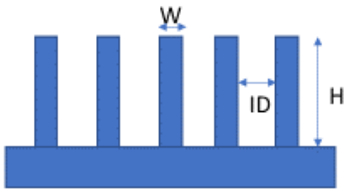
Acceptance Criterion

- Leak Check < 3mTorr/min
- Leak Rate 1e-10 Torr L/sec
- Etch test
    - Pattern: 1um etch depth, 250 nm diameter, 500 nm pitch
    - Test on Al pattern on Si wafer with F chemistry
    - Samples:
        - Gross test with Photolith wafer
        - Fine test with EBL wafers
    - 85 degrees sidewall angle
- Chuck thermal uniformity 200 degC <3%
- Etch rate: 20-2000 nm / min (better than 5% NU)

Application Details

The application for the system is given below. However, that is not added to the acceptance criterion but such a capability will be considered advantageous for the tendering.

1. Si micro/nanopillar using SiO2/SiN hard mask with 1D and 2D pillar arrays



1D or 2D pillar arrays
IPD: Interpillar distance
H: Pillar height
W: Pillar diameter

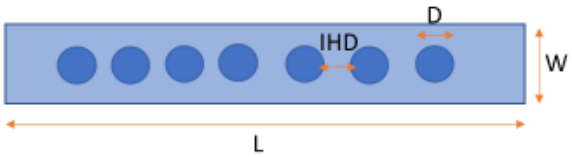
Acceptable etch specifications #:

- Min /Max range of H : 1-20 µm, W: 100 nm- 1 µm, IPD: 50 nm- 500 nm; with aspect ration W/H= 1:15
- RMS roughness < 3nm, pillar sidewall should be 87-90 degree vertical with possibility of slanting depending on recipe used.
- Controllable etch rate in the range of 50 nm/min to 2um/min maintaining uniformity of profile in 3 inches wafer area
- Acceptable standard deviation in as set parameters 5% (max)
- Onsite verification of Processes at minimum, room and maximum substrate temperature mentioned in Technical Specifications (Specific).

Suggestive recipe: Gases: SF6 and C4F8 simultaneous flow with 1:3 ratio (e.g. SF6 30 sccm and C4F8 90 sccm)

ICP: 500-600W, RF: 20-50 W; Pressure: vendor specified to maintain reasonable etch rate and uniformity

2. SiN nanobeam etching with EBL/ Photo resist mask (e.g. ZEP, HSQ) with 1D and 2D holes arrays



1D or 2D holes arrays
IHD: Inter holes distance
D: Hole diameter
W: Beam width
Beam Lenght

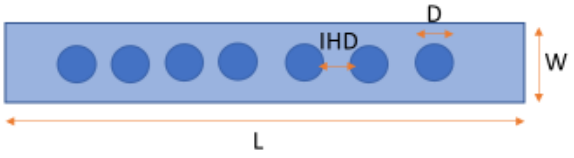
Acceptable etch specifications #:

- Min /Max range of D : 1OOnm- 500 nm, W: 200 nm- 1 µm, IHD: 50 nm- 300 nm; L: 20- 50 µm
- RMS roughness < 5nm, holes inner wall and beam sidewall should be 87-90 degree vertical.
- Controllable etch rate in the range of 20 nm/min to 200/min maintaining uniformity of profile in 2 inches wafer area
- Acceptable standard deviation in as set parameters 5% (max)

Suggestive recipe: Gases: CF4 and Ar/O2 simultaneous flow (e.g. CF4 50 sccm and O2 5 sccm)

ICP: no ICP, RF: 200-400 W; Pressure: vendor specified to maintain reasonable etch rate and uniformity

3 . SiO2 hard mask opening/etching with EBL/ Photo resist mask (e.g. ZEP, PMMA) with 1D and 2D holes arrays



1D or 2D holes arrays
IHD: Inter holes distance
D: Hole diameter
W: Beam width
Beam Lenght

Acceptable etch specifications #:

- Min /Max range of D : 1OOnm- 500 nm, W: 200 nm- 1 µm, IHD: 50 nm- 300 nm; L: 20- 50 µm
- Near Vertical etch profile (87-90 degree).
- Controllable etch rate in the range of 20 nm/min to 200/min maintaining uniformity of profile in 2 inches wafer area
- Acceptable standard deviation in as set parameters 5% (max)
-

Suggestive recipe: Gases: CHF3 and Ar/O2 simultaneous flow (e.g. CHF3 50 sccm and O2 5 sccm)

ICP: no ICP, RF: 200-400 W; Pressure: vendor specified to maintain reasonable etch rate and uniformity

Sr. No. 119 / Reference No. : 125 (Revised)
Detailed Description of Item :
Plasma Processing System :

Technical specifications for Plasma Etcher with Deposition Capability

References:

List of at least 5 international semiconductor industrial customers.

- List of 5 international academic/lab customers.
- List of Indian customers (note repeat purchases if any).

Documentation

- The complete manuals of the system, the parts of the system, and troubleshooting
- The system can etch Semiconductors, dielectrics, and Metals. System capabilities to be listed and the list of recipes to be provided.
- The safety features and precautions for the system to prevent errors, emergency shut down options, and procedures should be provided.
- Cleaning procedure of the chamber between the process to be provided.
- The user manual, Maintenance, troubleshoot events, necessary and supporting documents for the system, and other parts used in the system to be provided.
- The library of recipes and other necessary and supporting information for the etch materials to be provided.

Process:

1. Provide deposition process details where possible:
    a. Deposition: Si, SiO_2, SiN
    b. Etching: Si, SiO_2, SiN, HfO_2, TiN, W, Al
2. Deposition and etch rates tuning by controlling the process parameters such as pressure, substrate temperature, gas flow, etc.
3. Uniformity, Low surface roughness, and damage in etching and deposition.

Configuration:

1. Wafer size: small piece- max. 4inch
2. Product yield: 1 wafer/run
3. 3-chamber type (RIE+PECVD+Loadlock)
4. Substrate size and load capacity: 4inch wafer- 1 wafer/run
5. Source(gas) injection type: Showerhead typeWater cooling chuck for RIE

6. Molded heater for PECVD, wafer temperature Max. 400 ^{o}C

7. RF generator 600W 1ea (include DC self bias reading) + Auto matcher 2ea + RF select module(2channel) 1ea

8. Dry pump -PECVD

9. Rotary pump -RIE

10. The vacuum pumps should be resistant for corrosion and compatible for Cl, F chemistry.

11. Auto pressure controller & Throttle valve- each per RIE and PECVD (the process pressure should be controlled automatically by given value)

12. MFC: Ar, N2O, NH3, SiH4, CHF3, CF4, O2, GAS#1, GAS#2 (the GAS #1 and GAS#2 for Cl chemistry)

13. Top plate open/close type by manual

14. PC control

Specifications (to meet or exceed): Process Chamber Module for PECVD:

- Process chamber
    - Chamber material: Anodized aluminum
    - Substrate loading/unloading: Automatic loading/unloading by Loadlock (Manually top plate open/close)
    - Viewport with shutter
    - Cleaning cover
    - Chamber purge & vent

      Showerhead unit
    - Process gas injection through a showerhead
    - Direct power type electrode
    - Ceramic isolator
    - Substrate heater

- Heater type: Molded heater type
- Max. temperature: 400 ^{0}C (wafer temp.)
- Wafer size & capacity: 4inch 1wafer

Process Chamber Module for RIE:

-
- Process chamber
  - Chamber material: Anodized aluminum
  - Substrate loading/unloading: Automatic loading/unloading by Loadlock (Manually top plate open/close)
  - View port with shutter
  - Chamber purge & vent
- Showerhead unit
  - Process gas injection through a showerhead
- Substrate chuck
  - Dark shield space within chuck assembly
  - Focus ring: Quartz
  - System shielded perfectly from RF noise
  - Wafer size & capacity: 4inch 1wafer

Power Supply Module:

- RF generator (1) to be shared with both chambers
  - Output power: 600 W
  - Frequency: 13.56MHz
  - DC self-bias display

Option: Please add the upgrade cost of another independent RF generator to operate chambers independently.

- RF matching network (2ea)
  - Automatic matching type

    - Frequency:13.56 MHZ
- RF cable Kit (2set)
- Select switch (1set)
    - 2 channel (2 chambers will be usable with single RF generator)

Vacuum Module for PECVD:

- Vacuum pump
    - Dry Pump: 1170 L/min (Preferably: anti-corrosion pumps)
    - Ultimate pressure: < 8×10-3 Torr
- Pressure gauge
    - Low vacuum gauge: Convectron gauge
    - Pressure readout & cable kit
- APC (Auto Pressure Control) (1set)
    - Electrical throttle valve
    - Pressure controller
    - Baratron gauge
- Vacuum valves & lines
    - Pneumatic type angle valve
    - Auto vent line
    - Stainless steel hard line and flexible bellows line

Vacuum Module for RIE:

- Vacuum pump
    - Rotary Pump: 700 L/min anti-corrosion pumps compatible with Cl
    - Ultimate pressure: < 5×10-3 Torr
    - **Option: Please add an equivalent dry pump option with the quote.**
- Pressure gauge
    - Low vacuum gauge: Convectron gauge

    - Pressure readout & cable kit
- APC (Auto Pressure Control) (1set)
    - Electrical throttle valve
    - Pressure controller
    - Baratron gauge
- Vacuum valves & lines
    - Pneumatic type angle valve
    - Auto vent line
    - Stainless steel hard line and flexible bellows line

Loadlock Module:

- Loadlock chamber
    - Substrate tray capacity: One (1) wafer
    - Automatic transfer operation
- Vacuum unit
    - Rotary pump: 600L/min
    - Ultimate pressure: $<5\times10^{-3}$ Torr
- Pressure Gauge
    - Low vacuum gauge: Convectron gauge
    - Pressure readout & cable kit
- Vacuum valves & lines
    - Roughing line valve: Pneumatic type angle valve
    - Soft pumping line valve:1/2 inch Pneumatic type diaphragm valve
    - Auto vent line
    - Stainless steel hard line and flexible bellows line

Gas Delivery Module:

- Used gases & flow control

- Process:
  - Ar: MFC
  - N_2O: MFC
  - NH_3: MFC
  - SiH_4: MFC
  - CHF3: MFC
  - CF4: MFC
  - O2: MFC
  - GAS #1: MFC
  - GAS#2: MFC
- Purge & Vent: N_2: Metering Valve
- Gas #1 and 2 are for BCl3, Cl2, diborane and phosphine, etc.

- Gas valves & gas line
  - Pneumatically operated diaphragm valve
  - Metering valve for N2 purge & vent
  - The gas line is helium-leak tested to 10^{-9} Torr·L/s

Control Module:

- System control
  - The system is controlled by PC
  - Automatic and manual override operation capability.
  - MS Window 10 based control and operation software
  - Industrial PC
  - 21” wide monitor
  - Including analog & digital input/output card
  - UPRO Process control software
  - User-friendly screen & easy Graphic User Interface (GUI)

- Process data logging
- Recipe edit, save, download, run

Main Frame with electrical contact mechanism

- Electrical power drive panel (ON/OFF/Emergency switch)
- RF power control panel
- Pressure controller panel
- MFC controller panel
- Pump on/off operation panel

Frame Module:

- System frame is mild steel
- White & Blue colored panels & frame covers
- 19inch control panel mountable
- Easily movable casters & leveling foots

Warranty:

Manufacturer warrants for a period of one (1) year from the final acceptance.

Etching:

- Materials to be etch
    1. Semiconductors: Si
    2. Dielectrics: SiO_2, Si_3N_4, Al_2O_3, HfO_2 etc.
    3. Metals: TiN, Al, W, others if any

Demonstration of the following process for RIE for on-site acceptance:

- Leak Check < 3mTorr/min
- Leak Rate 1e-10 Torr L/sec
- Materials etch demo (NU <5%) -
    1. Si (Etch rate 100-500nm/min)
    2. SiO2 (20-100 nm/min)

3. HfO_2 etch (>1A/min by Ar/CF4 plasma of 500W at 100mT pressure) - using ellipsometer.

Etch rate tuning

4. Si etch-rate (50-500 nm/min) – Tuning by Pressure, Flow, etc.

- Selectivity

1. High Selectivity - High Si (vs. SiO2)>10:1

2. Low/No Selectivity - SiO2 vs Si (<1.4)

- Anisotropic etch of Si (Sidewall angle > 85^0) for 2-5um depth etching in line-space, edge pattern - based on SEM measurements

- Etch surface Roughness (RMS)< 2 nm for Si

Process Demonstration for PECVD:

- Leak Check < 3mTorr/min

- Leak Rate 1e-10 Torr L/sec

- Deposition thickness, Rate, RI, (NU <5%),

1. SiO_2 (20-30nm/min)

2. Si_3N_4 (20-30nm/min)

3. amorphous Si (20-30nm/min)

- Deposition rate tuning with process parameters (such as Gas Flow, Temperature, etc.) shown for the SiO_2 deposition

- Clean recipe for process chamber

- Heater temperature uniformity <3%.

- Film quality is measured by a wet etch rate (6:1 BOE) data in the Si3N4 film. Etch rate should improve by >5x from 260 degC to 360degC. At 360 degC etch rate < 10A/s

Packaging and shipment

- Each Package should not exceed 900mm W, 1900mm D and 1900mm H

- Pricing must include freight, insurance, and packaging to IITB as an option.

Sr. No. 120 / Reference No. : 126 (Revised)
Detailed Description of Item :
Oxygen/Nitrogen Elemental Analyzer :

Technical specifications

Oxygen/Nitrogen Analyzer/determinator in ferrous samples :

(1) The range for Oxygen and Nitrogen for 1 gm sample should be

Oxygen: 0.5 ppm to 0.2% for a 1 g sample (0.5% RSD)

Nitrogen:0.5 ppm to 3.0% for a 1 g sample

The analysis time shall be typically less than 150 sec.

(2) Instrument must have the capability to determine oxygen and nitrogen simultaneously with one sample.

(3) Instrument must support analysis in either argon or helium carrier gases (Without the need for any hardware configuration change).

(4) The instrument software must contain real-time service diagnostics including ambient charts of instrument temperatures, pressures, and detector signal; manual control of solenoids and switches; automated leak checks; and network and communications diagnostic.

(5) Software must allow for data recall and recalculation and support various methods.

(6) Instrument must provide compatibility to an external balance and printer

(7) Instrument must be PC controlled using Windows 10 64-bit operating system or higher.

(8) Instrument blank stability must be less than 0.5 ppm for oxygen and nitrogen.

(9) Instrument software must support automatic system leak checks and provide the option to by-pass the furnace from the check.

(10) Instrument detectors must be independently heated in order to thermally isolate them from environmental temperature fluctuations.

(11) Instrument software must support both independent multipoint calibration and blank for each infrared and thermal conductivity detector. Drift correction of these independent multipoint calibrations must also be supported.

(12) Instrument must utilize a single solid-state CO2 infrared detector for the determination of oxygen and nitrogen and a dual flow controlled thermal conductivity detector for the determination of nitrogen.

(13) Instrument must support a two-stage incoming carrier gas purification system.

(14) Instrument must support an integrated liquid-to-air heat exchanger for cooling of the furnace upper and lower electrodes. This cooling system must also support an integrated liquid-to-liquid heat exchanger that can be connected to external cooling water sources.

(15) Instrument must support a programmable auto cleaner that can clean the upper and lower electrodes simultaneously.

(16) Instrument auto cleaner must utilize an integrated vacuum cleaner to remove and contain dust.

(17) Instrument software must dynamically display average, standard deviation, and relative standard deviation.

(18) Vendors must have supplied the equipment to at least 10 users in India and the service centre shall be ideally located in Mumbai or nearby.

Sr. No. 121 / Reference No. : 127 (Revised)
Detailed Description of Item : Laser for single and two photon ceramic microstereolithography :

Specifications:
• Central Wavelength (nm): 780 ± 3 nm
• Pulse Width (fs): < 90 fs
• Average Power (W): 1.0 W
• Repetition Rate(MHz): 80 MHz
• Pulse Energy (nJ):> 12.5 nJ
• Spectrum Width (FWHM, nm): 8 – 10nm
• Power Stability over 8 hours (%, RMS):< 1.0 %
• Beam Quality (M2):< 1.1 in all planes
• Beam Diameter at Exit (typical, mm): 1.3 mm (beam roundness > 90%)
• Polarization Extinction Ratio (dB):> 20 dB
• Beam divergence: < 1 mrad
• Output/Termination: Free space, collimated beam
• Supply Voltage: 85 - 264 VAC at 47 – 63 Hz,
• Operating Temperature (°C): 17 - 30°C
• Storage Temperature (°C): 0 - 50°C
• Cooling: Air-cooled (No Chiller Required)
• Warm-up Time (min): < 10 minute
• Communication Interface: RS-232 Serial Port,
• Expected lifetime:> 10,000 hours
• Front Panel Control Interface: Power Switch, Laser Key Switch, Emergency Stop Button
• Operation: Easy to Operate, Pulg & Play, Remote system diagnostics
• Warranty: 1Year after installation

Note:
• Please provide certificate of measurement of major specifications at factory
• Provide point by point compliance of the specifications
• Free of Cost Installation & Training of the system at IIT Bombay
• Include AMC for 1 year after expiry of warranty period
• At least 1 Indian customer reference for similar Laser supplied at IITs/NITs/CSIR Units

Sr. No. 122 / Reference No. : 128
Detailed Description of Item :

Constant-rate-strain (CRS) Thermal Consolidation Apparatus :

The proposed equipment will be capable of performing both constant-rate-strain (CRS) and conventional consolidation tests on soil and other geomaterials under subzero and elevated temperature within the range of −20°C to 99°C. Temperature in the confinement chamber and that at the ends of the specimen should be measured and recorded automatically. The equipment should be capable of applying both CRS (at a maximum rate of up to 100 mm/min or more) and constant stress (up to 4 MPa) on the sample. Precise automated control, for load and displacement adjustments to maintain constant stress or strain rate on the sample, should be an integral part of the load-displacement mechanism. Control of defining a loading history prior to a test will be considered as an added advantage. The equipment should facilitate testing under both initially isotropic and anisotropic stress conditions. Automated pore pressure and pore water volume change measurement should be an integrated part of the equipment. Moreover, the equipment should be supplied with sample preparation kit and integrated data acquisition system.

Sr. No. 123 / Reference No. : 129
Detailed Description of Item :
Fully Automated Anechoic Chamber till 110 GHz for 5G and higher standards

Specifications :

A. **Anechoic Chamber :**

1. **Shielding and structure**

- Shielding modules PAN type.
- External steel structure.
- Rubber membrane under the chamber for humidity protection.

2. **Shielding Effectiveness standard from 10 KHz to 40 GHz**

Frequency	Shielding Attenuation	Field
10 KHz	>= 80 dB	Magnetic

100 KHz	>= 100 dB	Magnetic
1 MHz	>= 100 dB	Magnetic
100 MHz	>= 110 dB	Plane wave
400 MHz	>= 110 dB	Plane wave
1 GHz	>= 110 dB	Plane wave
18 GHz	>= 95 dB	Microwave
40 GHz	>= 90 dB	Microwave

3. **Quiet zone 1m^3 at 3m test distance. -30 dB till 40 GHz.**

4. **Absorbers conforming to Fire class A2 European Standard EN 13501-1**
- Fully covering small walls, long walls, ceiling and floor.
- Flat absorbers for corners.

- Walkway above absorbers (8 m^2).

- Fixation profiles for hanging the absorbers.

5. **SLD 12/21/M Personal door with clear opening 1238 x 2118mm, manual latching, prepared for receiving absorbers**

- Leaf painted.

- Integrated dry contact (NO/NC) for remote amplifier stand-by.

- Door Stopper.

6. **Penetration panels, feedthroughs & connectors**

- Penetration panel (PP) 400 x 400mm, including C-frame – 2 Pcs.

- N connector – 4 Pcs.

- N+ BNC adaptor – 4 Pcs.

- 2.92 mm connector – 4 Pcs.

7. **Power filter high performance 100dB from 14kHz to 40GHz and grounding point**

- Power filter 2x16A -250V AC -50/60Hz–for lighting.
- Power filter 2x32A –250V AC 50/60Hz.
- Grounding point close to power filters.

8. **Electrical installation**

- Lighting LED low noise 4 x 42 W.
- Shielded access box to the electrical distribution box – *inside access.*
- Electrical ducts in raised floor.
- Socket: 1phase 230V 50Hz 16A blue – 3 Pcs.
- Battery buffered emergency light above the door.

9. **Honeycombs 400 x 400mm - 40GHz – 2 Pcs.**
10. **Ground Assembly.**
11. **10 year warranty on chamber.**

2. **<u>Positioner, Test Antennas and accessories</u>**

    1. **3-Axis floor mount 3D radiation pattern measurement system till 110 GHz**

- Positioner, phi/Roll axis, theta/elevation axis, linear z axis.
- Internal 3-axis micro-processor based Controller.
- Theta/elevation resolution: 0.025º Full step mode.
- Roll / Phi Axis: Resolution 0.05º Full step mode.
- Weight Capacity – At least 11 Kgs.
- Ultra low loss cables provided (2.92 mm/ 1.8 mm/ 1 mm).
- Tools, accessories, digital level, laser level, laser distance meter.
- Tripod for Source antenna.

    1. **Test Antennas**

- LP and CP standard gain antennas from 500 MHz to 110 GHz

    1. **Software for automated radiation pattern measurement**

- One touch antenna profiling.

- Multiple S-parameters (S21, S11, etc.)
- Built in Matlab Runtime to generate 3D plot.
- Reference antenna import feature.
- Phase center Measurement.
- Multiple trace plots.
- Exportable vector plots.
- Over frequency measurements.
- Various calibration methods.
- Fully configurable positioner settings.
- Data set manipulation.
- Linear Gain transfer.
- Circular Gain via linear H – V.
- Gain Substitution.
- Calibration profile with automatic gain calculator.
- Total power factor.
- Reference antenna gain to the 3-point method using the FRIIS transmission formula.
- Data Export direct to Excel .TXT or .SIP
- Complete antenna efficiency module including Total Efficiency, Material Loss, and Radiation Resistance.
- Near field measurement setup.

3. **Vector Network Analyzer**

- Benchtop model , Frequency till 90 GHz
- Dynamic range – At least 100 dB
- Compatible with the Positioner and software mentioned in point 2.

Sr. No. 124 / Reference No. : 130

Detailed Description of Item :

Core plug saturator is a system that consists of a pressure control panel, a core plug holder vessel, a pneumatic pump to drive liquid/gas into the sample saturation chamber, and a vacuum pump to evacuate the pore spaces of the sample. It is used to saturate clean and dry core samples. Liquid phases include oil/water/brine, gaseous phases include CO2/CH4/N2.

Core holder :

- Pressure resistant saturation cell rated up to2000 psi, sealable with a threaded plug.
- Wire mesh basket for placing the core and loading in saturation cell
- Saturation cell diameter: 58 mm
- Saturation cell height: 300 mm
- Adaptable to smaller sample sizes using spacers.
- Non-corrosive upon interaction with water/brine/oil/gas.

Vacuum pump

- Double stage rotary vane pump
- Attached to core holder for evacuating void spaces before analysis
- Vacuum upto 10^{-5} psi
- Trap tank between core holder and vacuum pump
- Equipped with filter and manometer.

Plumbing

1. Pressure gauges for visualizing inlet fluid/gas pressure and saturation pressure.
2. Control panel for controlling valves and observing pressure.
3. Wetted materials of SS316
4. Pressure resistant non-corrosive pipelines
5. Back pressure valve for safety

Pumps

1. Manual hydraulic pump for fluid saturation. Pressure requirement upto 2000 psi
2. Saturant vacuum tank
3. Syringe pump for pressurizing gas before injection. Pressure requirement upto 2000 psi.
4. Gases required: CO_2, N_2, CH_4

Other specifications and requirements

·Feed tank must be supplied

·A set of plastic disks used to fill the unoccupied cell volume

·Warranty of three years

·Spare parts must be supplied

·Required gauges and plumbing as needed (other than mentioned)

Additional pre-qualification: A similar facility must have been supplied and functional, preferably in India. User reports may be provided and performance demonstration may be sought.

Sr. No. 125 / Reference No. : 131

Detailed Description of Item :

Multiphase relative permeameter :

Bench top system should be able to determine both liquid/liquid and gas/liquid steady and unsteady relative permeability of core samples under confinement. Liquid phases include water, brine and oil. Gaseous phases include CO_2, N_2, air, He, CH_4. The system should be high pressure resistant with temperature control module for the gas/liquid and the sample. The system should be able to operate automatically and manually with precise control of flow and pressure. User friendly operation including manual, MS Excel spreadsheet calculation template using dedicated computer and software is required. System should be plumbed and tested in factory/workshop as per mentioned application and calibration to be demonstrated during installation.

Core Holder

1. Confining pressure tolerance: up to 7500 psi
2. Confining pressure loading: Hydrostatic
3. Pore pressure tolerance: up to 6000 psi
4. Temperature range: Ambient up to 100 °C
5. Core diameter: One (1) 1 inch, 1.5 inch, or 54 mm diameter, interchangeable parts
6. Core length: 1 to 4 inches
7. Core holder: Hassler type
8. Sleeve: Viton
9. One hydraulic hand pump for applying overburden pressure in core holder (up to 5000 psi)

Plumbing

1. Valving and piping: 316SS or better
2. Pressure tolerance: up to 7500 psi
3. Non-corrosive material
4. Automatic valve controls
5. Humidified gas delivery system allowing system to be used for gas/water unsteady-state relative permeability studies.

Injection pumps

1. Maximum injection pressure up to 7500 psi
2. Flow rate: Constant rate operation ranging between 0.1 to 10 ml/s
3. Flow rate and volume accuracy: +-0.1% of set point
4. Rate and volume repeatability: +-0.05% of set point
5. Pressure accuracy: +-0.1% of full scale
6. HPLC pump with operation at rates from 0.1 to 10 millilitres per minute and pressures up to 6,000 psi.
7. Constant rate and constant pressure mode

Fluid accumulators

1. 2 floating piston SS316 fluid accumulators of 2 litre each for storing injection fluids. Rated pressure: 6000 psi
2. Thermocouples with minimum of ±1°C resolution (Temperature range: Ambient to 100°C)

Other specifications and requirements

- Core holder and accumulators designed to 4:1 safety factor and tested to 1.5x working pressure.
- Back pressure regulator for safety purpose
- Computer/laptop to operate the rig
- Software for easy data acquisition and operation, logging and interpretation
- Spare parts for 3 years operation
- Proof of calibration
- Warranty for three years period

Additional pre-qualification:

- A similar facility must have been supplied and functional, preferably in India. User reports may be provided and performance demonstration may be sought.

Sr. No. 126 / Reference No. : 132

Detailed Description of Item :

Helium porosimeter can measure the porosity and density of solid core samples by saturating the cores with helium through isothermal expansion.

Porosimeter is used to rapidly and precisely determine the effective porosity of core samples. The benchtop instrument is based on Boyle's law to make grain volume measurements on core plugs. The instrument should have easy user interface with automatic functions for porosity and density determination through isothermal helium expansion.

Core Holder

1. Pressure resistant, leak proof stainless steel holder (SS316 or better)

2. Core diameter to be used 1 or 1.5 inch
3. One whole core matrix cup style core holders (interchangeable)
4. Interchangeable between grain volume or pore volume measurement mode
5. Core length up to 3 inches.
6. Ambient temperature operation
7. Measurable porosity upto 60%
8. Filter discs on either side of coreholder

Plumbing

1. Stainless steel SS316 tubing and diaphragm valves for easy and accurate pressure control
2. Ambient temperature operation
3. Pressure transducer (0-200 psi) with linearity and hysteresis of less than ± 0.11 % of full scale.

Other specifications and requirements

·Core holder and accumulators designed to 4:1 safety factor and tested to 1.5x working pressure.

·Automated computer-controlled valves for easy and automatic operation

·Reference volumes incorporated in the system to be used for cuttings, plug and full diameter samples

·Calibrations to be performed during installation and calibration discs to be provided

·Computer and related accessories for easy operation, data acquisition and processing from the instrument

·Software for data acquisition and instrument operation

·Spare parts for 2 years operation

·Warranty for three years period

Additional pre-qualification:

·A similar facility must have been supplied and functional, preferably in India. User reports may be provided and performance demonstration may be sought.

Sr. No. 127 / Reference No. : 133
Detailed Description of Item :

Drill press is used to cut core samples of variable length and diameter from blocks of geomaterials/building materials. Core samples are extracted using diamond mounted motorized drill bits with hand operated lifting mechanism.

Manually operable floor-mounted heavy-duty standing drill press for coring blocks of rocks and concrete. The equipment should have a heavy-duty drill bit with coolant flow and movable drill bit rack.

Drill bit

1. High speed stable drill motor having less vibration for drilling into fragile rocks (coal/shale) as well as hard rocks (granite/basalt) and concretes.
2. Adjustable drill-bit rack with hand crank movement.
3. No creeping in the drill bit rack
4. Diamond mounted drill bits for 1 inch, 1.5-inch, 50 mm and 54 mm diameter coring
5. Maximum coring height is 20 cm.

Sample tray

1. Adjustable sample tray with tilting features (upto 45 degrees)
2. Sample size accommodation upto 3x2x2 cubic feet.
3. Clamping facility to keep the block sample stable.

Other specifications and requirements

·Constant coolant flow to prevent overheating of drillbits

·Facility for coolant recycling

·Reservoir for coolant storage

·Plumbing for coolant flow

·Spare drill bits for 2 years of use

·Warranty for three years period

·Splash guard and easy cleaning mechanism of the sample tray.

Sr. No. 128 / Reference No. : 134

Detailed Description of Item :

Trim saw with end face grinder is used forprecision cutting and smooth, parallel face preparation of rock samples and concrete using motorized low vibration diamond mounted blades.

Trim saw is used to resize rock core samples for various applications. End face grinder ensures flat top and bottom surface for accurate testing of cores.

Core holder

1. Diamond mounted saw blades (double or triple) ensuring vibration free trimming of top and bottom surface.

2. Able to cut through fragile rocks (coal/shale) without breaking/chipping.

3. V shaped core mount ensuring parallel face of cores having variable widths.

4. Grinder for polishing the end faces of the cores.

5. Ability to mount 1 inch and 1.5 inch diameter core plugs as well as 50mm, 54mm diameter full sized cores.

6. Ability to accommodate cores of variable length.

Other specifications and requirements

- Constant water/lubricating fluid flow mechanism
- Spare grinding wheels and saw blades for 2 years of use
- Warranty for three years period

Sr. No. 129 / Reference No. : 135

Detailed Description of Item : Multimode Microplate Reader

A Multimode Microplate Reader with Absorbance, Fluorescence Intensity, Luminescence, Time-Resolved Fluorescence, Polarization measurement capability will enable setting up novel bioassays, miniaturization of existing assays, multiplexing at different platforms. These are critical for screening of large library of molecules for their efficacy against specific targets in cell based assays, allow genetic screens based on CRISPR/Cas9 systems, studying interaction of drugs with its targets etc. The microplate reader supporting such applications should be able to adopt different sample holding platforms (96, 384 well), should be able to detect absorbance (200–1,000 nm), fluorescence (270–840 nm) and luminescence (360–670 nm). The system should provide filters enabling spectral scanning with double excitation and emission monochromators for time-resolved fluorescence analysis. The system should have inbuilt temperature control (from ambient + 4°C to 45 °C), orbital shaking options, CO_2 maintenance (0.1–15%) facility and online reagent dispensing capabilities (2–5,000 µl, in 1 µl increments with 1 ml syringe and 5–25,000 µl, in 5 µl increments with 5 ml syringe). It should allow End-point, kinetic, spectra, multipoint and kinetic spectra measurements.

Sr. No. 130 / Reference No. : 136
Detailed Description of Item : **Ceramic 3D printer system**

Specifications: Ceramic 3D printing system and accessories

Technology:

Static mask exposure (DLP) system along with suitable system for ceramic colloid layer preparation.

Machine parameters :

- Processable ceramic slurry viscosity range between 0.1 - 100 Pas.
- Intensity of light exposure>or equal to 70 mW/cm^2 (Faster process times for higher productivity) selectable with parameter access for customer materials including sluggish slurries
- Specify standard wavelength provided and quote separately for additional wavelength LEDs (405 nm, 375 nm)
- Pixel size(x and y): better than or equal to 60 µm
- Slice thickness: 10-100 µm user selectable option required
- Component Building Range (XYZ): more than 110mm, 60mm, 200 mm in X Y Z respectively.
- Highly-efficient material usage: initial material requirement< 10 ml to start
- Data format : STL or any other specify.
- Printed component top surface typical surface roughness: top surface better than 0.1 µm side surface better than 1µm
- Time for change over of material: < 3 mins
- Range of available standard materials - Al2O3, ZrO2, Si3N4, with comparable mechanical properties to conventionally manufactured components.
- Proof: scientific publications (peer reviewed) or test certificates from accredited laboratories. Components must besintered with out pressure and built standing up (testing of the adhesion of the coating)
- σ Al2O3 > 400 MPa (4PB)
- σSi3N4 > 700 MPa (4PB)
- σZrO2 > 900 MPa (4PB)

Materials :

- The wide range of standard materials should be provided (one cartridge each at least 200ml) along with the printer along with their parameter specification for use with the proposed ceramic 3D printing system software. The standard slurries/catridges with the following materials: alumina, zirconia, silicon nitride, ßtri calcium phosphate, hydroxy-apatite must to be provided and any additional can be specified.

- To be provided along with Full package of printing process parameters to enable immediate production of parts. Guidelines for post-processing (thermal treatment) tuned to every material need to be specified.

- 3 empty cartridges should be provided to fill our own material. Procedure to fill the cartridge should be provided.

- Shelf life of each of the materials and their solid loading % should be specified.

- Each cartridge cost should be provided in quotation for optional for additional purchase

Software:

- Should have facility to check (suitability for printing) and correct. STL files if need be.

- Should have facility to provide supports for over hanging structures.

- Should print component automatically without need of intervention after giving the print command.

- Need to have all safety features to protect the system in several possible usage cases (say for example power failure etc.) : Please provide list of all such cases, coded in software.

- Software options: Open Parameter Access specifically developed for R&D. Should give access to all printing parameters enhancing the development of new materials and optimization of printing parameters. Please provide list of parameters for which access would be given. Parameters should be changeable for every layer independently. The parameter access need to be quoted separately if not included already in the standard software.

Training:

- Training programs to be quoted separately for academia specifically tailored to suit different requirements including training on use of advance open access parameter.

Warranty:

- Should be provided for 12 months and optional quotation for annual maintenance contract (AMC) should be provided separately.

Spare parts and accessories:

- UPS to be provided needed to make sure printer works fine in case of power failure
- All other necessary spare parts, accessories, and advanced tools needed should be quoted separately.

Test components to be provided:

Components always printed green and sintered, and crack-free, without need of re working:

- Fine resolution : Al_2O_3Cubicgridwithchannels in all axes. Ridges< 100µm in all axes Channel diameter< 200µm in all axes.
- Debinding capability : Al_2O_3withminimum wall thickness> 10mm (e.g. cylinder with 10 mm diameter and 10 mm height). Density> 98 %
- Continuous channel : Al_2O_3cylinderwith 3 mm diameter and 15 mm height, has a helix channel with at least 3 rotations and a maximum diameter of 400 µm
- Non-oxide ceramics: Turbine impeller made of Si_3N_4

Please provide Application notes for working with nano particulate materials

Following questions should be answered in addition:

1. Specify ultimate strength both compressive and tensile of a typical ceramic structure printed (Alumina, 3YSZ, and any other material). Specify dimension of component for which it is measured.

2. Specify porosity and density of a typical ceramic structure printed (Alumina, 3YSZ, and any other material).

3. What would be cost per gram of printed ceramic component (Alumina, 3YSZ, and any other material)

4. Is it possible to print composite material or graded material. If yes specify the procedure. If its by using change over of the cartridge then can feed from different cartridges be used to print a single component.

5. Is it possible to print ceramic composites with particulate matter or chopped fibers?

6. What is largest volume of the cartridge?

7. If cartridge is not in use for some time, can it be reused? How much is inventory time and what is procedure to reuse cartridge?

8. Specify if there is in-process diagnostics? If there is a way incorporated in the system to know if previous layer is properly cured before exposing the next layer or if the new layer is really ready for curing, etc.

9. Would you provide debinding profile with slurries?

10. Specify smallest component that can be printed in the system?

11. Specify smallest size of the orifice (hole) that can be printed with 2-3 layers?

12. What is edge radius in xy plane and xz plane. (z is direction of layers) Say for example for a cube printed?

13. Specify over hang that can be provided with out use of supports?

14. Academic and Industrial customers list: names and broad industry domains

Sr. No. 131 / Reference No. : 137
Detailed Description of Item :

The Flash differential scanning calorimetry (Flash DSC chip nanocalorimetry) revolutionizes rapid-scanning DSC. The instrument can analyse reorganization processes that were previously impossible to measure. The Flash DSC is way superior to conventional DSC with heating and cooling rates (K/s) that cover a range of more than 7 decades. Moreover, to the best of our knowledge this unique instrument is going to be the first of its kind in the country till date.

1. The Fast-scanning differential scanning calorimetry or Flash DSC should be accompanied with a MEMS (micro-electromechanical system) **chip sensor, which is equipped with at least 16 thermocouples for high sensitivity and excellent temperature resolution.** In that case two sets of 8 thermocouples should be arranged symmetrically around the measurement area on the sample and reference sides of the sensor, permitting temperatures to be measured with great accuracy, even at low heating and cooling rates **The MEMS chip sensor should be mounted on a stable base (e.g., ceramic substrate with electrical connections). sensor permits measurements in a wide temperature range from –95 to 420 °C.**

2. Should permit samples to be measured under oxygen-free conditions
3. Sample preparation is to be carried out with the aid of a microscope. This needs to be provided along as an integrated part of the instrument. The microscope is also used to accurately position very small samples onto the sensor.
4. Can be cooled by intracoolers – electrical cooling devices with a closed-loop cooling system. The vaporized coolant should be liquefied by means of compressors and heat exchangers. Should be able to provide cooling at least at 0.1 to 4000 K/s and heating at least at 0.1 to 40000 K/s
5. There should be controllable and easy-to-read color touchscreen displaying the status of your instrument is located at the front of instrument. Individual sequences and queries may also be added directly via the touchscreen without the use of a PC
6. Software should be capable to include running specific experiments, develop methods for advanced analyses and perform flexible result evaluations. The program should come up with separate sections/windows, e.g., method, experiment, analysis/evaluation etc. Any type of temperature profile, with up to 200 temperature segments, should have to be programmed in the Method Window of the software. Many complex operations – such as loops, or conditional termination of experiments has to be included in the method generation feature. The experiment window should allow one to select a method and enter the relevant data for the specified experiment. Such data, in a typical Flash DSC/fast scanning calorimetry experiment, should include the conditioning and correction procedure for the new MEMS sensor. The evaluation/ analysis window included in the software should offer the possibility of advanced evaluation tools, such as the Mathematics option, and a superior layout program.
7. The supplier/vendor/ OEM should be capable of producing and supplying appropriate MEMS based chip sensor for the entire lifetime of the instrument or upgrade the instru-

ment to compatible sensor usage in future. Since ideally those chip sensors will be procured as consumables for sample preparation on top of those time to time.
Detailed specifications are followed below:

Temperature data		
Temperature range	Air cooling	Room Temperature to 500 °C
	Intracooler (2-stage)	–95 to 420 °C
Cooling rates (typical)		6 to 240000 K/min (or 0.1 to 4000 K/s)
Heating rates (typical)		
		6 to 2400000 K/min (or 0.1 to 40000 K/s)
Sensor data		
Sensor membrane material		Silicon nitride
Number of thermocouples		16 or more
Signal time constant		Approx. 1 ms (UFS 1)
Applied sample mass range		Approx. 5 to 400 ng (org. materials, polymers); 100 to 10'000 ng (metals)
DSC MEMS sensor		
Pmax heat flow signal		±20 mW
Noise heat flow signal		rms < 0.5 µW (typical)
Isothermal drift heat flow signal		< 5 µW/h (typical)
Future supply		The OEM/vendor must be able to supply (upon purchase) compatible chip sensor for the fast-scanning calorimetry (flash DSC), otherwise should upgrade the instrument capable to sense appropriate sensor
Gas conditions for measurement		
Oxygen-reduced atmosphere		< 50 ppm O_2
Terminal		
Touch control		Color TFT; WVGA 7" 800 x 480 pixel
Signal detection		
Sampling rate		Max. 10 kHz (10'000 points per second)
Resolution of temperature signal		2.5 mK (UFS 1)
Noise temperature signal		rms < 0.01 K (typical)
Communication		
With personal computer (PC)		Ethernet
Dimensions		
Instrument dimensions (intracooler separate) (width * depth * height)		Minimum 45 * 60 * 50 cm Maximum 50 * 65 * 55 cm
Intracooler		Needs to provide separately yet part of the whole integrated instrument capable to meet above cooling/heating specifications
Optical Microscope		Needs to provide separately yet part of the whole integrated instrument capable to meet above observation related specifications

Sr. No. 132 / Reference No. : 138
Detailed Description of Item :
Super Resolution (SR) Microscope Imaging Platform(SIM/STORM) :
The imaging workstation should include

i) Super Resolution imaging device (SIM or Multipoint Array scanning) as well as with 2D and 3D STORM / PAL-M / TIRF(not quasi TIRF)modes of imaging for single molecule localization for fixed and live cells

ii) Confocal mode of imaging with deconvolution =

A. **Inverted microscope (Fully Motorized) :(a)**. System should have Bright field, Fluorescence and DIC Imaging capability. **(b)**.System should have fully motorized beam path selection for wide field, 2D/3D SIM/ Multi Point Array Scanning, with 2D, 3D STORM/ PALM and TIRF modes of imaging. Also, the system should have Single deck or dual deck configuration for combining all these techniques such as wide field, 2D/3D SIM/ Multi Point Array Scanning, with 2D, 3D STORM/ PALM and TIRF modes of imaging on the same platform. **(c)**.System should have motorized Peizo/Galvo Z-axis focus drive optimal for super resolution imaging with minimum resolution/step size of 5nm or less. **(d)**.System should have 6 position or higher motorized FL filter wheel for excitation and emission path and 6 position motorized DIC nose piece. **(e)**. Motorised XY scanning stage for the movement of specimen using ergo joy-stick as well as total control by the software. Stage holder should be universal type capable for holding 35/60mm dishes and chambered cover-glass apart from standard slides and multi-well plate. **(f)**.System should include a minimum of 12v/100w halogen/LED illumination for transmitted light with automatic shutter having DC (direct current) to provide constant and non-fluctuating light. **(g)**. Motorized universal condenser turret with NA 0.5 or better; motorized 6 (or better) position objective turret with 6 or more DIC slots; motorized filter turret with at least 6 positions for band pass fluorescent filters for sample visualization. Band pass filters for GFP/FITC, DAPI, TRITC/ Rhodamine/ cy3, CFP/YFP should be quoted. **(h).** System should be supplied with high resolution objectives 10x,40x/0.95NA, 60x/63x Oil (N.A1.40) and 60x/63x Water(N.A 1.27 or better) for deeper SIM Imaging and 100x oil/NA 1.49 and 100x Silicone oil lens (N.A 1.3 or above)should be usable for SIM or Multi Point Array Scanning Technology and Localization imaging. System should also have 40X(NA 1.2 or above)Silicone immersion objective.[Silicone objectives should be given as optional] **(i).** System should be equipped with correcting spherical aberrations by using automatic collar correction system for achieving best PSF for user convenience for High N.A objective for TIRF/STORM/PALM experiments. **(j).** Automated DIC accessories for all objectives. Band pass fluorescent filters for sample visualization should be offered. **(k)**. The microscope system should be capable of conducting long duration live cell imaging with image acquisition occurring at intervals of msecs to secs. The microscope should be equipped with hardware to correct for focus drift through a LED or laser (wavelength 750 nm or more) based continuous focus correction system for long term live cell 2D/3D SIM/Multi Point Array Scanning and 2D/3D STORM/PALM data acquisition. The system should be able to store large data sets obtained from long-term live cell imaging. **(l).** System should be capable to have Automatic Water dispenser for Long time live imaging with water objective. **(m).** System must be equipped with a complete cage enclosure with weather controlled environment including independent control for CO2, O2 (in form of air) and, humidity, N2for hypoxia experiments. The incubator enclosure should have the following: dark or transparent panels, temperature range from ambient 25 deg C to 45 deg C. The temperature accuracy on the sample should be +/-0.3 deg C or better. The air-filtering unit for inlet air, sliding doors for easy handling and illumination inside the enclosure with suitable light should be provided. **(n).** DIC attachment motorized for 10x to 100x objectives with analyzer and polarizer attachment, sliders and modules for the respective objectives. **(o)**.The system should be capable of imaging close to the cell membrane within a depth of 150 nm or less using the TIRF module. **(p).** High-performance (Newport, Melles Griot, Thorlabor equivalent) active vibration isolation lab tableshould be quoted.

B. SIM/ Multi Point Array Scanning based Super-Resolution Module : **(a)**.The system should be based on SIM/ Multi point 2-D Array scanning Super Resolution technique with capability of X-Y resolution of ~ 100 –130nm or better. **(b)**.Capable to resolve in Z: ~300 -350 nm or better. **(c)**.Temporal Resolution of the system should be 200 fps (minimum) @ 2msec exposure with 1024 x 1024 resolution enabling the study of dynamic interactions in Living cells. Also, the system should reach the maximum speed of 1000 fps @ 1024x192 Pixel for capturing the very fast dynamic interaction. **(d)**.The system should be capable of at least two colours simultaneous imaging with two sCMOS cameras of more than 90% Q.E. **(e)**.The System should have a selectable pin hole sizes; 10 -64um, to match pin hole size to microscope objective. **(f).**The system should not use any intermediate magnification changer for achieving the desired resolution. **(g).** System should have observation modes as 2D and 3D mode along with two colours simultaneous imaging. All the change-over between different modes should be automated. The acquired Super Resolution Data should be quantifiable in terms of intensity of individual SR Images. **(h)**. System should be capable of performing Multi-colour Imaging with "at least two-colours Simultaneous SR Imaging" without loss of resolution in any spectral region from 405 -640 nm. **(i)**. System should be capable to perform Long time Live cell Imaging experiments in super resolution. The System should have multi point 2-D Array for scanning all images with the same scanning beams to minimize image to image variations.

C.Localisation Based Super Resolution mode(PALM/STORM) :

(a) The system should be capable of achieving a X-Y resolution of 30 nm or better
(b) Resolution in Zshould be 60nm or better
(c) The system should be capable of doing localization in different modes: 2D, 3D and TIRF mode [TIRF should be fully Automated (XY and Z focus automated) and with automated critical angle search]
(d) System should have capability of Live cell imaging with different format using 128x 128/ 256x 256 and 512x 512 in super-resolution mode. This should be documented on the website/brochure.
(e) Data should become available as the images are being acquired. There should be image based auto focussing. Multi-channel or multi-color acquisition in a sequential mode should be possible
(f) Should be capable to acquire different imaging area like 80micron x 80micron/ 40micron x 40micron/ 20micron x 20micron & 10micron x 10micron
(g) The system should be able to use a wide range of available fluorescent proteins as well as organic dyes (photo activable, photo convertible, photo switch able and photo chromic) for working with the system. Photo activation controls and processing tools for PALM / dSTORM should be available.

D. Laser unit :

•All DPSS/Diode high power, long life lasers; pre-aligned having AOTF control with following lines and should be workable with both Confocal and Localization based super-resolution techniques:
•DPSS/Diode 405nm
•DPSS/Diode 445nm
•DPSS/Diode 488nm
•DPSS/Diode 561nm
•DPSS/Diode 647/640/635nm
•DPSS/Diode 514 nm
•The SIM/Multi Point Array Scanning Super Resolution System should be quoted with separate laser combiner having 405nm, 488nm, 561nm, 640 or 642nm with High Power and should be controllable with the same software been used for the Localization Based Super Resolution technique for the Correlative study on the same field.

•The lasers should have appropriate power for both SIM/ Multi Point Array Scanning, STORM and Confocal usage.

E. Detection system for epi-fluorescence and two Super-Resolution techniques (Separate Detector should be provided for both the Super Resolution techniques, Structured Illumination/ Multi Point Array Scanning method(dual camera) and Localisation based method(one camera)) Detection for Super-Resolution modules should be based on Scientific CMOS camera having effective no. of pixel 2k x 2k or better with Pixel Size of 6.5 microns x 6.5 microns and it should be capable of acquiring at a max speed of 89-95fps or better @ full frame, Q.E, should be more than 90%. Readout noise should be 1.0 e-or better with full well capacity should be 30,000 electron or better or having similar output with justification will be considered for Super Resolution modules. Optimal FOV of 80 µm X 80µm or better using 60X or 63X/1.40 oil objective or equivalent objective should be available.

F. Confocal and widefield (for observing the sample) module :

a) The system should be able to switch to confocal and widefield mode without any additional hardware alignment.
b) The system should be capable of archive confocal effect using point scanning or equivalent method with additional capability to remove out of focus light to achieve X-Y resolution of120nm nm or better and Z resolution of 300 nm or better.
c) System should be able to achieve high speed –up to 20 fps(512X512for 1 channel--to get high temporal resolution and low photo toxicity and photo bleaching to allow live cell imaging.
d) System should have high quality excitation and emission filters and dichroic mirrors
e) Laser scan head :
   •Confocal laser point scanning unit should be quoted. It should be capable of line-scanning in 1D and 2D (space-time) as well.
   •Scanner should have laser ports to connect to above mentioned lasers and should have either low angle of incidence semrock or crystal-based dichroic for high efficient excitation laser suppression.
   •Motorised and computer-controlled continuously-variable confocal pinhole with software control.
   •High speed XY galvo scanner with min.180 deg scan rotation with total scan flexibilities of line, free hand curved line, XY, XYZ, XYZ t and XYZ t λcombinations.
   •The laser scanner should have dual scan capability of fast volumetric regions bleaching/activation/ablation & normal scan for Imaging to conduct experiments like FRAP, FRET, FLIP, photo activation/conversion.
   •Scan resolution should be at least 4K x 4K for all channels and can be selected freely down to 64x64pixels.
   •Scan Zoom range 1.0x to 40x or more and should be adjustable in steps of 0.1.
   •System should be capable of acquiring minimum of 6-8 fps or higher at 512x512 pixel resolution. It should also be capable of ROI-based scanning. Should also have speed of more than 20 fps @ 512X512 with more than 20 mm FOV and upto 700 fps @512X16.
   •Scan field diagonal should be 20 mm or less @ up to 20 fps (512X512).•Data acquisition and digitization capability with at least 8, 12 and 16 bit should be available.
f) Detectors :
   •The detection unit should have dual detection capability with intensity-based confocal imaging as well as spectral confocal imaging.
   •Should have minimum 4 detectors (of which at least 2 should be highly sensitive GaAsP/HyD) and a tunable spectral detector like GaAsP/HyDor equivalent with minimum 45% quantum efficiency. The system should be capable of simultaneous detection and sepa-

ration of at least 4 fluorophores with built-in or separate confocal detectors. The system should have one transmitted light PMT detector for laser scanning DIC imaging.
•The spectral dispersion of the emission light should be of latest technology with high efficient separation. The system should be capable of online separation of auto fluorescence and bleed through.
•Capability for lambda-scan should be quoted.
•The system should be capable of recording emission spectra with minimum spectral resolution of 10nm of better.

G. Controlling and Analysis Software Should meet the following parameters and requirements :

- Basic image acquisition, Complete microscope control, Scan head control and Laser control software. Same software should be capable to control Super-Resolution microscope, confocal and widefield system
- Saving of all instrument parameters along with the image for repeatable/reproducible imaging
- Frame/line/lambda capturing, Z-Stack, Time series imaging capabilities
- Multipoint Time Lapse Imaging.
- FRET analysis
- Co-localization analysis and 3D volume rendering
- 3D measurement
- Real time ratio-display
- 2 D and 3D image deconvolution
- Diverse measurement and statistical processing
- The software should have the capability to show two live windows for two cameras while performing simultaneous dual colour imaging
- Direct streaming of data and parallel processing while streaming of data should be possible.
- Huygens Professional deconvolution software [Optional]
- Two licenses of the main software with all the features.

H. Workstation

- Dual Intel Xeon Gold 6226 2.7GHz, 3.7GHz Turbo, 12C, 10.4GT/s 3UPI,b.19.25MB Cache,HT(125W) DDR4-2933, 1TB OS SSD, 8TB Fast Acquisition Drive (RAID-0), 20TB additional storage (RAID-10), 1300W power supply, backlit wired keyboard
- 4 × USB 3.0, 4 x USB 2.0, 2X Gigabit Ethernet, Windows 10 Professional
- 24" LCD TFT wide aspect true colour monitor 2 no. for connection to workstation to enable 2560 x 1600 pixel resolution
- Another Identical workstation with 32 TByte storage capacity for complete offline analysis of all the imaging data should be available

I. Power back up for the entire system

- A suitable ONLINE UPS system (with back up for 30 min and with voltage stabilization capability) for trouble-free operation for the complete system

J. CMC

- Warranty should start from the day of installation + 2 yrs of CMC + 2 yrs of AMC
- In case of downtime, the system should be attended within 48 hours of complaint.

K. Operator

- One company trained operator should be recruited and maintained by the company onsite for three years from the date of installation.

L. Multipoint array scanning based super resolution system can be offered by either main microscope bidder or their exclusive authorized distributor in India separately.

M. Other requirements.

- 100% CO2 and O2 cylinder with regulator, dehumidifier and two 2tonswitchable converter ACs.
- Additional computer table for CPU and monitor and second workstation
- The bidders should provide full details of after sales service support and detailed list of users in India over the last 3 years with contact details.

Note-Bidders must mention clearly the Room dimension/conditions required to install the above set-up.

Sr. No. 133 / Reference No. : 139
Detailed Description of Item :

Cubic Immersive Virtual Reality System

Specifications of Immersive Virtual Reality System : An immersive virtual reality system (IVRS) provides an artificial environment with a real-world feel to its users. It is commonly known as Cave Automatic Virtual Environment (CAVE). The IVRS that Indian Institute of Technology (IIT) Bombay intend to setup should have the following specifications:

1. 3D virtual reality projection system Active Stereoscopic Single-chip DLP laser projector with - 4 Quantity

• Resolution: Minimum 2,560 x 1,600 @ 120 Hz • 3D technology: Active • Brightness: Minimum 9000Lumens • Light source: LASER • Life: Minimum 35,000 hours • Projector lens: FLD+ Short Focus 0.8 - 1.21 : 1 • Projector mountings: 1 roof and 3 floor mounting • Operating voltage: 220V

2. Projection screen 4 sided projections (left, front, right and floor) with widest possible viewing angle - 1 setup

• Type: Flexible scratchproof, wet washable, flame retardant hot-spot or glitter free screen • Size: Minimum 2m x 3 m • Peak gain: 1.0 for front and side screens 1.1 for floor projection screens • Screen mountings: Fixed mountings for front and side screens Movable floor projection screen • Mirror rig: For front and side screens (if needed) • Temperature Stability: 0 to 70 deg. C

3**. Display management system and image generators** - As required Computing system with: • Processor: Speed – minimum 3.6GHz and 3.9GHz Turbo; Core – minimum 4; Cache – minimum 8.25MB • RAM: Minimum 128 GB • Storage: Minimum 1 TB SSD • Graphics: NVIDIA Quadro RTX A6000 or better • Appropriate Sync card for a CAVE setup • Monitor: Minimum three 27-inch LED monitors • Operating system: At least the latest version of Microsoft OS • Input/Output: For the projectors, monitors, wireless keyboard, wireless mouse and masterslave setup • Operating voltage: 220V • UPS with minimum 15 minutes backup.

4. Audio system - 1 Set, AVR with digital signal processor and: • 8 surface mount speakers • 1 subwoofer • 4 multichannel amplifiers

5. Cables and display related accessories - As required • Video extenders • Video and CAT6-network cables • Optical fiber cable and Audio cable • Fast ethernet smart switch • Equipment rack • Power adopters

6. 3D optical tracking system - 1 set Includes: • At least 4 nos. of 3D optical tracker camera • Navigation device with head tracker • 2 pairs of Finger tracking data gloves • 15 nos. of 3D glasses and at least 1 RF Emitter • Eye tracking solution integration kit

7. Software - As required The software with perpetual license should have the following capabilities: • Integrating tracking device information • Video projection interfacing and display software supporting high-quality 3D stereo projections on four sides with appropriate ble nding, high-resolution quad-buffer stereo, desktop head mount display. • Simultaneous interactions between IVRS (or CAVE) and multiple head mount displays • Recording of data captured from tracking systems, head mount displays and connected driving simulators. • Support a mechanism for data integration from major CAD and geospatial terrain data sources including but not limited to Unity applications, Solidworks, 3DS Max, NX Unigraphics and CATIA. • Allow fast development of complex 3D scenarios and provide application programming interfaces (APIs) and standard development kits (SDK) with possible publishing of non-commercial applications (exe) files. • Compatibility: At least the latest version of Microsoft operating system.

8. Installation and training - The setup should be installed at the site in IIT Bombay with minimum 1-year warranty on parts and service and training for operations and troubleshooting technical errors. Further, a documented manual on operations and troubleshooting for future use must be provided after the installation of the setup.