

May 4th, 2018

To Whom It May Concern

Limited Tender for a Carrier Trap/Recombination Lifetime Measurement System

This is an RFQ (Request for Quote) for procurement of a contactless trap/recombination lifetime measurement system as part of an limited tender for the Centre for Nano Science and Engineering (CeNSE) at IISc, Bangalore.

CeNSE is a multidisciplinary research department at IISc that houses a 14,000 sq. ft. cleanroom and characterization facility used by 50 faculty members from various disciplines at IISc. CeNSE also runs a program called Indian Nanoelectronics Users Program (INUP) which has allowed 4200 participants from more than 700 universities and institutes all over India to use the facilities at CeNSE. Consequently, any tool in CeNSE receives significant exposure to scientific community at IISc and beyond. The vendors are requested to factor in the value of this exposure in to their quotes. Details of existing facilities and INUP program can be gleaned from:

<http://nnfc.cense.iisc.ac.in/>

<http://www.mncf.cense.iisc.ac.in/>

<https://www.inup.cense.iisc.ac.in/>

Also, CeNSE hosts equipment on behalf of vendors, as a national standard or 'model' system. If the vendor is interested, CeNSE can consider working out a similar arrangement for the lifetime system.

Procedure

1. Vendors will be required to submit a technical proposal and a commercial proposal in **two separate sealed envelopes**. Only vendors who meet the technical requirement will be considered for the commercial negotiation.
2. **The deadline for submission of proposals is the 28th of May 2018, 5:30 pm Indian Standard Time.** Proposals should arrive at the office of Dr. Sushobhan Avasthi, TF-06, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore 560012, India, by the above deadline.
3. The decision of purchase committee will be final.
4. The technical proposal should contain a compliance table with 5 columns. The first column must list the technical requirements, in the order that they are given in the technical configuration below. The second column should describe your compliance in a "Yes" or "No" response. If "No" the third column should provide the extent of the deviation (please provide quantitative responses). The fourth column should state the reasons for the deviation, if any. The fourth column can be used to compare your tool with that of your competitors or provide details as requested in the technical requirements table below.
5. 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.

6. Vendors are encouraged to highlight the advantages of their tools over comparable tools from the competitors
7. If multiple systems can fulfill the requirements, vendors can submit multiple bids.
8. In the commercial bid, please provide itemized cost of the system and *required* accessories, such as software, power supply, etc.
9. 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.
10. The quotes should be CIF Bangalore, India. So please include cost of shipping.
11. Please indicate the warranty provided with the tool. Warrant of 3 years of more is preferred.
12. Provide itemized cost for *required* spares for 2 years of operation. For sake of this calculation, the vendor may assume active tool usage of 20 hours/ week. This number will be used to estimate the life cycle cost of the tool.
13. Clarify if periodic (preventive) maintenance be done by a trained on-site engineer or requires a specialist from the OEM.
14. If maintenance requires OEM, as an additional option, provide cost of an annual maintenance contract (AMC) for 3 years, post warranty. The AMC must cover 1 scheduled and 1 emergency visit per year. It must also indicate who will service the AMC, an Indian agent or the OEM. The AMC cost must also include an itemized list of spares that are essential for the scheduled visits.
15. The RFQ must include references of 3 previous installations, preferable in India. Please provide the names and contact addresses of the referees, so that the committee can contact them independently.
16. Any questions can be directed to Dr. Sushobhan Avasthi, TF-06, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore 560012, India. (savasthi@iisc.ac.in)

Technical Requirements

1.	Primary application	<ul style="list-style-type: none"> • Measure trap/recombination lifetime (τ) of carriers in a semiconductor as a function of minority carrier density (n) without using any contacts (contactless measurement). Preferably from the minority carrier decay transients. • Must conform to some SEMI standard for recombination lifetime measurement, e.g. SEMI PV9-1110, PV9-1215, SEMI PV13-0714, SEMI MF1535-1015, etc.
2.	Secondary application	<ul style="list-style-type: none"> • Track cross-contamination in cleanroom equipment such as CVD, thermal oxide furnace, doping furnace, etc. • (Optional but preferred) Ability to differentiate between trap and recombination lifetime.
3.	Range/ Sensitivity	<ul style="list-style-type: none"> • Recombination/Trap lifetime: 10 ns to 10 ms with repeatability of +/- 5% • Detectable range of minority carrier density: 10^{12} to 10^{18} cm^{-3}

4.	Sample dimensions	<ul style="list-style-type: none"> • Semiconductor thickness: 0.1-1000 μm. • Sample area: 0.5 cm^2 to 6" wafer. The measurement system must map the sample area with a resolution of 1 mm^2.
5.	Measurement speed	<ul style="list-style-type: none"> • Less than 5 min for 6" wafer for single shot measurement with 1 mm^2 resolution • Less than 1 min for 100 measurements at the same spot.
6.	Semiconductor and sample details	<ul style="list-style-type: none"> • (Required) Measure lifetime in GaN, GaAs, Si, Ge, and MAPbI₃, other semiconductors with bandgaps in between these. Bandgap range (3.5 eV to 0.7 eV) • (optional but strongly preferred) Any semiconductor upto 5.0 eV. CeNSE has a free-space 266 nm laser. Ability to interface this laser with the system is a plus.
7.	Substrate	<ul style="list-style-type: none"> • Substrate may be insulating, e.g. glass or sapphire; semiconducting, e.g. Si; or conductive e.g. as ITO glass or steel. • Must be able to measure recombination lifetime on finished solar cells (with both electrodes and active layers) and unfinished solar cells (with active layers but one of more electrodes missing).
8.	Measurement modes	<ul style="list-style-type: none"> • The instrument should extract the recombination lifetime, trap lifetime, and implied V_{oc}. • For microwave-based systems, both in-phase and quadrature modes must be separately reported. • Non-microwave systems (that use eddy current of RF coils) must clarify if equivalent capability exists in their systems
9.	Extra capabilities.	<p>Mention which of the following can be integrated with the system. Mention each as a option in the commercial bid.</p> <ul style="list-style-type: none"> • (optional) Bias-light • (optional) Resistivity measurement • (optional) Substrate heater • (optional) Lifetime measurement under applied bias, to extract a pseudo J-V characteristic. Similar to a Suns-VOC experiment. • (optional) Spot-size variation, to change resolution of the measurement.
10	Excitation source	<p>Most contactless systems use a laser as the excitation source.</p> <ul style="list-style-type: none"> • (Required) The system must come integrated with 3 lasers a ~ 900 nm laser for Si, ~ 600 nm laser for GaAs, and ~ 400 nm laser for wide bandgap materials. • (Optional) As a option, mention the cost of a ~ 350 nm laser that can probe GaN

		<ul style="list-style-type: none"> (Optional) Ability to interface with external pulsed fiber and free-space lasers. Please provide details of how the external laser will be interfaced with the system. What is the limits of the laser (power, pulse energy, etc.) that can be safely interfaced with the system.
11	Data Acquisition	<ul style="list-style-type: none"> The system should have completely automated data acquisition. The data should be digitally acquired and stored on a computer for easy extraction. The price should include all the accessories required for data acquisition.
12	Footprint & weight	<ul style="list-style-type: none"> The system should a table-top system that can be easily accommodated research laboratory. Please specify the total foot print in cm x cm, and weight.
13	User Interface	<ul style="list-style-type: none"> The system must be highly automated and preferably be in a plug-and-play condition at delivery. The software must allow varying levels of instrument access. A simplified basic access for a user to a full access to an engineer. Interlock that can interface with the online reservation system, so that the tools can only be used by authorized users.
14	Maintenance and Calibration	<ul style="list-style-type: none"> The system should require minimal maintenance. Any accessories needed for calibration, e.g. standard samples, should be mentioned in separately the itemized quote. The system is expected to be placed in a class 10000,1000/100 cleanroom, so it must be compatible with that environment. Mention the recommended preventive maintenance schedule for the system. Can the preventive maintenance be done by a trained on-site engineer or requires a specialist from the OEM? If the latter, please provide cost of a 3 year AMC with required kit/consumables. It is preferable, if the system can be supported by a trained local representative
15	Training	<ul style="list-style-type: none"> Please provide itemized cost of user training, either on-site or at OEM If periodic maintenance can be done by the on-site engineer, please include the cost of training the engineer.
16	Power & utilities	<ul style="list-style-type: none"> The instrument should work at 220-240V 50 Hz AC power Mention the power requirement. Mention any utility requirement (water, air, exhaust, etc.)
17	Safety	<ul style="list-style-type: none"> Mention any special safety requirement of the tool

		<ul style="list-style-type: none">The tool must come with a complement of interlocks to prevent common user errors.
18	Recommendation	<ul style="list-style-type: none">The system must submit references from atleast 3 previous installations, preferably in India.The names and contact addresses of the referees must be submitted with the proposal, so the purchase committee can contact them independently.
19	Pre-purchase testing	<ul style="list-style-type: none">To ensure the equipment conforms for specifications, the committee requires the vendor to perform some standard tests <i>before</i> the purchase process is complete. The validity of the tender will hinge on the successful and accurate measurement of these test samples.The vendor must conclude the testing and submit the data within 1 week of receipt of samples.
20	Installation	<ul style="list-style-type: none">The system must be installed at NNfC cleanroom, CeNSE, Bangalore.
21	Acceptance tests	<ul style="list-style-type: none">Ability to measure lifetime in bare Si, thermal-oxide-coated Si, and epitaxial GaN, using all the integrated lasers. Samples to be provided by CeNSEInterface an external free-space laser with the system. Laser to be provided by CeNSEInterface an external fiber laser with the system. Laser to be provided by CeNSEDemonstrate lifetime mapping on 6" bare Si, finished Si solar cell. Samples to be provided by CeNSEDemonstrate working of all the optional accessories.

Thanking you,



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