Request for Quote and Specifications of e-beam evaporation tool for deposition on up to 8" substrates

- The GEECI (Gallium Nitride Ecosystem Enabling Centre and Incubator) at SID-Indian Institute of Science is seeking bids from qualified industries for an electron beam evaporation tool 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 row wise 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 quote for as many add-ons as their tool portfolio permits.

The tentative configurations below should have the option of including a load lock for substrate and/or source loading that should be quoted for as an option and that can if need be interfaced separately with the system at a later date.

System Configuration: Up to 1 x 8" in non-batch mode and multiple wafers (at least 3) when 6" and 4" wafers are used.

The pumping system for the chamber size required needs to be chosen such that the pumping time to 1 x 10^{-6} Torr from atmospheric pressure is less than 15 minutes when using a load lock. More details are given below.

Technical Details for Compliance Table: Please add columns detailing compliance, deviations if any and highlight advantages over customers.	
1.	**Chamber:** Preferably SS. If any other material, please specify. Cost of SS upgrade should be included as an option.
2.	**Pumping:** The chamber volume and the capacity of the pumping provided should be such that a pressure of $<1x10^{-6}$ Torr is achieved in 15 minutes and a pressure of $<1x10^{-7}$ Torr in less than 60 minutes. While these are guideline figures, a tool that allows for the least cycle time, given the requirement specified would be preferred. Tool vendors should include pump down curves along with the technical bid. Chamber base pressure and time to reach base pressure given the pumping capacity should be specified
3.	**Pumping:** It is preferred that the above pumping be achieved with a combination of a (preferably) turbo pump (preferably Pfeiffer) and a **DRY** backing/roughing pump. A cryo-pump option should be included.
4.	**Pumping/Loadlock:** For the single wafer configuration, a load lock, automated cassette (4, 6 and 8") **and** manual, that allows changing of wafers **must** be quoted as option/options for single wafer mode.
5.	**Pumping/Gate Valve:** For the batch processing configuration, a gate valve that isolates the electron gun assembly while loading of substrates should be quoted as an option, if available.
6.	**Pumping/Loadlock**: The ability to buy the load lock separately and integrate it at a later stage **must** be included in the technical bid.
7.	**Pumping/Loadlock:** The price for integrating the load lock separately at a later date and the time for which this price is valid must be included in the commercial bid.
8.	**Pumping/Loadlock:** The possibility of getting down to a base pressure of $1x10^{-9}$ Torr with a suitable combination of pumping system + load lock should be quoted as an option.
9.	**Pumping/Leak Testing:** A leak test port with isolation valve and ¼" (VCR type) face seal fitting should be provided for connecting a He leak detector or an RGA.
10.	**Substrates**: The e-beam evaporator is being procured for deposition on 2 inch to 8 inch substrates.
11.	**Substrates**: The substrate stage should be capable of taking at least one 8" and multiple 4" and 6" substrates and pieces, should have rotation built in and should have the capability of heating substrates up to 300°C. Uniformity demonstration will be sought for 6" substrates. When using in single wafer more details of fixturing available for wafers of different sizes should be included in the technical bid.

12.	**Film Uniformity:** Vendor should specify the thickness uniformity possible in single wafer deposition and for batch across all wafers in +/- x% format. A map of uniformity across 4 inch, 6 inch and 8 inch wafers should be submitted with the quote for as many of the elements in item 17.
13.	**Substrate heating:** In addition to the above heating of substrates to temperatures above 300°C should be quoted as an option to help deposit refractory materials. The temperature option available should be included in the technical bid and quoted for separately in the commercial bid.
14.	**Substrates:** If available, a system that allows for simultaneous loading of all wafer pockets but has the ability for independent deposition, should be quoted. This is needed for instance when in a single pump down one could deposit different stacks on different wafers.
15.	**Substrate temperature measurement:** This must be quoted as an option for a single wafer configuration.
16.	**Substrate mounting:** Clips and mounting fixtures should be such that they do not introduce a point load that will can introduce wafer defects and/or cause breakage. Details of such fixturing should be included in the technical bid.
17.	**Electron source:** A 10 kW electron source (~10 kV and ~1 A) that can be controlled to yield point heating and distributed heating for evaporation of a range of materials such as Au, Ti, Ni (2 Å/sec), Ta (1Å/sec) and Al (5 Å/sec). The minimum **controllable** deposition rates are given above. The maximum controllable rates possible, taking into consideration such as crucible failure, should be included in the quote. The sweeping of the electron beam and the sweep profiled should be programmable.
18.	**Electron source-Target distance**: The system should be designed to yield uniform deposition, ±2%, at the above rates in all the configurations mentioned against point 10 and 11, in single wafer configuration. Uniformity, in ±x%, across all the wafers that can be loaded in a 6" wafer dome should be quoted. The ability to adjust source to target distance should be quoted as an option. Range of distances available should be included. The cost of demonstration of uniformity using any one of the metals above and/or a stack of Ti/Al/Ni/Au should be quoted for as an option.
19.	**Electron source-Target distance:** The thickness of Au that can be deposited with a single crucible load, mass to be specified, given the uniformity requirements above should be quoted. The aim of this point is to estimate the number of runs between source loading and efficiency of Au usage.
20.	**Materials to be deposited and typical rates:** Au, Ti, Ni (2 Å/sec), Ta (1Å/sec) and Al (5 Å/sec).
21.	**Uniformity:** Technical bid should include uniformity in ±x%, across a 6" wafer in single configuration, across wafers in a dome configuration and run to run variation, that will be demonstrated as part of the acceptance test criteria.
22.	**Cycle time:** Given point 14 above the cycle time expected from loading to unloading for a single 6" wafer for deposition time of Ti/Al/Ni/Au of 20/120/30/50 nm thickness should be quoted and demonstrated during acceptance.
23.	Given the system configuration – source to substrate distance – at which the cycle time above can be demonstrated, it should be ensured that electron bombardment of the substrate is kept to low enough levels such that it does not affect resists that are sensitive to this effect.
24.	**Target dome:** In the case of multi wafer options a dome fixturing that ensures an angle of incidence yielding the required uniformity and for lift off processes should

	be included.
25.	**Target dome:** Rotation and its degrees of freedom should be specified. A planetary rotation capability that allows for conformal coatings should be quoted as an option
26.	**Target variable angle fixturing:** If available should be quoted as an option.
27.	**Thermal resistance source:** The cost of optional thermal resistance sources for refractory materials such as Ta should be included as an option.
28.	**Deposition rate monitoring**: Quartz crystal monitors should be provided to monitor deposition rates at the substrate plane. In addition, quartz crystal monitors should be provided, as option, above the source plane and below the shutter to stabilize evaporation rates prior to exposing the substrates to the metal flux.
29.	**Deposition rate monitoring:** Number of sensor heads in the QCM should be provided. The system should have the capability if switching sensors should there be failure in the middle of a run to ensure prevention of loss of the run itself.
30.	**Shutters**: A suitable shutter mechanism should be provided above the source plane or below the substrate plane to isolate the substrate during the period of flux stabilization. In the case of
31.	**Gas flow**: 3 gas flow lines with a single mass flow controller and suitable valving should be provided for flushing the chamber. This should be quoted on a per line basis as an option. We expect a requirement for Ar, O_2 and N_2.
32.	**Hearth**: The hearth needs to be able to house up to 6 evaporation sources. While a crucible volume of 25 cc is preferred, for the crucible volume being quoted, the total thickness of deposition of each of the above metals on a 6" wafer for a single charge should be mentioned in the technical bid.
33.	**Hearth:** A system that prevents or minimizes cross contamination of material from one pocket to another is desirable and if available its description should be included in the technical bid. A photograph that shows how cross contamination is reduces would be desirable.
34.	**Hearth:** Crucible liners should be quoted as an option.
35.	**Shields:** Two sets of removable shields should be provided to minimize deposition on chamber walls.
36.	**Ion beam:** An ion beam, neutralizer and its details for pre-deposition cleaning and deposition should be quoted as an option.
37.	**System control:** All important machine parameters should be controlled through a PLC and accessible through a touch pad human machine interface (HMI) or a laptop. A list of parameters that are logged and/or controlled should be included in the technical bid.
38.	**System control:** In the automated load lock option, programming of different deposition recipes to be implemented on different wafers in the automated cassette as and when they are loaded into the chamber should be allowed and quoted as an option if not included in the software already. For instance one should be able to deposit Au on Wafer 1 in the cassette and Ni on Wafer 2 in the cassette.
39.	**System control:** A list of all safety interlocks available on the system and the cause/effect diagram that summarizes these safety features should be part of the technical bid.
40.	**Process recipes:** Process recipes for deposition of the said metals and other should be provided and should be programmable through the HMI. Vendors who have

	optimized process recipes and demonstrate these during installation will be preferred. The combination of electron beam parameters, metal and metal holders that result in consistent evaporation with consistent lifetime of crucible from specified sources is available with the vendor for the said system, should be listed in the technical bid. Vendors who can provide such information will be preferred.
41.	**Process Simulation:** Vendor should indicate in the technical quote if whether vapor cloud modelling and mask design, for the required throw distance needed for <2% thickness and sheet resistance uniformity, is feasible for a film of a single metal and the heterostructure in point 16. If the uniformity can only be demonstrated using a single metal, its vapor cloud and a suitable mask, the expected non-uniformity on the other layers given this configuration should be included in the technical bid.
42.	**Mask Sets:** Given the above two sets of masks should be included in the commercial bid.
43.	**Process on III-V semiconductors:** Capability of the substrate holder with handling III-nitride heterostructures on Si (given that the wafers are fragile) should be addressed.
44.	**View ports**: The system should have view ports, suitable shuttered and bolted to the system through conflat metal seals that allow for monitoring of sources (mandatory) and substrates (optional) should be provided. As part of the technical bid the location of these ports should be indicated.
45.	**Leak test port and He leak integrity:** The system should have a He leak integrity of $4x10^{-9}$ sccs of He or better and should have an easily accessible He leak test port for trouble shooting.
	Common Terms and Conditions
46.	**SEMI Standards:** The technical bid should include details of the SEMI standards the tool confirms to.
47.	**Clean Room Compatibility:** The system should be compatible with better than class 1000 cleanroom environment.
48.	**Shipping:** On all systems the cost of shipping up to IISc should be included. IISc will help with customs clearance at Bangalore Airport. Please include your payment option. IISc would prefer to retain at least 20% of payment till instruments have been commissioned and successfully demonstrated.
49.	**Tool Qualification and Acceptance**: Commissioning shall involve demonstration of growth of single or multiple metal layers mutually agreed upon between the client and vendor and characterized by the client within time frames agreed upon. Given the requirements in the RFQ, 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. Please list a set of acceptance tests for on-site (vendor) inspection and after installation at IISc.
50.	**Tool Training:** The bid should include as an option the cost of training personnel on site before shipment and post installation at IISc.
51.	**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.**
52.	**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.
53.	**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 and should be described in the technical bid.
54.	**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.
55.	**Maintenance:** System operation, process and troubleshooting manuals and detailed drawings are a must. Their inclusion must be indicated in the technical bid.
56.	**Online support:** System should have the capability for online diagnostics from a remote location in case of tool problems.
57.	**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.
58.	**Shipping:** On all systems the cost of shipping up to IISc should be included. IISc will help with customs clearance at Bangalore Airport.
59.	**Payment Terms and Conditions:** On all systems the payment terms should be specified in the technical and commercial proposal and is subject to negotiation. Please include your payment option. IISc would prefer to retain at least 20% of payment till instruments have been commissioned and successfully demonstrated.
60.	**References:** Bidders should provide details of other locations in India with similar tool installations.
61.	**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.
62.	**Company financials:** 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 accounted. Income Tax return for assessment year – 2017-18, 2018-19 and 2019-20.
63.	The following documentation should be provided. ISO9001 quality certification. CE marking confirmation.
64.	**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.

Details to be provided in addition to other utility requirements the tool may require. If not applicable mark as NA: Not applicable.

				Electric		**Chilled Water**		**Gases**																**Exhaust**	**Thermic load**
Tool Foot Print, (LXBXH)			Area	Power consumption average	Peak power	Cooling capacity maximum	Cooling Water Process	UHP Nitrogen	UHP Hydrogen	Dopant Silane	Pure Silane	Ammonia	Chlorine	He	Oxygen	Regular Nitrogen	CF4	CHF3	SF6	NO2	BCl3	Argon	Forming Gas		Thermic load to clean room
L (mm)	B (mm)	H (mm)	Sq. Metre	kW	kVA	kW	l/h	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	m^3/h	kW