



Society for Innovation & Development
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Request for quote and Specifications of a plasma enhanced ALD reactor for deposition of oxides and nitrides

- The GEECI (Gallium Nitride Ecosystem Enabling Centre and Incubator) at SID-Indian Institute of Science is seeking bids from qualified industries for atomic layer deposition of oxides and nitrides as per the specifications below.
- Companies need to submit two bids, a technical bid and a commercial bid, in **two separate** sealed envelopes. The bids should be submitted no later than 30 days from the date of posting of this tender, as listed on the website date/time stamp, and by 5 pm on the 30th day or next weekday in case the 30th day falls on a weekend or a national holiday.
- Both technical and commercial bids should be addressed to “The Chief Executive, SID, IISc, Bangalore 560012, GST # 29AAATS5333E1ZJ.”
- All quotations should be CIF Bangalore.
- Cost of last mile transportation, including any insurance, from port of shipment to IISc has to be quoted as an option.
- In case of courier shipments maximum permissible weight would be 70kgs.
- The envelopes should be addressed to “Prof. Srinivasan Raghavan, CeNSE, IISc, Bangalore, 560012” and submitted to the office at CeNSE, IISc in Room No. GF 15 between 9 am and 5 pm.
- All questions regarding this tender should be addressed to Prof. Srinivasan Raghavan at the email address sraghavan@iisc.ac.in
- Post such submission all vendors should send an email to sraghavan@iisc.ac.in with the subject line: “GEECI_Bidder’s name_Tool Name” to intimate him of the submission within one day.
- Deviations from the technical specifications requested are allowed. Such deviations must be highlighted and justified. Their acceptance or rejection will be left to the discretion of the technical committee.
- The equipment sought will be placed at the Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc). IISc is India’s No. 1 institution on higher learning and the Center for Nano Science and Engineering is home to one of the best academic fabs in the world.
- The technical response, corresponding to the tool being offered, should be in the form of a compliance table with at least 5 columns. Serial number in column 1. Each of the numbered items below should be addressed in a separate row of the table in column 2. Compliance to this requirement, in Yes/No, deviation from it and justification should be provided in the neighboring columns 3-5. Post the opening of a hard copy of the technical bid the committee will request for a soft copy of the files for further processing. Companies should **NOT** mail soft copies of the files unless specifically requested for.
- Detailed technical specifications of the tool being offered should be included.
- Any additional capabilities or technical details, that you would like to bring to the attention of the purchase committee, can be listed at the end of the technical table.
- If multiple systems can fulfill the requirements, vendors can submit multiple bids.
- Vendors are encouraged to highlight the advantages of their tools over comparable tools from the competitors.
- The commercial bid should be broken up to the maximum extent possible into separate items with a cost against each to enable better comparison of price for various configurations across the bidders. As an option, please provide itemized cost for any *suggested* accessories/add-ons that may enhance the usability, capability, accuracy or reliability of the tool. Vendors are encouraged to create separate items for accessories/add-ons that are not included in the standard specifications.

1. Growth chamber:

- a) Stainless Steel Chamber. Any other chamber material should be mentioned in the technical bid.
- b) Capable of controlling (closed loop PID control) and operating at temperatures up to 500°C (+/- 1°C) continuously.
- c) The option of going up to higher temperatures, if available, should be quoted separately.
- d) The typical deposition pressures, pressure cycles imposed for deposition (Pressure vs time curves) and details of pressure control, if any, should be included in the technical bid, for the item (m)) below.
- e) Capable being pumped down to a base pressure of 10^{-6} Torr. This can be quoted as an option.
- f) Capable of depositing binary and ternary oxides Al, Hf, Ti and Si and nitrides of Al and Si.
- g) Capable of depositing the said layers on wafers up to 4" and 6" in diameter with thickness variation across the wafer of less than $\pm 1\%$ and across wafers of less than $\pm 0.5\%$.
- h) System should be also capable of holding smaller test pieces.
- i) Vendor should highlight if whether the same system can go up to 8" diameter wafers. If not and the cost is significantly different, vendor should quote separately for one system that can handle up to 6" wafer and another that can handle up to 8" wafers.
- j) Growth chamber shall be provided with a suitable load lock and mechanism for loading samples without exposing reactor to the site ambience provided. This can be included as an option if not a standard attachment.
- k) Technical quote should include details on whether the load lock is manual or can include an automated cassette. The two should be quoted separately as options.
- l) The vendor should include details in the technical bid on the orientation of the wafers in the chamber and on the number of wafers that can be deposited on in a single run.
- m) Time taken to deposit 10-20 nm of alumina and its characteristics (thickness uniformity, breakdown voltage and refractive index at suitable wavelength) should be included in the technical bid.
- n) The technical bid should include details of the plasma generator, wavelength, power and mode of integration with the chamber. The commercial bid should include the plasma attachment as a separate line item.

2. Gas Manifold:

Gas manifold will consist of

- a) Separate run-vent stacks for metalorganic sources and oxygen/nitrogen sources.
- b) In the case of nitrides please specify if your choice for a nitrogen source is N_2 or NH_3 . If the latter, please include details of any separate NH_3 line in addition to the nitrogen line.
- c) Vent-Run stacks shall include suitable valves for fast switching of precursors and make-up flows between vent and run lines. Details of the fast switching valves should be included in the technical bid.

- d) At least 6-metalorganic channels for Al, Ti, Zn, Hf, Si, O (H₂O) precursors that incorporate necessary valves to divert flows through and bypassing bubblers, mass flow controllers for carrier and pusher flows, pressure controller of suitable range and flow rate to control total pressure in bubblers and baths equipped with PID temperature control of $\pm 0.1^{\circ}\text{C}$ and capable of cooling down to -20°C and heating up to 100°C .
- e) The tool vendor may quote for metal organic source loops on a cost per loop basis.
- f) Bid should contain details of lines for precursors with high (such as TMAI) and low vapor pressure (Such as TEMAHF) that need to be cooled or heated respectively, the temperature ranges available and details of line heating in case of sources heated above room temperature. Given the downstream electronics/sensors/valves, technical bid should include the maximum continuous line temperatures allowed.
- g) If instrumentation is present that allows for control of mass flux as opposed to standard volumetric rate control it should be quoted as an option.
- h) Technical bid should contain details of whether the source piping all the way to the reactor from each MO sources is kept separate or if they join a single run line upstream of the reactor.
- i) Suitable leak test manifold to enable He-leak testing of gas manifold
- j) Gas manifold will be made out of welded (using orbital tube welding) SS316L electropolished tubing construction with Swagelok VCR type connectors for all fittings and leak tight to less than 4×10^{-9} sccs of He.

3. Computer control:

- a) Valves, mass flow controllers, pressure controllers on metalorganic lines, pressure control of growth chamber and temperature control should be capable of being operated through an automated interface working in a stable software environment, MS Windows or equivalent. A graphic user interface should be provided to monitor process status during a typical run.
- b) The automated interface should also allow a “manual” and a programmed mode. In the “manual mode” it should be possible to send set points to the MFCs, temperature controller, growth chamber pressure control system (most likely a throttle valve controller) and also operate valves when not running a pre-programmed growth recipe. The programmed mode will be used for running a pre-saved growth recipe.
- c) Automated interface should also be sensitive to alarm sensors and interlocks required for the safe operation of the system.
- d) Automated interface should also log and save process data and status of various alarms during the course of a process.
- e) The following features are desirable in the run program. The ability to stall the growth process, the ability to abort the growth process to a safe abort recipe, the ability to end the process, the ability to reset the process, the ability to jump to a different or subsequent segment in the growth process and the ability to stall and edit non-executed portions of the growth recipe during a growth run.
- f) A cause effect logic should be included in the technical bid.

4. Reactor Exhaust:

- a) Growth chamber shall be evacuated through a pump capable of handling oxygen, metalorganic precursors and corrosive precursors such as the chlorides of Si and Ti. The pump should be able to evacuate the entire growth chamber and the entire leak free gas manifold to below 1 milli Torr in less than 30 seconds (if number is different please specify in the technical bid) in the absence of any gas flow.
- b) The pump should be suitably protected through a filter. Filter elements should be included in the spare list.
- c) Exhaust system should feature a pump bypass line operated through a suitable check valve that prevents pressure build up in the system in the event of a power failure or in the event that the pump is not operational.
- d) Exhaust system should feature, as an option, a suitable gas scrubbing system that reduces metalorganics in the exhaust to safe level prior to final release into the atmosphere.
- e) Dew point monitor on the exhaust capable of going down to -130°C should be quoted as an option.

5. Input Gas Handling systems:

- a) The technical bid should include details of the facilities line pressure required of the bulk gases, oxygen, nitrogen and or ammonia.
- b) It should include details of whether inline regulators are provided in case the facilities line pressure is larger than the required pressure
- c) Gas purification system shall be quoted as a separate item provided for purifying all the above gases of oxygen containing species down to ppb levels as an option in the quote. Vendor is requested to quote for point of use purifiers, life time end-point detectors and purifiers that can be regenerated **as an option**.
- d) All bulk inlet gas lines should have inline sub-1 micron particle filters.
- e) An ozone generator and its specifications should be quoted as an option.

6. Safety features and interlocks:

- a) System shall contain safety features and interlocks for safe operation of the reactor.
- b) In particular, safety interlocks and alarms should include among others.
 - i. Inability to open the reactor chamber during a run process.
 - ii. Inability to open the reactor chamber when it is connected to the pump and at sub-atmospheric pressure.
 - iii. Inability to open the reactor till it has cooled down to less than 100°C , all NC valves are closed, the reactor has been purged with nitrogen for a preset time and pressure is at atmospheric pressure for a preset time.
 - iv. Reactor over pressure alarm and pressure release mechanism.
 - v. Low cooling water pressure alarm if water cooling is used.

7. Installation and commissioning:

- a) Quote should include **as an option** the cost of shipping the system and locating it **AT THE SITE** specified by the client. This includes the final mile transfer from the airport or dock to the site. IISc will provide documents for customs clearance.
- b) The technical bid should include details of utilities required – power, water, gases and vacuum- for the stable operation of the reactor.
- c) Quote should also include **as an option** a turnkey contract for installing the system on site:
 - i. Connecting lines from location of source gases to the inlets in the reactor using electropolished SS tubing, welded construction and VCR fittings. For ammonia and Silane coaxial tubing to be used.
 - ii. Connecting lines from exhaust to scrubber using electropolished SS tubing, welded construction and VCR fittings
 - iii. Connection of a dilution nitrogen stream from nitrogen source to scrubber if warranted
 - iv. All other SS tubing construction as deemed by manufacturer that is warranted for the safe operation of the system
 - v. Connecting vents from gas cabinets, scrubber, pump cabinet, reactor cabinet, gas manifold cabinet and other vents to the building exhaust provided by client on site.
 - vi. Making hardwired electrical connection if required from electrical outlets provided by client on site:
 - vii. Hooking up cooling water systems from points provided by client on site.
 - viii. Connecting in house dry compressed air supply at required pressures to the system for operation of pneumatic valves
 - ix. All other hooks ups as deemed by manufacturer that is warranted for the safe operation of the system
- d) System shall be He leak tested after installation on site either with leak detector provided by the client or by turn key contractor and certified to not have leaks greater than 4×10^{-9} sccs of He
- e) Commissioning shall also involve training of a certain number of personnel agreed upon between the client and vendor.
- f) Trained personnel will run the reactor independently and be certified by vendor representatives that they are satisfied with the level of training. **The vendor will not be held liable for such certification.**
8. **Tool Qualification and Acceptance:** Commissioning shall involve demonstration of growth of alumina as listed in item 1(m) on a flat 6” wafer and **a trench of dimensions** mutually agreed upon between the client and vendor and characterized by the client within time frames agreed upon during installation. Details of the stage wise certification protocols to be pursued for tool acceptance should be included in the technical bid. The PO will include a mutually agreed upon set of tool qualification criteria.
9. **SEMI Standards:** The technical bid should include details of the SEMI standards the tool confirms to.
10. **Clean Room Compatibility:** The system should be compatible with better than class 1000 cleanroom environment.
11. Technical bid should include details of recipes for deposition, especially dielectrics for GaN that can be shared with the client.
12. **Tool Training:** The bid should include as an option the cost of training personnel on site before shipment and at IISc post installation.
13. **Tool footprint and utilities:** A floor plan should be part of the technical bid. A list of utility requirements should be part of the technical bid. The system should be compatible

with 240±10V, 50 Hz single phase or 415±20V, 50 Hz 3 phase supplies. The **MINIMUM** set of utility requirements needed are provided in Table 1. If there are additional utility requirements please include them in the technical bid. **Please list connector types for all utilities.**

14. **Cost of Ownership and supply of spares:** The quote should include a listing of spares that need to be replaced periodically to ensure that the system is in operation in a stable fashion – the stability parameters being defined by the vendor and agreed to by the client – the cost of such items, the ability to guarantee their availability at this cost for a period of 5 years from the time of procurement. The aim of this exercise is to compare cost of ownerships between reactors.
15. **Maintenance:** The cost of an annual maintenance contract and cost of emergency technical support that may involve an engineer being on site should be quoted for in the commercial bid and addressed in the technical bid. The availability of trained engineers in India for servicing the system will be preferred. If more than one type of maintenance contract is available they should be listed as separate line items in the commercial bid.
16. **Maintenance:** On all systems a set of basic tools required -non-standard screw or spanner head that is required for routine tool maintenance should be mentioned- for performing routine maintenance should be included.
17. **Maintenance:** System operation, process and troubleshooting manuals and detailed drawings are a must. Their inclusion must be indicated in the technical bid.
18. **Online support:** System should have the capability for online diagnostics from a remote location in case of tool problems.
19. **Post sales service and Indian Presence:** Bidders should provide details of after sales service and support available in India. If not India, the nearest geographical location should be specified. Please provide details of the number of trained personnel in India who can service the machine, the number of tools sold in India and the corresponding number in the southern region or in Bangalore.
20. **Payment Terms and Conditions:** On all systems the payment terms should be specified in the technical and commercial proposal and is subject to negotiation.
21. Bidder shall have to submit audited accounts of financial year 2017-18, 2018-19 and 2019-20. Audited statement must be signed and stamped by qualified chartered accountant. Income Tax return for assessment year – 2017-18, 2018-19 and 2019-20.
22. **References:** Bidders should provide details of other locations in India with similar tool installations.
23. **References:** Bidders should provide details of at least 3 other locations globally where similar tool installations have been deployed for device fabrication in a clean room preferably for production purposes.
24. **III-V nitride processing:** Please include information on whether the tool and its fixturing has been used for deposition of the said metals on GaN on Si wafers of 6” diameter for power applications.

