



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

Reference No. (PR No. 1000019382)

RFx No. 6100000791

**TECHNICAL SPECIFICATIONS**

**Aberration corrected TEM system for soft materials with Cryo capability**

Soft materials aberration corrected Cryo-TEM system consisting of

- A. 200KV aberration corrected Cold-FEG TEM, with items for sample preparation,
- B. Cryo-ultramicrotome with knife maker and block trimmer,
- C. Automatic Plunge Freezer, and
- D. Freeze fracture with vacuum cryo transfer unit; suitable for a variety of cryo-TEM work with biological, nanomedicine, soft-solid and complex-liquid related samples.

**A. 200KV aberration corrected TEM**

Sr. No	Parameters	Desired Specifications
1	Accelerating Voltage	200kV - user changeable from 30 kV — 200kV without intervention of a service engineer. Condenser lens should be aligned at least for three of the voltages such as 200, 120, 80 kV, or 60kV at no extra cost. Minimum Step size $\leq 50$ V.
2	Electron Source	W COLD FEG. The emitter brightness should be $8 \times 10^8 \text{A/cm}^2 \cdot \text{sr}$ or higher at 200 kV. The vacuum level in gun area up to the bottom of the acceleration tube should be $10^{-8}$ Pa or less. The probe current should be 1.0 nA or more for probe diameter of 0.19 nm.
3	Resolution and Spot size	Point image resolution $\leq 0.27$ nm Information Limit $\leq 0.14$ nm Lattice image resolution $\leq 0.14$ nm; STEM HAADF, BF, DF lattice image resolution should be $\leq 0.082$ nm with STEM corrector. The configuration should enable STEM Tomography with above resolution in place.
4	Magnification	i) TEM Magnification: Range 50x to 1.5Mx or higher ii) STEM Magnification: Range 200x to 150Mx or higher
5	Operation Modes	The TEM should be fully digital microprocessor controlled with following modes as standard: HRTEM, STEM, EDS, BF, DF, HAADF, Diffraction, CBED, SAED, NBD

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6	STEM Permissible Aberrations Coefficients	i) Spherical aberration: -0.1 mm to 1.0 mm ii) Chromatic aberration $\leq 2.0$ mm
7	Cooling system	Close circuit, automatic temperature and flow rate-controlled water-cooled chiller
8	Lens System	System consisting of condenser lens, objective lens, diffraction, intermediate and projection lenses
9	Vacuum System	Microscope should have suitable vacuum system consisting of Non-evaporable getter ( <b>NEG</b> ), Sputter ionpumps (SIP) FEG gun vacuum should be $\leq 10^{-8}$ Pa TEM specimen chamber vacuum should be $\leq 2 \times 10^{-5}$ Pa
10	Specimen chamber	i) Goniometer maximum tilt should be $\pm 70^\circ$ or higher ii) X movement range: $\pm 1$ mm or more iii) Y movement range: $\pm 1$ mm or more iv) Z movement range: $\pm 0.4$ mm or more v) STEM tomography should be automated with dynamic focusing capability. vi) Microscope should have a fully Eucentric goniometer with all 5-axis motorized for standard 3.0 mm TEM grid vii) Facility for recording specific specimen translation position as reference point in memory viii) Minimum step of $\leq 0.05$ nm for sample should be provided
11	Detectors	i) STEM detector should be consisting of BF, HAADF and ABF detectors. ii) STEM detector should be able to acquire BF, DF, HAADF, ABF, e-BF and LAADF images. iii) HAADF (ADF) with range from 27 mrad to 110 mrad Should be possible at camera length of 20 cm. LAADF with range from 12 mrad to 48 mrad should be possible at camera length of 20 cm.  Above goniometer, the dedicated multi-channel plate BSE/SE detector must be provided.  iv) The system should have an ability to acquire four Images simultaneously.
12	Probe corrector	Probe corrector to be provided with STEM resolution of less than 0.082 nm.
13	Recording System	Bottom Mounted, retractable, EELS compatible high-resolution CMOS camera of minimum resolution 4k X 4k pixel @ 20 fps. The camera should have in-situ operation mode

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14	3D-Tomography	TEM and STEM 3D-tomography holder with appropriate software should be provided and on-field upgradable to EELS in future. The system should be compatible for tomography with Cryo holder.
15	Window less EDS Detector	Window less Silicon Drift Detector EDS of total area $\geq 158\text{mm}^2$ using at least one EDS or more, solid angle should be $\geq 1.1$ srad, take-off angle should be $\geq 30.5^\circ$ Energy Resolution at Mn-K $\alpha$ should be at least 133 eV at 100,000 spectra/s or better Capability to detect elements with atomic number $>5$ (i.e. from B onwards)  Capability of auto protection in case of vacuum loss or high electron flux
16	Anti Contamination Device	Liquid nitrogen based anti-contamination device to suppress specimen contamination that may adversely affect high resolution imaging and analysis
17	Sample holders	i) Analytical Double tilt Holder- 1 No. ii) Single-tilt Holder - 1 No. iii) Analytical high tilt Tomography holder – 1 No, iv) CRYO Holder -2 Nos v) CRYO Transfer station and controller for CRYO holder – 1 No vi) CRYO Tomography holder– 1 No vii) CRYO Transfer station and controller for CRYO Tomography holder – 1 No viii) Cryo holder dry pumping station – 1 No.
18	User Interface	i) Fully computer-controlled system with windows-based software for operating the Microscope along with keyboard, mouse. ii) Manual control panel using knobs, sample movement by track ball or joystick iii) <b>Control Panel and Joystick</b> -Control panel including multifunction keys/knobs for control and adjustment of TEM parameters (focus, magnification etc) and manual joystick control for stage in X, Y, Z tilt and rotation directions.
19	Work Station and Software	i) Latest desktop system with sufficient USB ports and windows compatible operating system to operate FF-TEM and all attachments and 24 inch or higher HD LED monitor ii) Complete software for image analysis, topography,

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		<p>morphology, dynamic picture recording, and image manipulation for separation of different images, super posing and subtraction</p> <p>iii) Suitable for screening samples for subsequent singleparticle reconstruction (SPR) studies.</p> <p>iv) Tomography Software for automatic control and reconstruction</p> <p>v) Image file in JPEG, TIFF &amp; BMP formats. Backup software must be provided on optical media. Any further version of the software and updates must be provided freeof cost</p>
20	Manual	One set of instruction manual and service manual (both hard and soft copy in English) should be supplied with the equipment.
21	Pre- Installation requirements	Complete technical details of pre-installation requirements should be furnished along with the technical bid to ensure quoted resolution.
22	Installation	Installation, complete interfacing of the system with its subsystems, and commissioning is to be carried out by the vendor's factory-trained engineers, followed by a demonstration of the system's performance to the user's complete satisfaction
23	Training	The manufacturer/supplier of HRTEM should provide seven days onsite training initially during installation followed by regular follow up training during the warranty period on mutually convenient dates.
24	Accessories	Chiller/compressor /UPS/other necessary accessories for installation as required should be included in the offer and should be manufactured by the vendor or internationally reputed manufacturer
25	Sample Preparation	Following Accessories should be included in the offer: i) Cryo Ultramicrotome with knife maker and block trimmer ii) Automatic Plunge Freezer iii) Freeze fracture with vacuum Cryo transfer unitas per specifications below.

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26	Site-preparation requirements	<p>Offer should include complete site preparation for optimum installation of all units procured under this order.</p> <p>i) Including Precision Air conditioner, confirming to temperature variation requirements as specified by TEM manufacturer.</p> <p>ii) Electromagnetic interference tools /equipment to control Electromagnetic interference as per requirements of equipment manufacturer.</p> <p>iii) Anti-vibration tools tools/ equipment to control Electromagnetic interference as per requirements of equipment manufacturer.</p>
<p>Please note that demonstration of resolution confirming to parameter no. 3 above should be demonstrated at site by the equipment supplier and hence specifications of point 26 i, ii, iii should be planned and quoted by the TEM manufacturer accordingly after conducting thorough site survey at our proposed installation location.</p>		

## **B. Cryo-Ultramicrotome With Knife Maker and Block Trimmer**

### **Cryo Ultramicrotome**

1. Cutting transmission should be done by vibration decoupled gravity stroke
2. Specimen feed at steps of 1 nm or better
3. Cutting speed should be controllable in a range of 0.05 to 100 mm/sec
4. Complete system should be controlled by a touch screen controller of size 10" or more
5. Knife stage should be fully motorized and controllable by the touch screen controller
6. Movement range of knife stage in E-W (X) and N-S (Y) directions should be at least 25 mm & 10 mm respectively
7. Countdown, section counters, speed, feed, stage movement parameters should be visible on controller screen
8. Details of user, sectioning, knife parameters and grid box parameters should be downloadable via USB (logbook)
9. It should be possible to make segments of knife and it should be approached automatically
10. Ultramicrotome should have automatic trimming function, programmable by the touch controller
11. Stereomicroscope with magnification range of 10x to 75x or more should be provided
12. Ergonomic wedge with adjustable angle of 5°- 25° should be included with stereomicroscope
13. It should have eucentric movement with defined click stop positions for glass knife and diamond knife
14. There should be 4 LED illuminations with top light, spotlight, back light and specimen trans illumination



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15. All Illuminations should have independent control via touch screen controller
16. Cryo chamber should have adjustable temperature from +110°C to -185°C with automatic rapid cooling
17. The controls for Cryo chamber should be integrated within the main machine's controller
18. Individual temperatures setting for specimen, knife and gas temperature
19. Chamber wall should be heated and have high gas GN2 flow < -140°C
20. It should have 5 level LN2 indicator with reserve warning
21. Knife holder should be rotatable with position for 2 Cryo knives
22. Ionizer should be provided with electrostatic charge and discharge functions
23. Chamber should have warm arm rests and gaps for GN2 flow
24. Dual micromanipulators for Tokuyasu and CEMOVIS cryo-sectioning

**Glass Knife Maker**

1. 100% balanced break method
2. Breaks glass from 6.4 to 10mm
3. Variable scoring lengths with Accurate glass strip positioning
4. Drawer system with convenient and safe knife removal
5. Auto reset of breaking and scoring mechanism
6. Push action score for even scoring and Adjustable scoring pressure
7. Breaking wheel with scale for defined and reproducible glass break

**Block Trimming Unit**

1. High speed diamond miller with variable speed of 300 to 20000 rpm or more
2. Integrated stereo microscope with LED ring light for easy adjustment of the
3. block positions
4. Miller movement should be adjustable in steps of 0.5, 1, 10, 100 um
5. Auto feed function for minimizing human intervention
6. LCD display for showing the feed of miller
7. Safety cover for working area and auto stop mechanism on removal of safety
8. cover

**Consumables**

1. Diamond knife 3 mm for Cryo as well as room temp. sectioning
2. Cryo trimming blade for auto trimming of cryo sample
3. Glass strips 6.4 x 400 x 25 mm, 30 pcs.
4. Trufs 6.4 mm, 500 pcs.
5. Easymold, embedding mould for 5.6 mm diameter
6. Knife box for 6.4mm and 8mm glass knives
7. Grid box for 100 grids, 10 pcs
8. Dental wax

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### **C. Automatic Plunge freezer**

1. Movable climate control chamber with automatic adjustment of temperature up to 60° C or more as well as humidity up to 99% or more
2. Climatic chamber should be well lit inside with LED and a defogger/window heater should be available to maintain a clear view of chamber
3. Windows for inserting pipette should be available on both left as well on right side of the chamber
4. Touch screen control panel to program and run the system with easy to use graphic user interface with library of 15 or more editable operating programmes
5. Possible to set & adjust pre-blotting, blotting/hold time.
6. It should be capable of doing single or multiple side automatic sensor-controlled blotting.
7. Positioning of grid should be adjustable in terms of distance and height with respect to the blotting paper
8. There should be two separate containers for secondary cryogen & cryotransfer of sample with lid
9. One-liter LN<sub>2</sub> dewar and secondary cryogen should be stationary
10. Secondary cryogen temperature should be adjustable with a range up to -190°C or more
11. Container should have adjustable GN<sub>2</sub> flow for avoiding contamination due to ice
12. Secondary cryogen preparation with Ethane or propane, using a transparent and attachable lid on container should be available
13. Required accessories like cryo-tool dryer, grid box, insulating forceps, blotting papers etc should be provided along with the equipment

### **D. Freeze Fracture with Vacuum Cryo Transfer Unit**

1. A standalone benchtop equipment capable of doing freeze fracturing, freeze etching and high resolution cryo coating with e-beam.
2. Vacuum level of the system should be capable of reaching up to 10<sup>-8</sup> mbar or more
3. It should have inbuilt cold cathode gauges for monitoring the vacuum levels
4. It should be possible to keep the system under vacuum all the time and transfer/load lock systems should be available for samples and knife
5. Simultaneous dual e-beam coating sources should be mounted for metal and carbon
6. It should be programmable with a touch screen control panel to do automated operations
7. It should be possible to control the thickness of coating layer with film thickness monitor having resolution of 0.1 nm
8. Cryo stage as well as Cryo-knife should have adjustable temperature range of - 185 °C to 20 °C
9. Cryo-knife should be capable of easy movement in XYZ axis without any hindrance

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10. Feed of the Cryo-Knife should be controllable with an accuracy of 0.2-micron steps
11. Cutting speed should be adjustable in a range of 1-200 mm/sec
12. Stage should be motorized and tilt able with a range of  $-45^{\circ}$  to  $+45^{\circ}$  angle
13. The system should have a stereo zoom microscope mounted on the viewing window for convenient observation of the process and easy adjustments
14. Transfer between the freeze fracturing system and the scanning electron microscope should be done while maintaining the vacuum as well as cryo conditions.
15. Complete set should also include the necessary attachments and controller for upgrading the electron microscope with cryo stage including the controller for maintaining temperature.
16. Transfer between the freeze fracturing system and the cryo transmission electron microscope should be done while maintaining cryo conditions.
17. Transfer between the freeze fracturing system and the cryo ultramicrotome should be done while maintaining cryo conditions.

**Warranty:** Comprehensive Warranty for **three** years including part A, B, C and D. FEG Emitter and Gun are an integral and crucial part of the system and should not be considered as a consumable, hence should be covered under warranty.

**Delivery:** On **DAP (Delivery at Place)** basis. Insurance, shipping, customs clearance and delivery of material to IIT Bombay is the responsibility of supplier at no additional cost than the quoted price. However, customs duty (if applicable) at Mumbai will be paid by IIT Bombay on sharing the Bill of Entry.

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