Technical specifications for the high resolution high vacuum FESEM-EDS-EBSD with in-situ mechanical testing attachment

1.

S.No	Bidder Eligibility Criteria:	Compliance (Yes/No)	Reference Page No.
1	Equipment offered must be a model from the current serial production range of the manufacturer. Customized or One off Manufactured Model will not be accepted. Offer should be supported with printed catalogue / depiction on company website.		
2	The local vendor/OEM must have supplied at least 5 of the quoted model to IITs, IISERs, IISc and other Govt. of India organizations. Please attach the purchase order copies of supplies in last 3 years with contact details (Name, Phone, email address) of users.		
3	The company or companies (for combined quotations) should be original equipment manufacturers (OEMs) of the quoted systems. Please attach exclusive authorization certificate(s) specific for this tender with quote as per (Annexure VI), without which bid will be rejected.		

2.

S. no	Features	Specification	Compliance (Yes/No)	Reference Page No.
1	Resolution	0.7 nm or better @15 kV in high vacuum using SE detector 1.2 nm or better @ 1kV in high vacuum using SE detector 1.2 nm or better @ 1kV in high vacuum using in-lens / in-column BSE detector All above resolutions on standard gold on carbon samples to be achieved without application of external sample/stage bias The methodology for obtaining the resolution should be as per ISO/TS 24597 standard. The resolution quoted should be the average value and not the best value.		
2	Vacuum	The FEG SEM should be freely and simply be switched between the following vacuum modes. High-vacuum mode ($< 1 \times 10^{-4}$ Pa) Features of the OIL FREE vacuum system which include turbo-molecular, scroll, rotary, PVP, ion getter or other suitable pumps with seamless transition between the different vacuum modes.		

3	Electron Gun / Column	High Stability Schottky Field Emission Electron Source with automated filament cutoff safety device Beam acceleration or deceleration upto 4 kV or higher in column for achieving high resolution images at low kVs.		
4	Magnification	Lower mag. ×10 or less Higher Mag. ×2,000,000 or more		
5	High Tension	Lower limit: 200V, Higher limit: 30 kV and any chosen intermediate value. All the kV settings should be varied through software		
6	Chamber	a) Chamber should have at least 12 accessory ports, c) Infrared chamber scope (IRCCD) for real time view c) Integrated plasma cleaner, d) Navigation camera for easy sample identification, sample exchange should be within 5 minutes		
7	Stage	6 axis motorized Eucentric stage with X and Y of 120 mm or more and Z-axis = 40 mm or more, Tilt = -4° to +70° or more. 6^{th} axis for eucentric positioning should have a travel path of at least 10 mm. Manual Joystick as well as software control for stage movement.		
8	Sample holders	a) SEM should be able to handle at least 50 mm diameter and weight up to 0.5 kg in untitled position b) Multiple sample holder that houses at least 8 stubs to be provided. The sample holder should accommodate samples of varying sizes in the range 1 mm to 10 mm or larger		
9	Electron Optics, Lenses	The system must have electromagnetic and electrostatic assembly for high resolution imaging of ferromagnetic materials. The lenses should be thermally stabilized. Electron channeling contrast imaging (ECCI) should be possible with the supplied optics and detectors. This should be demonstrated at the time of installation on sample provided by us.		
10	Lens correction	Auto focus, auto stigmation and wobbling correction features		
11	Probe Current	Adjustable range from Minimum: 6 pA or less and maximum of 100 nA or higher, Noise < 1%, Drift < 0.2%/hour; In built specimen current meter and option for continuous current adjustment		
12	Scanning	Varying scan speeds of 25ns to 1 ms or more Spot mode: electron beam spot location to be defined freely in X and Y		

		Freely adjustable line scan, 360° Scan rotation at all scan rates and automatic tilt correction when the stage is tilted		
13	Imaging detectors / image processing	• High-vacuum mode: conventional Everhart-Thornley detector with variable grid bias. • In-lens or In-column SE detector or equivalent for HR imaging in high vacuum • In-column detector for energy and angle selective back scatter electrons • Retractable 5 or more segmented solid state backscattered electron detector which is optimized for low-kV (1 keV-6 keV) as well as high kV (upto 30 kV) operation for compositional and crystallographic contrast imaging. • A CCD camera should be included as standard, and 4 quadrant displays for simultaneous imaging using SE and BSE • Simultaneous Imaging of SE, BSE and other detector images in multiple quadrants of the screen • File type: TIFF (8-, 16-, 24-bit), JPEG or BMP • Single-frame or 4-view image display • 256-frame average for integration, line integration and averaging, interlaced scanning) • drift compensated frame integration mode • Digital image improvement and noise reduction filter		
14	User Interface	Computer controlled user friendly interface for the smooth routine operation of microscope The software should have function like auto-focusing, auto-dynamic focus, auto-contrast, auto brightness, drift and wobble corrections.		
15	Computer hardware and software	At least 2 State of the art computer systems with suitable processors and communication ports for SEM-EDS-EBSD with 64 bit Windows 10 PRO or similar operating system and at least 24 inch LED monitors. 3 GHz or better processor; at least 64 GB RAM; 10 TB HDD for integrated SEM-EDS-EBSD operation. Suitable SEM-EDS-EBSD data transfer system for hassle free copy of user data through a LAN to a computer. This computer will be provided by us. Software for automatic large area SEM image mapping and stitching Software for advanced image analysis, segmentation and image coloring		

		Module to organize and align images for correlative analysis from optical and SEM tools		
16	EDS-EBSD-TKD Detectors	The state-of-the-art integrated EDS-EBSD-TKD system should work on the same user Interface and should consist of the following: <u>EDS detector</u>: Motorized and Peltier cooled silicon drift detector (SDD) with pulse processor, Active detector area of 60 mm^2 or more with energy resolution of 125 eV or better at Mn K alpha with e-beam excitation. The detector should detect Al and Si L alpha lines. Detection of elements down to Beryllium and quantification from Boron onwards. Robust EDS detector window made up of Silicon nitride or similar material compatible for operation at temperatures upto 900°C. Pulse pile-up correction at high count rates High resolution quantitative analysis at mapping speeds greater than 400,000 output cps <u>EBSD-TKD detector</u>: Camera Speed: 4500 or higher indexed patterns per second with 8 × 8 binning or better on Ni standard at beam currents < 20 nA, Motorized, high-precision camera slide, Proximity sensor for collision prevention, Integrated Forward Scatter Detectors for orientation contrast imaging, Compatible with in-situ heating and tensile stage for EBSD analysis upto 900°C with suitable thermal protection / IR filter, Compatible with in-situ mechanical testing. <u>EBSD-TKD sample holders</u> Pre-tilted (70.5°) sample holder for EBSD (4 Nos.) and TKD sample holder (2 Nos.) EDS-EBSD detectors should be fully compatible with the SEM and provide suitable hardware and software for complete integration with the microscope		
17	Software for EDS and EBSD	Qualitative and quantitative spectrum analysis for accurate peak identification, background subtraction and automatic peak evaluation Deconvolution of spectra for separate element contributions		

	analysis	Quantification software must have options for ZAF or similar corrections User interactive qualitative and standardless quantification with K, L, M, N line database. Quantification of elements from Boron in point, Line Scan, Mapping. Real time elemental mapping with auto elemental identification, quantification based on ZAF or similar correction algorithms. Quantification of phases. Display of quantitative results as atomic and weight percentage of points, area. Multi-points, lines, maps; Color-coded concentration distributions (element maps, phase maps) for any number of elements within an arbitrary field of view. Raw data to be exported in atomic%, weight% and intensity profiles (Excel or CSV format). Spectral imaging with up to 4096 × 4096 pixel resolution, online deconvolution and pseudo color mapping. Storing of spectrums at each point during mapping for online and offline analysis (2 offline licenses). EBSD-TKD data collection and analysis software: • Intuitive operation for novice and expert users • Graphical interface that enables quick access to features and functions • Functions for automatic optimization of data collection and reporting • Single or multi-user modes • Option to use Windows® Authentication for login • Individual settings saved for each user • Minimize sensitivity to wrong band detection • Achieve high indexing success rates (> 95%) at acquisition speeds of 4,500 or more of indexed points per second on standard sample at probe currents < 20 nA • Quantitative quality measurement for the crystallographic indexing solution • Optimized band detection settings using Hough based Transform to allow for		

		successful indexing of all crystal structures • Produce high-quality, indexing results on actual samples • Facilitate easy collection of EBSD patterns • Hexagonal grid sampling for enhanced data sampling • EBSD acquisition per application requirements • Assessment in real-time (visual and numeric) and provide feedback during scan • Grayscale maps include Image Quality, SEM signal, • Imaging using positional electron detectors and forescatter detectors at top and bottom of EBSD camera for orientation, topography and atomic number contrast images in both EBSD and TKD modes (live as well as post EBSD scanning) • Comprehensive toolbox for processing, coloring, and extracting useful information from the images generated from the multiple positional detectors • Colour maps include Inverse Pole Figure, Indexing Quality, Phase, and EDS Elements • Combine grayscale and colour maps to better understand results • Neighbour pattern averaging based scanning to facilitate to work at higher noise levels than conventional indexing • Data statistics summary • EBSD pattern and indexing display • Crystal Unit Cell display • Hough band detection • Feedback provides users with information on collection quality • Scan large areas using stage movements to collect multiple fields of analysis • Automatically stitch data into a single file for comprehensive analysis • Oversampling available to improve matching between fields • Collect a series of scans as a single batch process • Define standard free-form, Montage, and line scans within a batch • Define the magnification, scan area, step size, simultaneous EDS, and stage location within the batch • Enable efficient use of SEM for analyzing multiple areas or samples		

		• Project tree structure for seamless organization of data • 64-bit software architecture for handling big data • Single file for both EDS and EBSD collection • Ability to specify file name and location to meet user needs • Full integration of Energy Dispersive Spectroscopy (EDS) and EBSD for comprehensive materials characterization • Combine EDS spectrum with EBSD pattern collection for correlation of chemical and structural information • Utilize advanced EDS quant engine optimized for high-tilt EBSD geometries • Simultaneous EDS-EBSD scanning compatible with chemistry assisted indexing-Scan processing for enhanced multi-phase analysis • Customizable report generation based on user defined templates • Tailored report layout with export option to MS word / pdf / ppt /MS excel • User-defined report content in template files with default design templates available • Use reporting with batch scanning capability • Simulate EBSD patterns based on the physics of dynamical diffraction of electrons. • Dictionary Indexing • Master Pattern Database for commonly used engineering materials (For example: steels, Al alloys, Ni alloys, Ti alloys and Cu alloys) • Automatic Structure File Optimization • EBSD Background Simulation • Capability to post-process the EBSD data using dictionary indexing • EBSD-TKD data analysis software should include for grain size, phase, orientation, mis-orientation and texture analysis. • Free upgrade to the EBSD-TKD data analysis software for 5 years. • 15 licenses (preferably using network IP based access) for offline use of the EBSD-TKD- data analysis software. • A server with i9 processor and 10 TB hard disk and 64 GB RAM for running the network based EBSD data analysis software • Perpetual ICDD materials database license for metals, alloys, intermetallic,		

		ceramics and polymers with free updates to the database for 5 years		
18	Calibration standard samples	• 1 No. of standard sample for calibration of SEM images (Gold on Carbon and Tin on carbon) and suitable ultra-high resolution sample for STEM and in-lens/incolumn detectors. • 1 No. Standard sample for EDS calibration • 1 No. Standard sample for EBSD and TKD calibration • Suitable baking kit and spares (2 Nos. Halogen bulbs) for the standard samples		
20	Essential Consumables	a) The quote should provide consumables (FEG tip, apertures, vacuum pump related spare parts and any other essential spare parts/consumables for smooth operation for 5 years)		
21	Essential Accessories	a) Vibration and noise free chiller b) Compressor for pneumatic systems of the microscope c) Suitable vibration isolation system, EMI active cancellation system to achieve the required specifications for the instrument d) Suitable UPS for 1 hour of back up		
22	Other essential requirements	Should be compatible to install existing heating stage (Model Murano 525, make Gatan, 2018 (working)). Provide necessary hardware (flanges, O-rings, gaskets etc.) and software if any for the integration. Should do the integration, operation, and training after installing heating stage on the FESEM.		
23	In-situ testing attachment	In-situ tensile testing stage at room temperature with ability to perform EBSD during testing Load capacity upto 5 kN at room temperature with load cells of 200 N, 1kN and 5 kN The loading rates should be in the range of 1 µm to 30 µm per second or higher Should hold samples upto 60 mm in length for in-situ tensile testing. Suitable clamps/grips for holding flat dog-bone samples of 0.2-2 mm thickness The entire testing should be controlled through a software and suitable data acquisition to acquire load, stroke and strain. Should have ability to interrupt the test at any given force, strain and displacement to perform EBSD. Suitable computer for control and data acquisition to be provided. Automatic feature tracking, Configurable result graphs, Sample exchange wizard,		

		Analysis of multiple regions of interest (ROIs) with arbitrary imaging or analytical parameters, Digital Image Correlation software for local strain analysis		
24	Power supply	All equipment including accessories should operate with 220 V, 50 Hz power supply		
25	Warranty and service	Comprehensive warranty (from the date of full installation) with AMC for 5 years along with free software upgrades for the entire system including all the 3rd party attachments and accessories The service engineers must undertake periodic inspections (every 3-6 months) to ensure that the SEM provides high quality imaging and spectroscopy results		
26	Documentation	Vendor should specify the model number of the FESEM and those of the attachments and submit the brochure that supports all the quoted specifications		
27	Operation & maintenance manuals	Online user guidance: Soft copy of the operation & maintenance manuals should be provided along with all the detector operation principle and techniques behind it.		
28	Availability of spares parts	The vendor has to guarantee that all the spares parts for the offered FESEM model and 3rd party attachments will be available for at least next 10 years		
29	Installation & training	Onsite installation, demonstration of all specifications quoted. training for 5 persons in the operation of the entire system including attachments at the installation site		
30	Service Support and operation	The OEMs should have trained engineers preferably in Chennai for service and repair and attend to the issue within 48 hours of the notification of the service complaint. Provide the list of service engineers. Provision for remote diagnostics with OEM factory should be available, Provide a trained operator for a period of 5 years		
31	Pre-installation requirement (civil& electrical EMI and gas, etc.)	Should be mentioned along with offer. Free survey of vibration and EMI at site and provide the results of the survey and the necessary modifications if required for achieving best results		
32	Sample preparation accessories	Broad beam Argon milling for the high quality EBSD surface polishing with cold stage to cool the sample with liquid nitrogen. Suitable connectors to connect to Argon cylinders. Suitable liquid Nitrogen container and related accessories for cooling sample. Temperature controlled liquid nitrogen specimen cooling stage. Oil free dry pumping system to achieve vacuum		

		or 10^{-8} bar or better. Facility for easy sample loading with sample rotation and adjustable beam diameter; Variable energy range from 0.1 keV to 8 keV. color touchscreen control: Fast, simple access to all control parameters; Sample size 30 mm diameter × 15 mm height or more; Milling angle 0 – 18° (Independent gun adjustment); Real-time operation view during milling and store images for correlation with SEM analysis. Ion current density upto10 (mA/cm^2) or more.		
33	In-situ tensile testing stage at elevated temperature (optional)	In-situ tensile testing stage capable of testing at room temperature to elevated temperature of 800°C with ability to perform EBSD during testing. Other specifications as per S. No. 23		
34	In-situ pico-indentation testing system (Optional)	In-situ pico indentation/nano-scratch testing with load range of 10 mN to 3.5 N with displacement upto 150 μm, Sample positioning sensitivity of 1nm or better. Automated indentation capability of large area of at least $1mm^2$. Facility to do EBSD/TKD/STEM analysis post-indentation. Rotation and tilt compatible stage. Capability to mount multiple samples (3 or more). 5 year comprehensive warranty		
35	Consumables for sample preparation and handling (Optional)	Provide sample preparation tools (100 numbers each of Al stubs of 12.7 mm and 25.4 mm diameter), SEM Pin Stub Mount Gripper Tweezers, 30° angle 4 Numbers), Tweezer Style Mount Gripper for Grooved 25mm stubs, 45° angle 4 Nos) Consumables i.e., 2 rolls each of 6 mm wide carbon tape, copper tape and 2 nos. conducting Silver paint and suitable thinner of 25 ml.		
36	Buyback offer:	• Buy-back offer for the existing FESEM (model Inspect F Thermofisher/FEI make installed in 2009) (Currently in working condition) • Buy-back offer of existing EDS (Elect Plus model, make Ametek) and EBSD camera (Velocity plus model, Ametek make) installed in 2019 June. (In working condition and under warranty till October 2024) • Buy-back offer for sample preparation accessory - precision etching and coating system (model 682, make GATAN Inc. installed in 2008) (in working condition)		

(Note: It is mandatory for the bidders to provide the compliance statement in tabular column format along with catalogue page number (comply/not comply) for the Above points with document proof as required. Failing which bidders will be technically disqualified)