

**National Centre for Nanoscience & Nanotechnology
University of Mumbai
(NCNNUM)**



National Center for Nanoscience and Nanotechnology, Ramkrishna Bajaj Sanskrut Bhavan,
University of Mumbai, Vidyanagari, Santacruz (E), Mumbai 400 098, India.
Tel: (022) 2654 3495, Fax (022) 26530299 Email: director@nano.mu.ac.in

Tender Document for

High Resolution Electron Beam Lithography System

No: NCNNUM/Tender/903/2013

Date: 28th September 2013

Part A - Terms and Conditions

Part B – Specifications

Price: Rs. 500/- (non refundable)

Important Dates:

Last date of Sale of Tender Document	18 th October 2013 , 4.00 pm
Last Date of Receiving sealed Bids/Tenders:	19 th October 2013, 1.00 pm
Tender opening (Technical bid)	19 th October 2013, 3.00 pm
Pre-bid meeting	05 th October 2013, 11.00 am

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Part A - Terms and Conditions

Tender Notice

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Vidyanagari, Santacruz (E), Mumbai 400 098, India

Tel: (022) 2654 3495, Fax (022) 26530299

NCNNUM/903/ of 2013

Date: 28th September 2013

Sealed Tender bids for the purchase of **High Resolution Electron Beam Lithography System**, for National Center for Nanoscience and Nanotechnology, University of Mumbai are invited for and on behalf of University of Mumbai by the Director, NCNNUM. Following schedule shall be maintained for various processes.

Last date of Sale of Tender Document	18 th October 2013 , 4.00 pm
Last Date of Receiving sealed Bids/Tenders:	19 th October 2013, 1.00 pm
Tender opening (Technical bid)	19 th October 2013, 3.00 pm
Pre-bid meeting	05 th October 2013, 11.00 am

Tender Document containing terms and conditions and technical specifications are available in the Office of the National Center for Nanoscience and Nanotechnology, University of Mumbai, Vidyanagari, Santacruz (E), Mumbai 400 098, on all working days between 11.00 a.m. & 4.00 p.m. from 28th September 2013 to till 4 pm of 18th October 2013. Terms & conditions and technical specifications can also be downloaded. In case, the tender document is downloaded from the website, the Tender Document fee of Rs. 500/- should be enclosed in the Technical Bid Envelop, in the form of a Demand Draft drawn in favour of **“Finance and Accounts officer, University of Mumbai”**. **(Kindly write your company name, instrument name and tender reference number on back of Demand Draft for Tender Fee.)** The tender bids duly complete in all respects, along with the necessary documents should be submitted to The Director, National Center for Nanoscience and Nanotechnology, University of Mumbai.

The technical bids so received, shall be opened on 19th October 2013, 3.00 pm in the office of The Director, National Center for Nanoscience and Nanotechnology, University of Mumbai in the presence of the representatives of the suppliers. The Financial bids of the tenderers shall be opened on the same day or on the following day. The names of shortlisted tenderers shall be announced on the website after scrutinizing the Technical bids and evaluating their suitability to meet the University requirements. Right to reject any or all tenders, without assigning any reason thereof is reserved by the University of Mumbai.

Sd/-
Director,
NCNNUM,
University of Mumbai

Terms and Conditions of Supply

1. The last date and time for the acceptance of the bids is 19th October 2013, 1.00 pm
2. Suppliers shall submit the following documents along with their quotations **(which should be placed in the Technical Bid Envelope, i.e Envelope No. 1)**.
 - (a) Income-Tax clearance certificate from the Income-Tax Officer concerned, certifying that the tenderer has cleared all the Income-Tax dues. Copies of Income Tax returns shall be applicable.
 - (b) Suppliers should be either manufacturer or authorized dealer of the said equipment and should submit the proof for the same. Also, the suppliers should state whether they are a Proprietary Firm, Partnership Firm or a Private/Public Limited Company and furnish the proof of the same.
 - (c) The names of the organizations and laboratories for which similar work carried out.
 - (d) Earnest Money Deposit in the form of a Demand Draft drawn in favour of **“Finance and Accounts officer, University of Mumbai”** on any Nationalized Bank, payable at Mumbai. Alternately, BG from a Nationalised Bank only may be acceptable. The amount of Earnest Money Deposit shall be Rs. 2,50,000/- (Rupees Two Lakhs fifty thousands only). **Kindly write your company name, instrument name and tender reference number on back of Demand Draft for EMD.**
 - (e) In case, the tender document is downloaded from the website, the Tender Document fee of Rs. 500/- should be enclosed in the form of a Demand Draft drawn in favour of **“Finance and Accounts officer, University of Mumbai”**
 - (f) VAT Registration No.
 - (g) Technical specifications offered by the Supplier.
 - (h) Technical compliance table
 - (i) Proprietary certificate, if any, should be included in the Technical bid
3. The rates should be mentioned in the **Schedule** attached with the Tender Document. Each page of the tender shall be signed in full and stamped with the seal by the supplier. The supplier must clearly state in what capacity he or she is signing the tender. **(which should be placed in the Financial Bid Envelope, i.e Envelope No. 2)**
4. The supplier shall submit the tender in two envelopes. The first envelope (Technical Bid) shall contain all the documents referred to in **para two above** and sealed. The second envelope (Commercial Bid) shall contain the **Schedule**, in which the supplier shall register the rates of supply. The second envelope shall also, likewise, be sealed. Both the envelope then should be put together, and shall be sealed in an envelope, and shall prescribe time and date. The Technical Bid shall be opened first to ensure that supplier have submitted all the requisite documents. If the Technical Bids are not in order or are deficient in some respect, the commercial bids in respect of such tenders shall not be opened. The date and time

of opening the Financial bids shall be announced immediately after opening all the Technical bids.

5. Tender bids not accompanied by the requisite amount of Earnest Money Deposit are liable to be rejected
6. The Earnest Money Deposit paid by the supplier shall be forfeited, if the supplier fails to pay the necessary security deposit in the event of his tender being accepted.
7. The amount of Security Deposit/Performance Guarantee shall be 5 % of the cost. In case of successful tenderer the amount of Earnest Money Deposit shall be converted in Security Deposit / Performance Guarantee. Security Deposit / Performance Guarantee shall be refunded after the warranty period is over. The Security Deposit / Performance Guarantee can be paid in the form of a Bank Guarantee from a scheduled bank will be deducted from the payments being made to the supplier against every bill.
8. Supplier should read carefully all the instructions and terms and conditions, etc before registering rates in prescribed schedule of the tender. Taxes and duties etc, should be shown separately.
9. The offers made by the suppliers shall be open for acceptance within 120 days after the last date of submission of tender.
10. **The Technical Documents shall be opened** by The Director, National Center for Nanoscience and Nanotechnology **at 3.00 p.m. on 19th October 2013.**The tenderers or their authorized representatives shall be allowed to be present at the time of opening of the tenders. Financial bids of only qualified tenderers shall be opened. The date and time of opening the financial bids shall be announced immediately after opening all the Technical bids.
11. In case of imported items/equipments, the rates should be quoted in the light of exemptions enjoyed by educational institutions. University is exempted from the payment of Octroi and the necessary certificate/form can be issued by the University. The customs duty applicable to the University of Mumbai is maximum 5% of the invoice.
12. Technical specifications of the instruments / equipments / articles are given in Annexure to these papers (Part B).
13. The delivery, installation of the works should be completed within 4 months from date of design review and acceptance placing of the order. No extension shall be granted to the contractors/suppliers for the period of delivery, under any circumstances. All drawings to be approved by NCNNUM. No change is allowed without written permission.

14. In case of delayed supplies / installation of the equipments at NCNNUM, liquidated damages at the rate of 1 percent per week of delay with a maximum of 5 percent will be levied.
15. If the supplier fails to deliver the article as per the delivery schedule, the University of Mumbai shall be free to procure the balance/undelivered supply, at the risk and cost of the supplier, from other such suppliers
16. The goods, articles, materials supplied by the supplier shall be accepted after inspection by an officer authorized by the competent authority. No articles/materials which do not conform to the specifications laid down in the terms and conditions or damaged in transit accepted
17. Before tendering, the tenderer shall inspect the site to fully acquaint himself with the condition in regard to accessibility of site, working condition of site and locality including unloading of materials, installation of tools and plants, etc., required for the satisfactory execution of the work contract. No separate claim whatsoever on these accounts shall be entertained by the University of Mumbai. No claim for expenses incurred in the site visit will be entertained by the University of Mumbai
18. The bills of suppliers shall be paid by the University only after the complete installation of system as per the stated specification in the tender documents and certified test reports are submitted
19. Only those contractors who can execute the complete project including all the optional accessories shall submit their bids. Bids received for part work shall not be considered. Tenderers of the **High Resolution Electron Beam Lithography System** should provide the entire equipments as described in part B, and will be responsible for the design, development and installation of the complete instrument.
20. Missing of any required or any of the optional accessories / features / modules of the system will disqualify the vendor from technical bid and commercial bid.
21. Furniture required should be supplied alongwith the equipment. It should be from Quality Laboratory Furniture Manufacturer.
22. The vendor must assume responsibility for any damage to equipment during the shipping process or unloading to NCNNUM
23. Vendor must submit Compliance statement in tabular form comparing each specification of the quoted item with that given in the Tender Document part B. The Vendor also must supply a soft copy of the Table only in Microsoft word format.
24. If the equipment is imported and requires PC, printer other peripherals, they can be

bought from India and should be of International brand such as HP. The monitor should be LCD/TFT screen. The printer should be LaserJet printer. The processor should be Intel latest processor. The amount quoted for the items bought in India, installation; servicing etc. can be in Indian Rupees and the imported items can be quoted in foreign currency.

25. The warranty period shall be of 2 year from the date of complete and satisfactory installation of the system.
26. As the suppliers shall be responsible for the supply and installation of equipment at Mumbai, the cost towards insurance until destination in the University, shall be borne by suppliers.
27. The vendor has to provide clear compliance statement with respect to the specifications given in the tender document and fully supported by the manufacturer's original literature and part numbers. Any other claims will not be accepted and may lead to the rejection of the bid. It is mandatory to specify the part numbers of the quoted items along with the technical offer without which the subject offer would be liable for rejection.
28. In the event of any breach of the terms and conditions of the supply, the University of Mumbai may terminate the contract placed with the supplier and forfeit the security deposit or the supplier.
29. Right to reject any or all tenders without assigning any reason there for is reserved by the University of Mumbai

Prequalification Criteria

A. Qualification Criteria for the System Vendor.

1. The vendor must be a well established company with a large market share in the field of High Resolution Electron Beam Lithography System. The vendor must have a long track record of at least 10 years (preferably 15 years) in development of Electron Beam Lithography System .
2. The vendor must have an Indian agent who will assist in the procurement process as well as provide after-sales service
3. The vendor must have EBL applications lab with High resolution EBL system – lab scientists available for consultation on EBL.
4. Technical compliance statement (Annexure ‘A’) with original EBL manufacturer’s seal and stamp in original must be enclosed

B. Qualification Criteria for the Product Brand (EBL system).

- a) The brand of High Resolution Electron Beam Lithography (EBL) System (Make) and accessories being quoted must have a record of being in use for at least 10 years in well known production or research establishments. The vendor must provide references to that effect. Documents citing technological / research breakthroughs achieved by users of the brand will be given weight during the selection process.
- b) The EBL system should be robust and contain adequate mechanisms to withstand short disruptions of the facilities (power, water, chiller, etc) without catastrophic failure
- c) **Installation in India:** List of Indian users for the quoted model and certificates of successful completion issued by the clients along with their complete contact details during the last 5 years must be enclosed.
- d) **Service facility in India:** The suppliers should clearly mention about their service facilities in India for prompt service support along with number of service engineers specially trained on the offered system. Down-time call attendance should be within 24 hours.

Schedule to Tender

Note:

1. Tenderers are advised to read carefully the Terms and Conditions of supply and "the Instructions to the Tenderers" before recording the rates in this schedule.
2. No erasures or overwriting shall be allowed, unless they are authenticated under the full signature and the seal of the tenderer.
3. The Rates shall be FOR, at destinations/godowns/places indicated in the delivery

Item no	Description of goods with details of specifications	Number / quantity	Price / Rate per Unit	Taxes	Duties	etc

Signature of the Tenderer

Date:

Seal of the Firm

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No: NCNNUM/Tender/903/2013

Date: 28th September 2013

Part B – Specifications

Specifications for High Resolution Electron Beam Lithography

1. System Description:

- 1.1 Supply, installation and performance demonstration of floor mounted, fully automated Electron Beam Lithography System having beam energy of ≥ 100 keV with necessary hardware and software at National Centre for Nanoscience & Nanotechnology, University of Mumbai.
- 1.2 The tender should provide the clear timeline by which the system will be built, inspected, shipped and installed. The complete system should work at 50Hz, 200 – 240 V single phase / 440 V three phase.
- 1.3 The major subsystem to be provided by the bidder should include (a) Plinth, Chamber, Airlock and Vacuum systems with automatic control, (b) X-Y Stage and Control system, (c) Electron optical column with beam formation control system, (d) Beam deflection, alignment and compensation systems, pattern generator and pattern data handling system, (e) Operator interface and beams control software using a workstation and distributed microprocessor sub-system controllers, (f) Thermal control/cooling water baths and vacuum pumps.
- 1.4 The thrust area using this system will be to fabricate (a) Photonic crystals, (b) Quantum dot arrays, (c) All kind of gratings [DFB laser, (Fiber-), Bragg, chirped, coupling, phase shifted or large area], (d) honey comb structures, (e) Nano sieves, (f) waveguides of all kinds (bended, coupled, arrayed, tapered, xray, plasmonic), (g) Ring resonators, microring filters, (h) Xray lenses, zone plates, (i) Atom chips (Bose-Einstein condensate templates), (j) SQUID coils, heating coils, etc.
- 1.5 The offered system shall be a ‘brand new’ system, and in no case shall use any refurbished item in building the same. Vendor to provide a certificate towards this.
- 1.6 System should have following specifications
 - a) The system must be capable of directly writing/defining mechanical, electronic and photonic devices consisting of nanoscale feature size (~ 10 nm) components.
 - b) The system should be robust and contain adequate mechanisms to withstand short disruptions of the facilities (power, water, compressed air etc) without catastrophic failure.

- c) The system should be compatible to a class 100 cleanroom environment. The installation process should also conform to the usual practices in such cleanrooms.
- d) **High Resolution Lithography** : The system must be able to write Inter Digitized Transducers (IDTs) like patterns (equal line and gap) having critical line widths $100 \text{ nm} \pm 10 \text{ nm}$ over an area of upto 2000 mm^2 on a variety of wafers/substrates like semi-conducting, metal coated insulating, piezoelectronic, pyro-electric, ceramic etc. and Cr masks. The system must support lithography of all kinds of shapes including triangles with any angle and circles etc. The system must support variety of resist materials (PMMA, SU-8 etc), whose sensitivity may varies from $0.1\mu\text{C}/\text{cm}^2$ to $500\mu\text{C}/\text{cm}^2$
- e) **Gray Scale Patterning**: The Machine should be able to make gray scale patterns over planar/non planar as well as substrates with curved surfaces (thickness $\geq 4\text{mm}$). It must be possible to define structures in resist, coated over these substrates with desired slope and periodicity (normally of 300 lines per mm). The surface roughness of the structures thus defined must be of the order of 5 nm.
- f) **Multi Layer Lithography**: The machine must be capable of executing multilayer lithography with overlay accuracy better than $\pm 15 \text{ nm}$
- g) **High Aspect Ratio Structure Fabrication**: The Machine must be capable of patterning minimum $5\mu\text{m}$ critical dimensions on thick resist ($\approx 10\mu\text{m}$) and be able to produce high aspect ratio structures.

2. Electron Beam Column and Detectors:

- 2.1. The electron optical column should consist of an electron source, zoom condenser lenses, objective lens, fine focus lens, electromagnetic alignment coils, blanking plate assembly, beam deflection system, dual quadrupole stigmator and an aperture array to select the final beam convergence angle.
- 2.2. Acceleration voltage range must be 100 kV or more .
- 2.3. High brightness Thermal Field Emission electron gun with resolution 2nm or better.
- 2.4. Cathode life time : $\geq 10,000$ hours
- 2.5. Writing speed $\geq 50\text{MHz}$.
- 2.6. Electrostatic Beam Blanker to stop the beam on an intermediate aperture
- 2.7. Backscattered electron detector control system
- 2.8. Absorbed current detector control system, Specimen Current Monitor should provide

- 2.9. Beam current must be 100 pA – 100 nA continuously adjustable
- 2.10. Spot size must be $\leq 10\text{nm}$ and user should be able to vary
- 2.11. Beam current uniformity: $\geq \pm 1\%$ over $1000\ \mu\text{m}$ field
- 2.12. Beam current drift : $\leq 0.5\%$ per hour (open loop)
- 2.13. Spot tables: Ability to create and recall/use repeatable spot tables.
- 2.14. Beam Parameters: Closed-loop correction mechanism and calibration using a software must be provided
- 2.15. Minimum line widths of 10nm or less at $100\ \text{kV}$.
- 2.16. Automatic set-up for electron gun run up, focusing, astigmatism correction and deflection calibrations.
- 2.17. Magnification: 200 to 200000; facility to change or choose magnification through computer must be inbuilt.
- 2.18. The system should be capable of working faithfully from small currents to large ones without the requirement of any outside physical changes in the electron optical column and should provide conditions to support application.

3. Specimen Chamber:

- 3.1. Specimen chamber should be connected to low maintenance and oil-free UHV pumping system
- 3.2. The working chamber should be thermostatically controlled to better than $\pm 0.1^\circ\text{C}$

4. Vacuum Systems:

- 4.1. Suitable vacuum pumps shall be specified for continuous, uninterrupted and reliable operation of various functions of the system, viz., load lock chamber, main writing chamber, electron gun emission chamber, and other modules.
- 4.2. Vendor to provide sufficient length of connecting lines to facilitate placement of pumps in the service area, wherever applicable
- 4.3. Air cooled dry pumps must be provided for roughing, backing and for achieving suitable and clean vacuum in sections of machine.
- 4.4. Suitable gauges, calibrated as per NIST traceable standard, must be provided for monitoring vacuum levels in different sections of the machine.
- 4.5. The airlock pump down time should be less than 15 minutes.
- 4.6. The range of vacuum should be 10^{-10} mB or better for gun column and 10^{-7} mB for the chamber.
- 4.7. All the above pumps shall only be of reputed and standard makes with local servicing facilities in India
- 4.8. Control and display: Automatic control and display with mimic facility for vacuum and other operations
- 4.9. Should have provision to automatically reset to safe condition in case of vacuum leak or power failures.

5. Sample Stage:

- 5.1. Sample stage should have movement ≥ 150 mm x 150 mm
- 5.2. Laser interferometer (mounted inside working chamber) for positional measurement and interferometer resolution 0.618 nm or better
- 5.3. Laser based focal plane sensor with a repeatability of $\pm 0.5\mu\text{m}$ or better
- 5.4. Stage calibration provision should be there.
- 5.5. Mechanical stage positioning error correction mechanism should be provided
- 5.6. The system should be able to produce desired structures on curved surfaces with help of the stage movement in Z-direction in conjunction with the height mapping methodology or equivalent, which will be used to compensate for any anomalies on the planar surfaces as well. Z-axis movement should be at least 10 mm.

6. Wafer / Substrate and Mask Holders / Handling:

- 6.1. Capable of holding 4" and 6" wafers (both top / bottom reference)
- 6.2. Individual holders for irregular shaped wafer samples
- 6.3. Substrate holder material should be vacuum-compatible and low drift material
- 6.4. Capable of holding multiple samples of various sizes (rectangular chips, wafer piece parts, etc) at once
- 6.5. Tools for pre-alignment of wafers should be provided
- 6.6. Substrate holder material should be vacuum-compatible and low drift material
- 6.7. Mask Holder : Individual 4" and 6" square mask holders
- 6.8. Current Measurement : All the sample holders should have Faraday cup with an integrated auto range pico ammeter having an accuracy of better than 0.5%
- 6.9. Wafer Pre-alignment : Suitable provision should exist to align wafer cut to X or Y axis with an accuracy of better than 0.1° or less at the time of loading.

7. Lithography System / Pattern Generator:

- 7.1. Method of writing: Vector Scan using a spot beam with Gaussian distribution. It must also have required controls and must be able to provide drift free long exposures (running even in 60 – 70 hours)
- 7.2. Able to carry out writing by finely changing the pattern size and the pitch between the patterns
- 7.3. Pattern Addressing: 20 bit or higher for beam positioning and ≥ 14 bit for writing of shapes
- 7.4. Exposure area : 150 mm x 150 mm
- 7.5. Pattern shapes supported: All kinds of shapes and angles including circles.
- 7.6. Writing speed (exposure clock) : Continuously selectable between 500 Hz – 50 MHz at 50 Hz interval. Higher writing speeds may be quoted as option
- 7.7. Dosage setting: Number of stepping frequencies should be 2^{14} or more
- 7.8. Deflection system: Electromagnetic and In-lens double deflection.
- 7.9. Minimum writing step size should be better than 1 nm.

- 7.10. Alignment: Automatic global alignment software to be provided. Software should also automatically correct errors in position, rotation, run out errors, and facilitate/correct mix-and-match operations to be performed with features realized with lithography
- 7.11. Field size : Continuously selectable $\geq 500\mu\text{m}$.
- 7.12. Field stitching
- Writes smooth, continuous patterns over large distances with no stitching errors
 - Able to perform stitching error free lithography for the applications specified in section 1.4
 - Stitching accuracy: The field stitching should be $<\pm 15\text{nm}$, worst values not to exceed $\pm 25\text{nm}$, both for X and Y axes.
 - Field stitching values to be provided from one end to other for 5 – 6 field length.
 - The lithography system should be able to perform stitch-free strips of dislocation sensitive devices like gratings and 2D arrays of dots or circles, which do not allow for discontinuities induced by stitch field boundaries
- 7.13. In field distortion $\pm 12\text{nm}$, maximum for any field
- 7.14. Overlay accuracy: Better than $\pm 15\text{nm}$
- 7.15. Resolution: DAC resolution must be 18 bits
- 7.16. Beam positioning resolution: 0.31nm
- 7.17. Line width: Minimum line width must be less than 8nm

8. Markers, alignment and calibration:

- 8.1. Calibration Markers: Suitable metal markers on a Si (or similar) substrate must be mounted on each holder for beam formation, deflection, focus and astigmatism calibration and drift compensation.
- 8.2. Imaging System for Calibration: Secondary electron detector having automatic contrast / brightness with manual override. At the lowest working current (i.e. at 100pA) also, it should give proper video signal and support all the calibration routines. Alternatively, suitable detectors to read the calibration markers may be provided
- 8.3. Direct Writing (overlay writing) : Overlapping with detection of the marks on the wafer
- 8.4. Calibration and dynamic online corrections for deflection, focus, astigmatism and height variations.
- 8.5. Marker detection speed shall be $<1\text{ sec}$ / marker for beam currents of 1nA - 100nA , $<1.8\text{ sec}$ for 100pA – 1nA .
- 8.6. Marker detection reproducibility $< 10\text{nm}$, 3σ .
- 8.7. Registration and Alignment: Markers for beam formation, deflection, drift, global alignment must be provided. Specific software for alignments (global, distortions, corrections for drift, position, rotation, off axis focus, stigmatism, etc.) must be

- provided. The system should have the facility for local and chip level alignment by registration of defined markers.
- 8.8. Measurement and calibration of beam current, beam position, focus, field size and height must be provided
 - 8.9. Calibration for other alignment, stage movements, etc., may be stipulated and provided.
 - 8.10. External calibration standards, if any, should be specified and provided with certificates of traceability.
 - 8.11. EM Field correction: The module for EM field measurement should be provided by the supplied by the bidder and provision must be made to counter-balance it.

9. System control and Image acquisition Hardware/Software:

- 9.1. System control should be through appropriately designed ergonomic keyboard with joysticks or knobs.
- 9.2. Appropriate software for system control and image acquisition, manipulation and storage.
- 9.3. Software should be user configurable
- 9.4. Upgrades/ Updates should be available free of cost or for a minimal fee
- 9.5. Pattern processing software package with latest configuration, to be used for designing, troubleshooting, compiling (into machine format) and plotting of data. The pattern processing software must be portable along with the data to a processing station with similar or better configuration. Licensed version of all the software must be provided.
- 9.6. The pattern processing software
 - a) Should support both interactive and batch processing modes
 - b) Should support unlimited number of shapes
 - c) The pattern processing software must be compatible with the machine format in Pre-machine fracturing approach and patter generator resolution.
 - d) It should have help function for all the instructions / commands of the pattern processing station
- 9.7. It must support the following operation on the pattern data
 - a) Analysis of input files for errors
 - b) Healing and overlap removal
 - c) Rotation and mirroring
 - d) Pan, zoom and measure
 - e) Biasing
 - f) Dilate / Shrink
 - g) Reverse Toning
 - h) Boolean operation
 - i) Continuous scaling

- j) Overlaying graphics reference grid
 - k) Overlaying of several pattern files
 - l) Determination of number of shapes, number of grids exposed, size of the pattern, critical dimension, area covered and % area exposed
 - m) Proximity effect correction
 - n) Conversion of the input data to output data. Able to input (read) as well as export in traditional .dxf as well as GDS-II format files. Image display of the input and output data.
- 9.8. The software and drivers must be compatible with Windows operating system or comparable operating system
- 9.9. A complete set of manual in English language with detailed **command set** or syntax (**including source code examples**), operating and troubleshooting procedures for major components such as high voltage power supply, current modules, X-Y-Z stage movement, beam blanker, image readout unit, detectors, aperture selection, magnification etc must be provided.
- 9.10. Manual override or control of the system, vacuum facilities and transport of wafers must also be provided.
- 9.11. Separate computer/workstation, suitable for pattern generation, etc., must be provided and interfaced with the main system computer.
- 9.12. Visual display of the exposure process and system parameters must be available with the system
- 9.13. User-settable machine parameters for control of the system, through software files/shells.
- 9.14. Provision for run time interpretation of pre-defined job files and logging of instructions executed for unattended operations.
- 9.15. Logging of all PSU voltages, current and vacuum levels etc
- 9.16. Programming: Capacity to store multiple programs/recipes, with multiple levels of password protection. Automatic data logging of all process parameters on a continuous basis for better process control and failure analysis should be provided.
- 9.17. Self-test and diagnostics facility with an optional remote diagnostics to be included in the system.

10. Other Accessories / features:

- 10.1. Automated height sensing tool so that sample surface height variation is detected and focal plane automatically corrected
- 10.2. Vendor should provide Faraday cup for current measurement
- 10.3. Anti-vibration table system should be provided by the bidder.

- 10.4. All connectors for interfacing, fixtures and electrical wiring for the complete system should be provided.
- 10.5. Any optional features should be indicated and quoted separately. Vendor should include any other additional items, which may be felt essential to carry out the complete integration and did not get mentioned in the above list.
- 10.6. The system should include all necessary water chillers and other support equipment with appropriate interlocks for safe operation
- 10.7. Tools for loading/mounting of samples and vacuum wand (including vacuum pump) should be provided.

11. Optional Accessories

11.1. Standard sample for calibration

- a) The tin ball or gold on carbon or better standard sample for periodic checking of system resolution to be included
- b) Standard sample for periodic checking of system alignment to be included

11.2. Metrology Tool

Supplier can quote suitable metrology tool. The operation of metrology tool shall be user friendly and shall be equipped with dedicated software.

11.3. Computer

A branded desk-top computer with Intel® i5 or better processor, ≥ 3.0 GHz speed, 8 GB RAM, 1TB or better HDD with DVD writer, 22" wide screen LCD color monitor and the required graphic adaptor card, latest licensed windows or comparable operating system should be quoted. Branded high quality colour Laser Printer should also be provided

11.4. UPS

Suitable online UPS of suitable power rating should be offered with minimum of one hour backup for the complete Electron beam lithography system including the all the accessories of the system.

11.5. Tool-kits and Spare Parts

- a) Complete set of tool-kits for operation and maintenance of High Resolution Electron Beam Lithography (EBL) System with accessories.
- b) Complete set of tool-kits for chiller.
- c) Complete sets of spare parts including (if appropriate).
- d) Consumables for 5 years operation including electron source and ion pumps etc should be provided

- e) The spares and support should be available for 10 years from the date of installation and commissioning of the quoted model and manufacturer should give in writing along with offer.
- f) Compatible cassettes, wafer holders, fixtures and accessories to handle the substrate and to run the process should be provided.
- g) Vendor should specify and quote the optional measurement/monitoring tools that could be required for trouble-shooting purposes
- h) Any other additional information, modules, which the supplier thinks as useful.

11.6. System Upgradability

The possible system upgradability options must be quoted. Any other support/accessory item required for operation of the Electron Beam Lithography for the application mentioned in section 1 of this document (part 2)

11.7.Substrate and Photo resist

11.7.1 Substrate

- a)Twenty five (25) quantity of 6” silicon wafer
- b)Twenty five (25) quantity of 4” silicon wafer
- c)Twenty five (25) quantity of approx 20 mm x 100 mm quartz wafer

11.7.2 Photoresist

- a) Photo resist such as PMMA, SU-8 should be quoted by the vendor.
- b) The resists should be compatible with the multilayer resist processes using electron beam lithography.
- c) The resists should have excellent adhesion to Si, GaAs substrates and chrome mask blanks.
- d) The resists should have a shelf life of atleast eight months after receipt at the destination.
- e) The vendor should clearly mention the manufacturer of the resists and provide the date sheet of the photoresist.

11.8.Spin Coater and Developer System

The supplier should also quote as an optional item for independent Spin Coater for coating of Photoresist on different substrates and an independent Developing System. The System should be in table top configuration and stable at its highest speed and acceleration with no vibration. System must be compatible with clean room of class 100.

11.8.1. **Substrate size:** Different sample size from 5mmx5mm to 4” and 6” diameter wafer.

- 11.8.2. **Speed:** ≥ 6000 rpm (programmable) with controlled acceleration in discrete steps. Acceleration: ≥ 4000 rpm/s
- 11.8.3. **Spin process time:**
 - a) Minimum: 1 second
 - b) Maximum: ≥ 999 seconds
 - c) Step size: 1 second or better
- 11.8.4. **Vacuum pump:** Oil free to hold wafers at all desired speeds with vacuum interlock Facility should be supplied by the bidder.
- 11.8.5. **Chucks:** for wafers of sizes: pieces 5mm x5mm and around and wafer 4" and 6" provision for future. Chucks for 4" and 6" must be with centering facility for wafer.
- 11.8.6. **Recipe:** Touch panel screen with user friendly operation and capable to programme and save up to 200 recipes with up to 40 steps in each recipe.
- 11.8.7. **Power requirement:** 230V single phase 50Hz with voltage variation of $\pm 10\%$.
- 11.8.8. **Top Cover:** Universal cover for usage of dispensing nozzle at different position of wafer and other possible application like EBR, Dispensing etc. altogether (as and when required)
- 11.8.9. **Dispensing system:**
 - a) Suitable photo resist as well developing solution dispensing system should be provide which can handle
 - b) Minimum 10 quantities of Interchangeable syringes / valves and nozzles to avoid contamination for dispensing different material
 - c) The system should able to handle the viscosity of dispensed fluid in the range of ≤ 1 to $\geq 50,000$ cps
 - d) Dispensing quantity range: ≤ 10 Nanoliters (nL) to ≥ 0.15 Milliliters (mL) per pulse
- 11.8.10. **Computer Interface:** Both the spin coater and photo resist dispensing system should have RS232 or equivalent for interface with computer. Detailed command set for PC interface through RS232 or equivalent

11.9. Soft and Hard Bake Plates

Both soft and hard bake system needs to be provide with programmable temperature controller.

12. Deliverable Documents

All documentation shall be in English language. In addition to the hard copies (clean room compatible), soft copies of the manuals shall be submitted vide – CD or DVD.

12.1. System Operational Manual in print and CD

12.2. System Maintenance and troubleshooting Manual in print and CD. All trouble shooting manuals must have drawings at module and card level giving complete description of the components used.

12.3. Calibration Procedure Manual in print and CD

- 12.4. Complete set of Service Manuals for all OEM products, circuit diagrams of sub systems and electronic boards
- 12.5. The supplier should provide compliance certificate/3rd party certification (as per international standard) for all the OEM parts.
- 12.6. Installation Manual in print and CD
- 12.7. Complete set of Engineering Drawings
- 12.8. Test Reports for all the mode of operations
- 12.9. A complete set of manual in English language containing detailed **command set** or syntax (including source code examples), operating and troubleshooting procedures for major components such as high voltage power supply, current modules, X-Y-Z stage movement, beam blanker, image readout unit, detectors, aperture selection, magnification etc must be provided.
- 12.10. The supplier should certify that the system is brand new and there are no refurbished components used in it. Year of manufacture and origin certificate for all the parts and assemblies shall be provided along with the supply.
- 12.11. The supplier should provide details regarding the safety measures adopted in the system in relation with the high KV, radiation levels etc and should ensure that it follows some international standards.
- 12.12. The supplier should certify that the system is EMI / EMC compliant as per international standard and should name the standard followed.

13. Installation and Training

- 13.1. The complete system along with accessories specified in Part B of this tender document must be delivered and installed at National Center for Nanoscience and Nanotechnology within 4 months from purchase order.
- 13.2. The successful tenderer shall coordinate sourcing of the auxiliary & accessory components such as water chiller, UPS, computers etc and delivering the items in the stipulated delivery period.
- 13.3. The supplier / manufacturer must provide qualified instructor(s) to train NCNNUM research staff on the use of High Resolution Electron Beam Lithography and its accessories.
- 13.4. The supplier / manufacturer must provide two (w) weeks on site training for the operation, trouble-shooting and maintenance complete system.
- 13.5. Vendor should provide for pre-shipment inspection training for one working week for two persons. All costs like airfare boarding and lodging should be paid by the vendor

13.6. Supplier shall provide two full time technical operators for machine operation and maintenance for a period of one year from the date of Installation and acceptance.

14. Warranty, Service and Support

- 14.1. Two years from installation and acceptance. Three years extended warranty may be quoted as an option.
- 14.2. Purchaser will not pay any amount during warranty period.
- 14.3. Down period will be excluded from the warranty period.
- 14.4. The supplier should bring out the parts not included under warranty / extended warranty and provide a budgetary quotation for the same.
- 14.5. The supplier should have an India based service support facility with a response time of less than 24 hours. The supplier should provide information about the level at which maintenance can be supported by them i.e component level / card level / assembly level.
- 14.6. The supplier should support the system for 12 – 15 years (post warranty, with all spares and services)

15. Facility requirements at installation site

- 15.1. System shall be suitably configured for the Indian power supply standards, viz., 230V, single phase, 50Hz or 415V, 3 phase, 50Hz. Details and requirements to be specified prior to installation.
- 15.2. Earth requirements and connections may be specified and the bidder should provide it on site.
- 15.3. Details of uninterrupted power supply may be specified. Offer for this feature can be mentioned as an option.
- 15.4. Details of the utilities required (Nitrogen and other gases, power, CDA, exhaust, cooling water, deionised water supply, general vacuum, etc.) should be given well in advance.
- 15.5. Supplier should quote as an option, for the utilities, which are essential for the operation of the system (including the ones outlined above)

- 15.6. The complete footprint and layout of the installed system along with the required utility equipments should be provided keeping in mind the service related issued. System footprint may be provided. Required space for location of the various modules, and space for access around the system may be mentioned. The system height must not exceed 6 feet. The available class 100 clean room space is 7 meter length and 3 meter width. The supplier should be able to fit the complete system in the available space as mentioned above.
- 15.7. Vendor to measure the magnetic field distribution at the proposed site of installation, and if required, install the field cancellation system prior to the installation of the main system.
- 15.8. Site preparation: Vendor or his representatives to inspect the site of installation and take up necessary site preparation activities, sufficiently well before the arrival of the system at NCNNUM.
- 15.9. System vibration isolation facility: The local active/passive vibration isolation facility for positioning the main EBL system writing console should be provided and installed by the vendor.
- 15.10. It will be the responsibility of the supplier to ensure transportation of the consignment within NCNNUM premises, un-packing, shifting in the designated site (Class 100 Clean room) and installation of the system along with its utilities.
- 15.11. Any other facility or operational requirements at the installation site may be mentioned and quoted by the bidder.

16. Acceptance

- 16.1. The supplier shall install and commission all the accessories covered under the Part B of this tender and demonstrate performance and quality parameters of the complete system as per tender requirements. NCNNUM Personnel shall witness the performance tests.
- 16.2. The supplier shall demonstrate performance and quality parameters of the complete system (including all the accessories / attachments) as per design and parameters specified under Part B of this tender. NCNNUM Personnel shall witness the performance tests.
- 16.3. The supplier shall demonstrate the performance of the system using NIST standard samples for calibration. The calibration sample is to be included in the scope of supply

- 16.4. The alignment guarantee must be validated at site by using standard reference.
The standard sample is to be included in the scope of supply.
- 16.5. Testing safety interlocks functions of complete system must be demonstrate at site
- 16.6. For the acceptance test, the supplier must demonstrate the following on the supplied system and hardware / software accessories at the manufacture's site as well as at NCNNUM, Mumbai after installation of the system and has to demonstrate
- a. Functional performance of all the vacuum pumps, time required to attain the working pressure, functioning of valves etc.
 - b. Auto and manual control of electron optics and achieve the specified spot size.
 - c. Long-term stability of probe current variation, beam drift and calibration parameters.
 - d. Typical value of field stitching for different fields
 - e. Field distortion, overlay accuracy as mentioned in this tender document
 - f. The system job-files for continuous exposures of multiple substrates
 - g. The software capability of automatic chip-level registration for multi-level exposures.
 - h. Conversion of industry standard pattern format such as GDS-II, DXF to machine acceptable format for subsequent exposures.
 - i. Complete features of pattern processing such as tone inversion, proximity effect correction, dilate / shrink / bias, mirroring etc as outlined in this tender document.
 - j. The uniformity, line-width control and repeatability of delineating a NCNNUM supplied pattern containing 100 nm IDT like structure (equal line and gap) over a pattern area of 20 mm x 100 mm with a CD tolerance of $\pm 10\text{nm}$ on Silicon and Quartz wafer.
 - k. The performance of the quoted system in patterning sinusoidal and saw-tooth wave like periodic 3-D structures over an area of 50 mm x 50 mm on planar as well as non-planar curved surfaces / spherical surfaces. The patterning will have to be done in resist coated on glass/quartz/silicon.

**Annexure 'A' – Format for submitting un-priced BOQ along
with technical bid**

Tender No: NCNNUM/Tender/903/2013

S No.	Description	Qty	Make / Model

Signature of the Tenderer

Date:

Seal of the Firm

Annexure 'B' – Format for submitting compliance/response of bidder

Tender No: NCNNUM/Tender/903/2013

With reference to the technical details described in different sections of Part B, the bidder shall provide their compliance/response as below format. It should be clear that all the required and optional features must be clearly mentioned.

Section Number	Nomenclature	Bidder's Compliance / Response
1	System Description	
2	Electron Beam column and detector	
3	Specimen Chamber	
4	Vacuum Systems	
5	Sample Stage	
6	Wafer / Substrate and Mask Holders / Handling	
7	Lithography system / Pattern Generator	
8	Markers alignment and calibration	
9	System control and image acquisition Hardware/Software	
10	Other Accessories / features	
11	Optional Accessories	
12	Deliverable Documents	
13	Installation and Training	
14	Warranty, Service and Support	
15	Facility requirements at installation site	
16	Acceptance	
17	Annexure 'A' –Un-priced BOQ along with technical bid	

If the tenderer specification has **any deviations** from the specifications or details provided in any of the sections described in Part B needs to be clearly specified in the above table. A point-by-point compliance chart in respect of the points mentioned in the specifications above must accompany the technical quotations

Signature of the Tenderer
Date:

Seal of the Firm