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From : Director, CSIR-National Physical Laboratory  
No. 14-VII/JST(2797)19PB/T-109

Dated : 12.02.2020

**CORRIGENDUM**

With reference to NPL's Global Tender No. 14-VII/JST(2797)19PB/T-109, Pre-bid meeting (PBC) was held on 05.02.2020 for the procurement of item No.1 ( ie. SEM with EDAX) and item No. 2 (i.e FESEM with EDS and Electron beam Lithiography (EBL)).

Consequent upon the outcome of PBC, **technical specification of captioned tender has been revised and the same are attached herewith as Annexure –I (for item NO. 1) & Annexure –A (for item No. 2).** Accordingly, all the interested bidders may submit their offer as per revised technical specification. Please also note that bids submitted without taking these changes into consideration will be rejected summarily.

All other specifications, terms & conditions of said tender will remain the same. The copy of said Corrigendum is also available on our website <http://www.nplindia.org> [under link of "Tenders/Pre-Indent" "Tender Notification"].

Sd/-

**Controller of Stores & Purchase**

**Annexure-1**

Scanning electron microscope (SEM) with Energy Dispersive Analysis of X-rays (EDAX)

Sr. No.	Item	Specification
1	Resolution	<ul style="list-style-type: none"><li>• <math>\leq 0.7</math> nm at 15 keV</li><li>• <math>\leq 1.0</math> nm at 1 keV</li></ul>
2	Electron source and column	<ul style="list-style-type: none"><li>• Field emission type/ Schottky field emitter/ In-lens Schottky field emitter</li></ul>
3.	Magnification	<ul style="list-style-type: none"><li>• Range : 50 X to 10,00,000 X or better on both sides</li></ul>
4.	Probe current	<ul style="list-style-type: none"><li>• Range : 3 pA to 100 nA or better on both sides</li></ul>
5.	Accelerating Voltage	<ul style="list-style-type: none"><li>• Range: 0.2 to 30 keV or better on both sides</li><li>• Accelerating voltage continuously variable with automatic compensation for focus, magnification and image shift</li><li>• Automatic compensation for accelerating voltage with working distance</li></ul>
6.	Electron optics	<ul style="list-style-type: none"><li>• Condenser lens with automatic compensation with focus on interest during spot size change (zoom type)</li><li>• Objective lens with selectable objective lens aperture.</li><li>• The system must be capable of imaging conducting, semiconducting, non-conducting and other specimens without compromising resolution.</li><li>• Beam Deceleration / Beam Booster/ Gentle beam technology or equivalent technology for imaging at low keV.</li><li>• The system should have capability of imaging magnetic samples without distortion.</li></ul>
7.	Focus	<ul style="list-style-type: none"><li>• Auto focussing with automatic compensation for entire accelerating voltage and magnification range</li></ul>
8.	Specimen Chamber	<ul style="list-style-type: none"><li>• Provision to accommodate specimen of size (width = 100 mm X Height = 40 mm)</li><li>• Chamber width - 325 mm or more</li><li>• Specimen holder to accommodate atleast 7 or</li></ul>

		<p>more specimens of 10 mm size.</p> <ul style="list-style-type: none"> <li>• 8 or more ports for future upgrades and attachments for various measurements.</li> </ul>
09.	Specimen Stage and Stage manoeuvrability	<ul style="list-style-type: none"> <li>• 5 axis motorized stage with eucentric specimen movement, Compucentric or equivalent <ul style="list-style-type: none"> <li>• X axis: <math>\geq 110</math> mm</li> <li>• Y axis: <math>\geq 80</math> mm</li> <li>• Z axis: <math>\geq 40</math> mm</li> <li>• Rotation: <math>360^\circ</math>; should be continuously varying</li> <li>• Tilt: <math>-4^\circ</math> to <math>70^\circ</math> or better with stage coordinate recall facility</li> </ul> </li> <li>• PC automated stage control in addition to joystick/ trackball and equivalent</li> </ul>
10.	Chamber Scope	<ul style="list-style-type: none"> <li>• CCD camera with infrared illumination for display of specimen, specimen stage, final aperture/lens, detectors, on SEM screen.</li> </ul>
11.	Detector	<ul style="list-style-type: none"> <li>• Secondary electron detector of latest technology or equivalent to acquire high resolution images</li> <li>• Back scatter detector (BSD) <ul style="list-style-type: none"> <li>• BSD with energy filter grid to achieve BSE images with differential contrast of same composition materials having atomic number close to each other.</li> </ul> </li> </ul>
12.	Vacuum system	<ul style="list-style-type: none"> <li>• Ultra clean dry, oil free and fully automatic vacuum system comprising of ion pump, turbo molecular pump (TMP) and rotary pump etc.</li> <li>• Gun column vacuum of the order of <math>10^{-7}</math> Pa or better</li> <li>• Chamber vacuum of order of <math>10^{-3}</math> Pa or better</li> </ul>
13	Working station and Vibration isolation	<ul style="list-style-type: none"> <li>• Anti-vibration platform must be provided for SEM with EDAX</li> </ul>
14	Control Panel	<ul style="list-style-type: none"> <li>• Control panel assembly for manual adjustment of microscope parameters like Magnification, Astigmatism, Brightness, Contrast, Focus, Wobbling etc.</li> </ul>
15	Display system, Operating system, Computer and Printer	<ul style="list-style-type: none"> <li>• 24/30 inch LED monitor for SEM</li> <li>• Latest updated Desktop system with specification Pentium i7 core processor, RAM <math>\geq 8</math> GB, HDD memory <math>\geq 3</math> Tb, speed <math>\geq 3</math> GHz, DVD writer, more than 10 USB ports Mouse, Keyboard, etc.</li> </ul>



		<ul style="list-style-type: none"> <li>• Black and white high resolution Laser printer (both side printing, etc)</li> <li>• To provide continuous upgradation of operating system for atleast 10 years</li> </ul>
16	Image storage and Display of image	<ul style="list-style-type: none"> <li>• Image storage resolution up to 32 K x 24 K</li> <li>• Image storage in JPEG/TIFF/BMP/PNG or any other compatible format</li> </ul>
17	Image processing software	<ul style="list-style-type: none"> <li>• Image analysis software for particle/grain size measurement and phase mapping analysis</li> <li>• Multiple copies of licensed imaging and analysis softwares including operating system should be provided in the CDs or other suitable format</li> </ul>
18	Certified Reference Materials (CRM) for SEM	<ul style="list-style-type: none"> <li>• SI traceable Certified Reference Materials for magnification calibration of SEM instrument for the specified magnification range.</li> </ul>
19	EDAX	<ul style="list-style-type: none"> <li>• Large detector area: <math>\geq 65\text{mm}^2</math></li> <li>• <math>\text{LN}_2</math> free SDD detector</li> <li>• The system should have element detection range from Beryllium (Be) onwards</li> <li>• Energy resolution of EDS detector <math>\leq 127\text{ eV}</math></li> <li>• Latest software for digital imaging, quantitative &amp; qualitative analysis capability with Auto peak and manual detection, phase mapping, spectrum match, smart materials library, smart quant map, elemental mapping (both qualitative and quantitative) Facility of mapping &amp; multipoint analysis (Point &amp; ID), Line Scan, online chemical classification and summary reports.</li> <li>• Data acquisition and display computer with latest specification 24/30 inches high contrast LED monitor and display resolution of 1024x 768 pixels or better.</li> </ul>
20	Certified Reference Materials (CRM) for EDAX	<ul style="list-style-type: none"> <li>• Multiple elements (Co, Zn, Cr, Mo, Mn, Pb, Au, Fe, Pd, Cd, Bi, Sb, Ti, C, Sn, MgO, Ge, Nb, Ag, Au, B, Ni, <math>\text{Al}_2\text{O}_3</math>, Se and more) Standard specimen/block for calibration of EDAX system traceable to SI units.</li> </ul>
21	Sputter Coater	<ul style="list-style-type: none"> <li>• Fully automatic operation</li> <li>• Two stage oil sealed rotary vane pump with oil mist filter with chamber evacuation capacity better than <math>10^{-2}</math> mbar sputter coater for SEM</li> <li>• Standard sputtering Au target of 0.1 mm or higher thickness of 4N purity or higher</li> </ul>

		<ul style="list-style-type: none"> <li>• Chamber diameter not less than 90 mm</li> <li>• With facility of thickness monitoring</li> </ul>
22	UPS	<ul style="list-style-type: none"> <li>• Compatible Online UPS, Capable of at least 1 hr power back up for SEM and EDAX System</li> </ul>
23	Power	<ul style="list-style-type: none"> <li>• As per Indian standards.</li> </ul>
24	Consumables and Spares	<ul style="list-style-type: none"> <li>• The system should be supplied with all necessary spares, accessories and consumables such as Fuse Kit (all necessary rating/type fuses required for complete system), Stage Motors [ X/Y and ZTR], All type of Apertures (All values each at least 5 Nos.), One additional Hardware Joystick Box, One additional field emission source module to be supplied as and when required for the system, One multiple specimen holder in addition to standard specimen holder, One complete set of O-rings should be provided, Complete set of tool kit, One Digital multimeter, Specimen stub – 100 nos, Mount gripper and Tweezers – 2 nos each, Silver Paste -50 gm x 2, Carbon tape (5 -7 mm) roll- 2 nos, Silica gel – 1 kg, Silica gel desiccators -2 nos, Au target for sputter coater – 2 nos</li> </ul>
25	General Requirement	<ul style="list-style-type: none"> <li>• Manuals of the system to be provided.</li> <li>• Guarantee of the availability of spares and consumable for next eight years for the main system as well as accessories after the completion of warranty year.</li> </ul>
26	Installation Training and demo	<ul style="list-style-type: none"> <li>• Installation, commissioning and demonstration as per tender specification of complete machine by company personals.</li> <li>• On site training on the operation of the system including use of the various software's of the system</li> </ul>
27	Warranty	<ul style="list-style-type: none"> <li>• Two years warranty commencing after successful installation of the system</li> <li>• Two year annual maintenance contract (AMC) after warranty period.</li> </ul>

**Item No. 2****Detailed Specifications for Field Emission Scanning Electron Microscope (FESEM) with Energy Dispersive Spectroscopy (EDS) and Electron beam lithography (EBL)**

<b>Sr. No</b>	<b>Specification</b>	<b>Details</b>
1	Electron Source	Schottky field emission/cold field emission electron gun, capable of providing high brightness/high current (stable) for noise-free imaging.
2	Resolution	Ö0.7nm at 15kV Ö1nm at 1kV and Ö0.9nm at 1kV (under beam deceleration or equivalent mode)
3	Probe Current (Range)	Minimum: 3pA or lower Maximum:100nA or higher Provision for measurement of probe current with minimum resolution of 1pA.
4.	Magnification (Range)	Minimum: 50X or lower Maximum: 10,00,000X or higher
5.	Accelerating Voltage	É Continuously adjustable from Ö0.5 to 30kV or better É Landing energy down to 20eV or lower É Automatic compensation for accelerating voltage with working distance
6.	Electron Optics	The system must demonstrate the capability of imaging on variety of samples including but not limited to conductive & non-conducting without compromising resolution. É Beam Deceleration / Beam Booster / Gentle beam technology or equivalent technology with including relevant detectors for high resolution imaging at low kV. É Optics should have hybrid lens/electrostatic lens or equivalent technology to give high resolution for variety of samples with shorter working distance. It should be supported by the printed brochure. É Objective lens with selectable objective lens aperture É System should have appropriate beam blanker for functioning of electron beam lithography (EBL) É Should have remote access to SEM column parameters like focus, magnification, probe current, astigmatism, wobble, brightness and contrast and sample navigation for EBL functioning
7.	Vacuum	É Gun chamber ó of the order of $10^{-7}$ Pa or better É Sample chamber - of the order of $10^{-4}$ Pa or better Fully automatic vacuum system comprising of Oil free vacuum system having Ion pump, air cooled Turbo Molecular Pump (TMP) & Oil free Rotary pump to achieve ultimate vacuum of $10^{-9}$ mbar or better. All necessary calibrated gauges and valves from reputed manufacturer must be included. Pump down time should be less than 10 minutes.
8	Chamber	É Provision to measure sample of size at least 100 mm in diameter and up to 40 mm tall. É Chamber size should be sufficiently large, more than 300mm so as to allow further upgradation of SEM with attachments like in-

		<p>situ mechanical properties measurements and/ or in-situ electrical probing (up to 4-6 probes)/measurements should be possible</p> <p>Number of Ports <math>\geq 10</math> or more which may be necessary for future upgradation and attachments for various measurements.</p> <p>Should have Chamber scope/ IRCCD camera</p>
9	Stage	<p>5 axis motorized eucentric/compucentric stage with stage movements equivalent to or better</p> <p>X-axis <math>\geq 100</math> mm</p> <p>Y-axis <math>\geq 100</math> mm</p> <p>Z- axis <math>\geq 40</math> mm</p> <p>Tilt = -4 to 70°</p> <p>Rotation - 360°; should be continuously varying</p> <p>Stage should be controlled via PC and also it should be controlled by Joy stick and Trackball or by equivalent device.</p>
10	Sample Type	The FESEM should be suitable for imaging and analyzing conducting and nonconducting, polymers, ceramic materials in the form of bulk, thin film, nano particles and powders.
11	Working platform	Working platform with ultra-low vibration isolation system must be included with the equipment.
12	Detectors	<p>É In-Lens/In-beam/ In-column Secondary electron (SE) detector or equivalent detector Technology to acquire high resolution SEI images.</p> <p>É In-Lens/In-beam/ In-column Back Scattered electron (BSE) detector or equivalent detector Technology for differential contrast of two almost same composition having close average atomic number.</p> <p>É Chamber mounted Secondary Electron (SE) detector</p> <p>É Retractable in chamber BSE detector (with 4 or more quadrant) for compositional and crystalline surface analysis, capable of doing crystal orientation/atomic contrast imaging.</p> <p>É There should be a provision for selecting individual and also mixing of the SE and BSE signals</p> <p>É System should have the Faraday Cup</p> <p>É Probe current meter/detector with pA resolution to measure the probe current.</p>
13	EDS System	<p>É Liquid Nitrogen free Silicon drift (SDD) detector or with equivalent technology.</p> <p>É Energy resolution <math>\leq 127</math> eV</p> <p>É Detector active area 30 mm<sup>2</sup> or higher.</p> <p>É The system should capability to detect from Be (4) to U (92)</p> <p>É The system should have the capability of Line Scan, Point ID, Mapping, Phase Mapping with Drift correction.</p> <p>É The system should be able to handle high count rate and deliver analytical throughput rate of at least 200,000 cps.</p> <p>É Should perform standard and standard less Quantification.</p> <p>É A separate latest and compatible data acquisition system with most recent and updated hardware data acquisition system with licensed software and 24 inch display for functioning of EDS</p> <p>É Licensed copy of EDS software</p> <p>Supplier will be responsible for installation of EDS on FESEM</p>

14	Certified reference material (CRM)	<p>SI traceable Certified Reference Materials (CRMs) for</p> <ul style="list-style-type: none"> <li>É Magnification calibration for entire range of magnification for 10 micrometer to 100 nm or better spacing standard.</li> <li>É Sharpness reference standard for astigmatism calibration.</li> <li>É Multiple element (including available low atomic number element) SI traceable standard for calibration of EDS system.</li> </ul>
15	Digital Image Store, Image Processor and scan features	<ul style="list-style-type: none"> <li>É Image store resolution up to 32K x 24K pixels or better for high resolution large image mapping.</li> <li>É Image storage in JPEG/TIFF/BMP or any other compatible format suitable for image</li> </ul>
16	Control Panel Assembly	Control panel assembly with track ball and 5 axis Joy stick for adjustment of microscope parameters like magnification, focus, astigmatism, wobble, brightness and contrast and sample navigation.
17	Display and control system	<ul style="list-style-type: none"> <li>É Two 24 inch or bigger LED Monitors for FESEM. One for control another for imaging.</li> <li>É Latest and compatible data acquisition system with most recent and updated hardware with dvd writer, sufficient USB ports, Mouse, Keyboard, color laser printer and most recent and updated licensed version of windows based OS.</li> <li>É Additional data acquisition system with similar specification to be provided for offline data processing/transfer, etc. for storage of data with preloaded image and other analysis softwares.</li> </ul>
18	E-beam lithography	<ul style="list-style-type: none"> <li>É The system must be able to write and draw basic shapes like Rectangle, Ellipse, Ring, Line, Polyline, Polygon, Trapezoid, Text, Spot etc.</li> <li>É The system must include the fast-electrostatic beam blander.</li> <li>É Writing speed 12MHz having pattern generator with dwell time range 100ns to ≥500ms with minimum dwell time increment of 1 nsec, and 0.1 nm addressing increment for exposures, imaging, and metrology.</li> <li>É Beam deflection system capable for writing field size from submicron to 1mm or above</li> <li>É Beam current stability: 0.5% in 1 hour for ambient temperature variation ±0.5 °C.</li> <li>É Fully seamless software integration - no additional standard software e.g. computer aided design software required for lithography designing and system operation</li> <li>É Design Layout- seamlessly integrated, fully hierarchical GDSII design editor and viewer allowing import of DXF, ASCII, CIF and GDSII layout files with provision for different number of layers</li> <li>É Provision for proximity correction</li> <li>É Should have Multi user environment</li> <li>É Two full software licenses to be run on Lithography SEM and off line PC should be included</li> <li>É System should be able to do parallel and serial patterning.</li> <li>É Grayscale bitmap NanoPatterning</li> <li>É Six field alignment and calibration DACs with 16 bit resolution</li> </ul>



		<p>for write field gain, shift and rotation - full main 16 bit main DAC range should be available for patterning</p> <ul style="list-style-type: none"> <li>É Write field and overlay alignment up to four marks in each write field.</li> <li>É Automatic and semi-automatic alignment mark detection.</li> <li>É Calculation and automatic download of the writing field correction parameters.</li> <li>É Sample to stage alignment - automatic or manual registration to known global marks</li> <li>É Automatic wafer/mask pre-alignment</li> <li>É Automatic dwell time correction by measuring beam current during exposure</li> <li>É Minimum feature size: <math>\leq 20</math> nm</li> <li>É Should have provision for write field calibration using standard calibration sample</li> <li>É The system must have the exposure module: Vector scan mode exposure of all types of arbitrarily shaped areas and curves, single pixel lines and dots, bitmaps in raster scan mode.</li> <li>É The system must include the lithography capability: Single isolated structure, mix &amp; match with local mark recognition functionality.</li> <li>É Sample holder for lithographic specimens which should include a standard reference sample and Faraday cup</li> <li>É Latest and compatible data acquisition system with most recent and updated hardware and OS for electron beam lithography control with 24" high resolution display and DVD writer.</li> <li>É Essential tools, accessories and EBL starter kit includes tweezers, screw drivers, Allen keys, latex sphere for focusing aid, sample with pre-coated PMMA resist on Si, Si chip Au markers array for EBL</li> <li>É Supplier will be responsible for installation of EBL</li> </ul>
19	Micromanipulator system for mechanical measurements inside FESEM	<p>Two number of three-axes micromanipulator system for electron microscopy. Should travel in the linear axis 12 mm, travel in the rotational axes <math>240^\circ</math>. The system should include control electronics, joy pad, tip holders for probe tips with required accessories and vacuum feed through.</p> <p>The system should be complete in all respect for stretching /tensile measurements. Should have a micro gripper for handling samples for Force measurements, rotational tip, and force measurement system for nanoindentation and tensile measurements with force measurement tool for up to 50mN or more. All required software for measurements should be included.</p> <p>Following consumables should be included in the offer:</p> <ul style="list-style-type: none"> <li>É Force sensors of length 120<math>\mu</math>m, tip radius &lt; 20 nm, tip height &gt; 5 m, tip force constant nearly 30 to 40 N/m and force resolution 10 nN <math>\pm</math> 10 Nos</li> <li>É Flat Sample Stubs mechanical measurements <math>\pm</math> 20 Nos</li> <li>É Glass Pipettes <math>\pm</math> 10 nos</li> <li>É Probe Tips (tip radius 500 nm, solid W needle)-25 Nos</li> </ul>

		<p>ÉVacuum compatible adhesive that is cured by e-beam irradiation. Supplier will be responsible for installation micromanipulator module</p>
20	Softwares	<p>ÉSoftwares for imaging and other analysis like particle size analysis, 3D modeling/image acquisition, EDS, electron beam lithography must be provided with FESEM</p> <p>ÉMultiple copies of licensed imaging and analysis softwares including Operating System should be provided in the CDs or other suitable format</p> <p>ÉUpgradation of all software for SEM imaging, analysis, EDS and electron beam lithography micromanuplator module for 10 years should be included.</p>
21	Sputter Coater	<p>A fully automatic sputter coater system from a reputed company and should have</p> <p>ÉHigh vacuum Sputter Coater with rotating stage, with thickness controller and monitor.</p> <p>ÉThe Coater should have all the accessories like noise free and high efficiency vacuum pump.</p> <p>ÉTarget- Au-Pd with thickness 0.1mm or higher and 4N purity.</p> <p>ÉChamber diameter size at least 150 mm.</p>
22	Spin coater	<p>A spin coater from a reputed company and should have following features</p> <p>ÉProgrammable with parameter such as speed , acceleration, dwell time and number of steps etc</p> <p>ÉRotation speed- 8,000 RPM with error not more than 10 RPM</p> <p>Évacuum pump for coater operation</p> <p>ÉChuck size of 4 inch or more</p> <p>ÉShould have foot switch for convenient operation</p>
23	Consumables, spare tools	<p>The system should be supplied with all the accessories and consumables-</p> <p>ÉOne number of X, Y and Z translation/rotation motor module</p> <p>ÉOne additional field emission source module to be supplied as and when required for the system</p> <p>ÉOne additional Joystick set for stage control</p> <p>ÉMultiple set of all types of apertures</p> <p>ÉOne full set of objective caps, gaskets, seals, O-rings etc.</p> <p>ÉFuse kit of necessary type and rating for complete system</p> <p>ÉOne number of multiple sample holder in addition to standard specimen holder.</p> <p>ÉOne number of cross-sectional sample holder.</p> <p>ÉSpecimen Stubs for sample mounting -100 numbers</p> <p>ÉSputter target ó Two number of Au-Pd with thickness 0.1 mm or higher and 4N purity</p> <p>ÉSilver paste (4 number of 25 gm) with thinner</p> <p>ÉTweezers and mount grippers - 2 number each.</p> <p>ÉTen number of Carbon Tapes bundle</p> <p>ÉComplete set of tool kit including a One digital multimeter</p> <p>ÉSilica gel 1kg along with 2 desiccators</p> <p>ÉPMA and developer for lithography from internationally reputed make</p>

		1. PMMA (M.Wt. 950000; 2% in anisol) - 500 ml - one 2. PMMA (M.Wt. 450000; 4% in anisol) - 500 ml - one 3. PMMA (M.Wt. 450000; 6% in anisol) - 500 ml - one 4. Copolymer (9% in Ethyl Lactate) - 500 ml - one 5. HSQ resist (2% in MIBK) - 250 ml - one 6. MIBK developer (1:3 MIBK to IPA) - 4000 ml - one
24	Accessories	Equipment should be provided with the following accessories, ÉInterface between SEM and EDS and electron beam lithography ÉAir Compressor, if required system operation ÉCooling system for smooth system operation, from reputed company as per system requirement. ÉHigh purity nitrogen gas (with at least 5N purity, 7 m <sup>3</sup> gas) cylinder with regulator compatible to system ÉUPS: 15 kVA online UPS system with two hours back-up for full fledge operation of the system, with maintenance free batteries with minimum three years of warranty for UPS
25	Safety Devices	Safety devices against power/ vacuum/water/air/gas failures.
26	Power Supply	For whole system -as per Indian standard
27	Spare availability	Supply of spares for 10 years should be guaranteed.
28	Warranty	36 months comprehensive warranty (excluding breakdown period) for the ENTIRE system from the date of installation. Two year annual maintenance contract (AMC) after warranty period.
29	Documents	A compliance statement should be attached with the quote. The vendor should highlight all the specification points with page number of the instrument catalogue/broacher.
30	Instruction Manuals	A copy of the operating manual, routine maintenance manual, attending procedures for routine problems, software back up, etc. should be provided.
31	Installation & Commissioning	The supplier should undertake to complete installation & commissioning of the equipment along with all the accessories and must demonstrate the whole system performance with all its features at site.
32	On-site training	Supplier should provide, ÉOnsite training for FESEM and EDS immediately after installation for one to two weeks ÉSeparate onsite training for electron beam lithography for 5 days after FESEM training ÉTraining for micromanipulator module.