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

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Technical Specifications for Field Emission Gun Scanning Electron Microscope (FEG-SEM) with EDS and EBSD

Sr.No.	Features	Specifications
1.	Resolution	Resolution: 0.5 nm or better at 15KV. 0.7 nm or better guaranteed at 1 KV. Resolution claimed must be supported with pre-printed literature.
2.	Magnification	Direct Image magnification range from 10X to 2,000,000X.
3.	Accelerating voltage	10V to 30KV
4.	Probe Current	Probe current from 1pA to 500 nA at 30 kV or from 1 pA to 100 nA or better at 5 kV.
5.	Electron Gun	Thermal Schottky field emission gun. The emitter should be covered under 3 years warranty or replaced as and when required within 3 years free of cost. Dedicated back-up power supply for ion pumps that provides power for at least 200 hrs continuously to eliminate the need for gun bake-out and realignment. This is separate back-up in addition to external UPS.
6.	Electron Optics	• Sturdy electron column with provision for isolation of gun area from rest of the instrument for creating vacuum and venting. • System should consist of a dual condenser lens to allow changes in beam current. • The condenser lens should be coupled with additional lens to minimize system spherical aberration and optimize the convergence angle to ensure minimum focus change at all beam currents. This lens should be computer controlled and fully automatic to provide the smallest probe diameter at low beam currents and the optimum probe geometry for high resolution analytical performance at high beam currents. • The beam current delivered to the sample should range continuously between 1pA to 500nA. • The objective lens (OL) aperture strip should contain four externally selectable, (able to align in X/Y directions) apertures plus an open position. • The apertures should be in the front focal plane to ensure

		optimum spot size as a function of beam current. • The objective lens should be highly conical to allow high tilt at short Working distance. • The Objective lens should be a hybrid type lens with both electrostatic and electromagnetic components for ultra-high-resolution imaging with beam acceleration and deceleration within the lens to reduce aberration and improve probe diameter. • There must be no OL electromagnetic leakage flux below the lens allowing high resolution imaging of magnetic or paramagnetic samples at short working distance and preventing pattern distortion while carrying out EBSD analysis. • There should be a dedicated lens setting for ultra-long depth of focus for the wide area analysis using beam Scan. • Probe current detector should be available just below the objective lens aperture (without altering the column length) for the purpose of measuring the probe current with readout in the SEM GUI.
7.	Electron Optical Engine	FESEM should be equipped with electron optical control system for stable observation while adjusting various microscope parameters. The electron optical control system should shave following features: • Automated control and adjustment of electron lenses in real time. • Correction of electron trajectories in real time auto alignment. • Enhanced auto functions (focus, brightness/contrast, astigmatism). • LIVE filter should be available for higher quality of live images and to display a seamless moving live image with no residual image. • Software for large areas with automatic acquisition of each area and correction of positional area shift should be provided.
8.	Vacuum System	• Fully automatic PC controlled vacuum system with status display for Vacuum; Airlock must be displayed on computer GUI. • Turbo Molecular Pump backed up by rotary pump for secondary pumping and two sputter ion pumps for FE Gun. • Automatic protection of vacuum system against failures of power, water supply and pump.
9.	Specimen chamber	• Specimen exchange should be possible in less than 5 minutes through draw out mechanism for large sample up to 170 mm diameter. • A specimen exchange airlock should be available for quick sample having diameter 100 mm exchange less

		than 60 seconds for . • Total 10 ports for should be available for various accessories. • The chamber should be mounted with colored CCD camera for the specimen navigation and seamless transition from optical to SEM image. • Chamber camera must be provided. • The chamber must be capable of accommodating multiple EDS detectors simultaneously and accommodating WDS and EBSD simultaneously. The EDS and EBSD detectors should be coplanar. The stage tilt should be perpendicular to the dedicated EBSD port. The chamber must have dedicated fully focused inclined WDS Port for future expansion.
10.	Specimen Stage	• The sample stage should be a large goniometer with mechanically fully eucentric tilt at all Z positions and tilts. • High Precision 5 axis fully eucentric motorized stage movements should be at least 70 mm or more in X direction, 50 mm or more in Y direction, 40 mm in Z direction and rotation of 360°. The tilt range must be -5° to +70° with the tilt axis perpendicular to dedicated EDS and EBSD ports. • All 5 stage Axes (X, Y, R, T, Z) should be motorized and include computer eucentric rotation. • The stage should be capable of meeting all resolution specifications without a stage lock. • The stage should be capable of having a bias voltage of up to 5kV. • Specimen current measurement facility should be provided in SEM GUI. • The stage automation system should be controlled through stage control panel, trackball and should allow the following functions: a. Computer eucentric rotation b. Continuous movement with the speed linked to magnification. c. Click centre and zoom d. Stage return to location of any stored image
11.	Specimen Holder	• It is preferable to have a multi-specimen holder.
12.	Stage Navigation System	• Stage Navigation System must be supplied to move to an area of interest easily and quickly by locating the ROI from a color image on the monitor.
13.	Detectors	• A secondary electron detector system consisting of in-chamber E-T type detector. • Upper/In Coloum Detector - A through the lens detector with a user controllable energy filter for collection of topographic (SE) contrast or atomic number (BSE) contrast.

		• In-lens secondary electron detector • RBED (Retractable Solid-State BSE Detector) - The backscattered electron detector should be a pneumatically retractable (from the GUI). The detector should be divided into 5 segments for detection, making it possible to select the signal suitable for the observation purpose.
14.	Low Vacuum System and Detectors	• FESEM should be equipped with Retractable Low vacuum system. • The switching from HV to LV should be possible through fully automatic software-controlled LV orifice without breaking the chamber vacuum and manual insertions. • The low vacuum BSE detector should be a part of LV Orifice. Dedicated LVSE detector should be provided for the Secondary electron imaging. • The Low Vacuum pressure should be adjustable in the steps. The Pressure range should be 10 Pa to 300 Pa or better. • The Retractable LV system should allow Low Vacuum EDS and EBSD without any limitation.
15.	PC/Workstation	• Computer of latest model and associated hardware and software capable of working in Microsoft Windows 10 based workstation. • User friendly software with easy retrieval of data. • Data should be compatible with MS office programs.
16.	User Interface	• Keyboard, mouse, Control Panel having multifunctional operations for the control and adjustment of frequently used SEM parameters. • Stage control panel and trackball for stage axis. • The microscope should employ an auto-alignment correcting procedure that automatically presents all the lens parameters for ultimate imaging and analytical performance. By pressing an AUTO button, the user should be able to auto-focus, auto-stigmate and automatically adjust the brightness/contrast ratio of the image.
17.	Display	• 24” LCD Display
18.	Water chiller	• Recirculating water chiller for lens and peripheral cooling must be supplied.
19.	Safety Devices	• Safety devices against power/vacuum/water/air/gas failures to be provided.
20.	Power Supply	• All power supplies should be Indian type 230+/-10% Volts, 50Hz, with Indian standard plugs. If Indian plugs are not available, suitable converters must be provided. • The electronics system of the FESEM should be highly stable, well ventilated, reliable and easily replaceable and should be rated for 230V, 50 Hz supply.
21.	UPS	• Suitable advanced online UPS for FESEM, EDS, EBSD

		and chiller with one hour maintenance-free battery back-up.
22.	Pre-installation	• The system and all its electronics should be rugged, sturdy and suitable for Mumbai climate. • Compliance certificate must be diligently prepared. Any false information will lead to disqualification of the bidder. • Before installation of the FESEM, the site would be tested and certified by the supplier in respect of stray magnetic field, ground vibration, and quality of air (humidity), water and electricity.
23.	EDS	• EDS should be state of art system designed to work in compliance with the ISO 15632:2012 • The EDS detector should be LN2 free type SDD sensor based having sensor area of atleast 60mm2 or more with the following published energy resolution to be guaranteed at site: Mn-kα : <127eV at count rate of 100,000cps F-kα : < 65eV at count rate of 100,000cps C-kα : < 48eV at count rate of 100,000cps • The EDS detector should have motorized slide having manual as well as software control. • The EDS system software should have following features in real time mode: Live Imaging in real time Live Spectrum in real time Live Auto peal labelling in real time Live Mapping in real time Live Trace showing sample scanned areas with concentration distribution for each element. • Navigator based EDS software designed to do Qualitative and Quantitative analysis based on latest XPP matrix corrections. Point & ID, Line Scanning, Mapping with spectral imaging to reconstruct EDS spectrums from stored Map data. Built-in reporting Templates, Simultaneous imaging and analysis on the EDS monitor. • The EDS system should have a feature to separate the mapping information when recorded from overlapped peaks. The system software should prompt for the possible energy line overlaps. • The EDS system software should have provision to add user's standards for improved quantitative Analysis.
24.	EBSD	• The EBSD system should include the hardware consisting of EBSD camera/detector and control electronics and the software for acquisition and indexing of electron backscatter diffraction patterns for phase studies, Phase mapping applications and texture related

		studies.
		• The EBSD camera should be based on C-MOS sensor having megapixel resolution of at least 1K X 1K. It should be capable of achieving the indexing speed as high as 4500 patterns per second.
		• EBSD camera should have sensitivity of at least 800 pps/nA on Ni.
		• It should have proximity sensor with alarm to avoid any possible collision with sample/stage.
		• The EBSD camera should have tapper nose design with rectangular phosphor to accommodate 4-6 fore-scattered imaging detectors to get atomic and orientation contrast images of sample in the tilted condition.
		• The EBSD camera should allow the software controlled 'in-column camera tilt' for observing the large size samples at longer WD. The EBSD camera moment should be motorized having manual as well as software control.
		• The EBSD system should have a feature of simultaneously acquiring EDS and EBSD data from multiple fields over a large sample surface and automatically aligning the images using correlation techniques and stitching the mapped images during data acquisition itself.
		• It should be possible to use this larger area map datasets for reviewing patterns, spectra, identify phases, reanalyse etc.
		• This automatic large area mapping should at least have resolution of 2K X 2K for simultaneous EDS and EBSD data acquisition.
		• The EBSD system software should have following features:
		  ○ Latest Data Acquisition Software working on WINDOWS 64bit platform
		  ○ System software with latest indexing algorithms.
		  ○ Auto tilt correction
		  ○ Phase Reflector File Creation Software
		  ○ Pole Figure Software – texture analysis
		  ○ Mapping Software – post processing for gain size, Grain Boundary Characteristics, etc
		  ○ ODF Software – texture analysis
		  ○ Imaging and Beam Control Software
		  ○ Stage Control Software
		  ○ Phase Identification Software
		  ○ Software for large area mapping
		  ○ ICSD Data Base and a separate CIF import utility to import the phases from external database.
		  ○ 3 additional offline licenses
		  ○ 2 EBSD Pre-tilt holders

25.	Warranty	3 years comprehensive warranty from the date of installation.
26	Delivery	Bidder/vendor will be fully responsible in successful delivery (including unloading), installation and commissioning of the instrument at installation site in IIT Bombay. Documents for customs clearance & transportation will be provided by IIT Bombay to the bidder/vendor in case of imported items.
27.	Pricing Basis	The vendor subsequently should quote the final price on the basis of delivery of equipment to IIT Bombay which includes all customs (in case of imported items) and shipping charges
28.	Eligibility Criteria	• The vendor should have supplied minimum 10 FESEM units in reputed Indian Institutes (e.g. IITs), Universities or research laboratories during the past decade. • The vendor should provide proof of after sales- service and availability of spares and accessories. • Only models launched after January 2019 that provide the latest technology should be quoted. • The vendor must provide the release note from the principal.