SPECIFICATION SHEET

Supply, installation and starting-up of a time-of-flight secondary ion mass spectrometry (ToF-SIMS) system for the Pilot Line PIXEurope at ICFO

FILE NUMBER: ICFO-2026-005

CLAUSE 1. Object of the contract

The purpose of this contract is the supply, installation and commissioning of a “Supply, installation and starting-up of a time-of-flight secondary ion mass spectrometry (ToF-SIMS) system for the Pilot Line PIXEurope at ICFO for ICFO’s laboratory.

The types of items supplied are linked to the CPV (Common Public Procurement Vocabulary), **38000000-5** Laboratory, optical and precision equipment (except glasses).

CLAUSE 2. Needs to satisfy

Time-of-flight secondary ion mass spectrometry (ToF-SIMS) system is an important microscopy technique for physics, chemistry and general materials science. The system must provide high-resolution surface chemical analysis capable of detecting and mapping elemental and molecular composition at the nanometer scale, enabling verification of each layer of a semiconductor device and ensuring the absence of contaminants that could affect functionality.

The system will be used as a ToF-SIMS system for the following applications:

- Failure analysis: contamination identification, delamination or adhesion failure, residue mapping
- Interface characterization: layer-by-layer chemical profiling, interdiffusion or contamination tracking, oxide and passivation layer analysis
- Materials study: surface composition and mapping, thin film analysis, dopant and impurity profiling, nanomaterials, quantum dots and particles study

For these applications the system must allow to perform:

- Surface mass spectrometry measurements
- Surface chemical imaging
- Depth profiling measurements
- 3D analysis
- Focused Ion Beam (FIB) for in-depth measurement and tomography
- Scanning probe microscopy to measure topography and other properties

CLAUSE 3. Technical requirements

Technical proposal structure

The proposal has to follow as much as possible the structure of this technical requirements document to facilitate evaluation. Any optional accessories not included in the proposal will have to be put in a separate section, and not mixed with the included items.

1. Machine / Process overview

The system must be equipped with three columns hosting 5 different ion sources (Bi, O2, Cs, Ar ang Ga), allowing different applications without any system modification, i.e., primary ion beam for ToF-SIMS, ions for depth profiling and sputtering with different energies and a Ga source for focused ion beam. It should allow to measure different sample forms and sizes; the measurements should be reproducible, implying a stable ion energy and reduced drift with time.

All the following technical specification should have already been proven by results obtained with the system. These data should be included into the technical presentation of the system. The system can host refurbished optional items, excluding the basic unit ToF SIMS system, the vacuum system, the primary ion beam and the analyser.

2. Column for primary ion beam
   a. The system will be equipped with a column hosting a LMIG Bi-Mn cluster ion emitter used as a primary ion beam for high mass resolution surface spectrometry and 2D and 3D imaging as well as high performance depth profiling
   b. The maximum beam energy must reach 30 keV and the maximum DC ion current 40 nA
   c. The system must include piezo controlled beam defining aperture
   d. Ion beam aligning apertures
   e. Internal analysis current measurement system for automated beam centring and current control
   f. Differential pumping by turbomolecular pump and a service valve for separate venting of the source
   g. High voltage power supplies fully computer controlled
   h. Electrodynamic mass separation for precise cluster selection

3. Column for low energy depth profiling and fast sputtering

   a. This column must contain two optical ion sources: an electron impact ion source and a thermal ionization Cs ion source
   b. The system must include vacuum coil unit controlled switching of gases for the electron impact source
   c. Ion beam aligning apertures
   d. Internal sputter current measurement system for automated beam centring and current control
   e. Differential pumping by turbomolecular pump and a service valve for separate venting of the source
   f. High voltage power supplies fully computer controlled

4. Column for sputtering and FIB

   a. This column should contain an Ar gas cluster ion source for sputtering and a Ga ion source for FIB
   b. Differential pumping by two turbomolecular pumps, including water chiller for the first pump, and a service valve for separate venting of the source
   c. High voltage power supplies fully computer controlled
   d. It should be possible to use the Ar gas as primary ion beam for ToF-SIMS measurements with energies down to 2 eV per cluster atom

5. Analyser

   a. Non-linear reflectron type ToF analyser with higher order energy focusing
   b. At least 10 kV post acceleration optics
   c. Combined microchannel plate, scintillator and photomultiplier ion detector
   d. Multistop time-to-digital converter allowing for repetition rates up to 50 kHz
   e. Extended dynamic range unit inside the analyser for high-speed and mass-selected attenuation of secondary ion signals.
   f. Delayed extraction mode, allowing mass resolution (m/Δm) above 10000 in combination with lateral resolution below 100 nm
   g. Includes hardware and software for high speed and mass-selected secondary ion package rerouting via two different attenuation pathways
   h. A pulsed high-quality Everhart-Thornley secondary electron detector for primary ion induced secondary electron imaging

6. Scanning probe microscopy module

a. Cantilever-based scanning probe microscope (SPM) for common SPM modes, such as contact, non-contact and intermittent contact topography measurements
b. Possibility of applying a tip bias for electronic characterization
c. Combined sample holder navigation for ToF-SIMS and SPM for correlative measurements
d. Fully linearized and calibrated scanner
e. System for exchanging and adjusting cantilevers under vacuum conditions, including a vertically positioned camera
f. Parking position for the cantilever holders into the vacuum and special holder for transferring the cantilevers into the vacuum
g. Lock in amplifier with the possibility to deconvolute different signal frequencies for advanced SPM modes such as electric force microscopy and kelvin probe force microscopy
h. Conducting AFM module, including a current amplifier, for measuring currents between the tip and the sample
i. Separate high-resolution microscope for precise pre-adjustment of the cantilever on the holder outside the system
j. Dedicated software to control the SPM mode

7. Sample stage and navigation

a. Motorized four-axes UHV piezo sample stage with precise sample positioning at the ToF-SIMS and the SPM analysis position
b. Fast and encoder-controlled sample movement with speeds up to 10 mm/s
c. Two high-resolution TV cameras for direct sample observation and rapid location of the area of interest at the TOF-SIMS analysis position
d. Photo box for high-resolution sample navigation, including a high-resolution camera and indirect sample holder illumination for maximum reflection suppression
e. Piezo motor controller, joystick, PC interfacing, and navigation software package

8. Sample holder and temperature control

a. One sample holder for rear mounting of up to 18 samples dimensions up to 10 mm x 10 mm x 8 mm
b. One sample holder for top mounting of multiple samples on an area of 100 mm x 80 mm with thicknesses up to 20 mm
c. One special sample holder for Hot/Cold (H/C) operations
d. Temperature controlled resistive heating and direct liquid nitrogen (LN2) circulation cooling system for the main chamber. Temperature controlled heating and cooling of the loadlock.
e. Cryogenic storage pump and LN2 pump
f. High precision PID temperature controller with PC interface
g. Mounting accessories

9. Vacuum system

a. A fully safety interlocked ultra-high vacuum (UHV) system with a buffer technology for low noise and cost-efficient operation. The base pressure of the system should reach 3e-9 mbar, or lower.
b. A UHV analysis chamber for a wide variety of configurations, including support for three ion columns with up to five different ion sources
c. Turbomolecular pumps to efficiently keep the UHV
d. Titanium sublimation pump for the main chamber hosting three Ti filaments, supporting automatic baking and interchanging of the filaments. It has to be controlled by the vacuum control unit
e. An internal bake-out system for the UHV analysis chamber

f. Load-lock chamber to rapidly introduce the sample in the system, with a dedicated internal bake-out system able to remove poor vacuum overnight
g. Pressure controlled leak valve and nozzle for sample gas flooding during analysis. This includes automated gas switching by the vacuum control unit (VCU).

10. Focused Ion Beam (FIB)

a. The FIB will be operated with a Ga source. It will deliver FIB milling and tomography capabilities
b. The Ga source can be mounted in the same column as the Ar ion source
c. It should be possible to use the Ar source as a FIB source for organic FIB applications
d. The system should include an additional pulsed secondary electron for full visualization of the milling process

11. Charge compensation

a. The system must include a self-adjusting charge compensation system using a pulsed, low energy electron flood gun to neutralize positive sample charge
b. The energy of the electrons should be in the range 1-300 eV and should be adjustable by computer control
c. Higher electrons energy ranges should be selectable for materials which don't suffer from beam damage

12. PC and software

a. PC with two 24'' flat monitors and windows 11 installed
b. Two software licenses to run one on the measurement computer, the other on another offline PC
c. Includes all the software necessary for the measurements and tools described above

CLAUSE 4. Power distributions and safety

- The system should be configured for EU (Spain) power grid (voltage, sockets, etc.) and be CE marked.
- The system will be fully protected against unexpected power cuts and, in that case, will be fully safe for the operators. A quick and easy turning on of the system has to be possible after a power cut.
- Component wiring routed to a centralized power distribution panel.
- EMO protection.
- Appropriate hardware and software safety interlocks. Extended error diagnostics.
- The system will be fully protected against unexpected power cuts and, in that case, will be fully safe for the operators. A quick and easy turning on of the system has to be possible after a power cut.

CLAUSE 5. System layout and services

- The proposal will include a complete set of pictures, drawings and layouts of the system, including dimensions, location and details of the different components.
- The proposal **will include full installation and start-up requirements (Unpack all system components; Assembly; Pump; Run system to helium liquid production ratio; During the installation process, instruction should be provided on proper procedures for operation and maintenance of the system)**, clearly specifying connection type, tubing materials, pressures, flows, etc, for the specific configuration of the offered system.
- A set of documentation should be delivered in English or Català/Spanish including the following topics:

- Complete set of manuals, drawings, schematics and layouts about system assembly and configuration (mechanical assembly, vacuum system layouts, electrical schematics, system modules interconnection, etc)
- Complete system user manual, including routine servicing, troubleshooting and basic repairs
- System components spare list, specifying quantity, manufacturer, part number, etc
- All the above documentation will be supplied in English, in electronic format (CD/DVD) and in paper copy.
- In case the system hosts refurbished optional items, they should be explicitly specified in the proposal. When possible, it should be detailed which refurbishment process they have been through.

CLAUSE 6. Transportation, installation, start-up and training

- The proposal will include transportation to ICFO's facilities including insurance and all export/import and customs duties. **DAP incoterm will apply.**
- The machine will be placed in the designated location by ICFO. The contract winner shall cover all costs, organization, and coordination related to the placement, including the provision of any required specialized equipment or vehicles, as well as any necessary component disassembly and reassembly for unloading and transportation inside the building, strictly following the route specified by ICFO.
- The machine will be equipped with its own wheels to facilitate transportation and with leveling pads to ensure a stable and properly leveled position once installed.
- Depending on the size, machine crate may need to be disassembled outside ICFO building. The contract winner will be responsible for taking accurate measurements of the transportation route outside and inside ICFO and plan in advance any required component dis-assembly and re-assembly. The contract winner will be responsible for checking the selected location and for taking any required measurements to guarantee the suitability of it for the offered system. The compatibility with the operation of the systems already installed in the lab and the mobility of users will have to be guaranteed as well. The system will be installed in a provisory location and should be moved within a duration of 4 years in a definitive laboratory. The contract winner will take care of the move to the final destination.
- Installation and start-up of the system, including system checking, functional tests and process qualification
- The contract winner will be responsible for the removal and proper disposal of the packaging when the machine is delivered and unpacked, or its storage during the warranty period in case the original packaging needs to be kept.

Process qualification

The flowing specifications will be demonstrated at the factory before shipment and at the side at the installation:

- The mass resolution specified in the proposal will be demonstrated using an Si wafer for mass 29 u and crystal violet (372 u) for higher mass. The mass accuracy will be demonstrated using a contaminated Si wafer.
- The mass range specified in the proposal will be demonstrated using a gold coated Si wafer.
- The sensitivity specified a in the proposal will be demonstrated on technical Al foil after pre-sputtering by oxygen.
- The specified signal-to noise ratio R = I(28Si+)/ I(28.5 u) will be demonstrated on an un-sputtered Si wafer in spectrometry mode.
- Maximum count rate within linear response will be demonstrated with standard TOF analyser and with EDR analyser.

- The operation of the charge compensation system will be demonstrated using a thick (app. 1 mm) PET sample. Positive and negative polarity SIMS spectra with good mass resolution will be obtained.
- For the SPM attachment the scan range will be demonstrated.
- The sputter mode with gas ion source operated with Argon or Oxygen will be demonstrated by measuring current in a Faraday cup in DC mode. Beam diameter is demonstrated by evaluating a line-scan from an SE image of a test sample (20% to 80% definition is used). The same for the sputter mode with Cs ion source and the gas cluster source.
- For analysis mode the primary ion pulse width of the gas cluster source will be determined by measuring the peak width of the H- peak in the secondary ion (SI) spectrum. The primary ion current is measured in the Faraday cup.
- The Ga focused ion beam will be characterized by measuring the ion current in the Faraday cup in DC operation. Beam diameter will also be demonstrated by evaluating a line-scan from an SE image of a test sample (20% to 80% definition is used).
- The heating and cooling in the analysis chamber will be demonstrated to have a range between -130ºC and 600ºC

CLAUSE 7. Warranty and Follow-on Support

- **1-year Full Warranty** on all parts and components of the system irrespective of the manufacturer. The warranty will include the replacement of any faulty or damaged part(s) during normal use of the system, no matter the manufacturer of the component(s). It will cover any cost related with the disassembly, transportation, reparation and re-assembly of the damaged component(s), including all travelling and living costs of the required service engineer(s). An on-site repair, or a justified alternative to reduce the system down time to the minimum, will always be the first service option. A team of properly qualified and skilled service engineers will have to be available.
- System lifetime support:
- By phone and e-mail with a response within 3 hours
- Emergency visit after a system breakdown within 10 working days
- Spare parts will be available during, at least, 10 years after system supply and, in case of failure, will be delivered within 10 working days
- An estimation of the cost of a warranty extension or available support contract options after warranty period will be included

CLAUSE 8. Training

- The contract includes training for ICFO staff. A minimum of 3 days of mandatory training for ICFO staff is established, and an increase in the number of training days will be evaluated. The training will cover both the operation of the system and the use of processes for ICFO users at ICFO facilities, as well as specific maintenance and advanced service training for ICFO laboratory technicians.

CLAUSE 9. Delivery and Installation Time

The machine should be delivered within **18 months starting from tender assignment.**

For the purpose of this tender, delivery time is defined as the period from the purchase order (PO) issuance until system delivery at ICFO facilities, including manufacturing, transportation, installation, and acceptance tests.

At the same time as the delivery of the equipment, the contractor must deliver the technical documentation and manuals indicated in clause 5.

Installations record

- Such a system must have been fabricated at least 3 times by the same provider in the last 3 years, with a proven record of installation. The record list should be provided upon request.
- For these systems, compliance with the specifications set out in paragraph "Process qualification" (clause 6) must be demonstrated in the phase of installation and start-up.

CLAUSE 10. Target price

- The target price for the system is 1.550.000,00 € (VAT excluded).

- Payment terms:
  - Payment on order - 30% total price
  - Payment on delivery, commissioning and training - 70% total price

CLAUSE 11. Environmental clause

It is hereby stated that, in compliance with the provisions of the Recovery Plan, Regulation (EU) 2021/241 of 12 February 2021 establishing the Recovery and Resilience Facility, and its implementing regulations, in particular Commission Communication (2021/C58/01) Technical guidance on the application of the principle of "do no significant harm", as well as the requirements of the Council Implementing Decision concerning the approval of the assessment of Spain's Recovery and Resilience Facility (RDF), all financed actions carried out under this contract must respect the principle of not causing significant harm to the environment (the "Do No Significant Harm" principle). This includes compliance with the specific conditions set out in component 17, measure I1, under which this contract falls. During the execution of the actions covered by the contract, no significant damage will be caused to the environment, in accordance with Article 17 of Regulation (EU) 2020/852.

The activities carried out will not cause direct environmental impacts, nor will they have primary indirect impacts throughout their life cycle, understood as those that may materialize once the activity has been completed.

The activities carried out by the successful bidder under this contract will not generate waste that, in its long-term disposal, could cause environmental damage, as this is one of the situations excluded from funding by the Recovery, Transformation and Resilience Plan, in accordance with the Technical Guidance on the application of the principle of "not causing significant harm" under the Regulation on the Recovery and Resilience Facility (2021/C 58/01), the Council's Proposal for an Implementing Decision on the approval of the assessment of Spain's recovery and resilience plan, and its annex. The activities carried out by the successful bidder will be adapted, where appropriate, to the characteristics set for the measurement and sub-measure of the assigned component, and reflected in the Recovery, Transformation and Resilience Plan.

The activities carried out will comply with all applicable environmental regulations in force.

For the transport, installation, and commissioning of the equipment covered by this contract, the contractor will implement waste minimization measures and, should any waste be generated, will be responsible for its collection, preparation for reuse, recovery, or recycling, or appropriate treatment.

Methods for monitoring and controlling compliance with the conditions

With regard to compliance with environmental and social requirements, the contractor remains obligated to:

- The contractor must sign, before the contract is formalized, the declaration of commitment regarding the implementation of actions under the Recovery, Transformation, and Resilience Plan (RTRP) and compliance with the principle of not causing significant harm to the environment, included as Annex of the Special Administrative Clauses.

- Issue a manual detailing the dismantling instructions for the equipment, including the reuse, recovery, or recycling operations, or appropriate treatment, including the disposal of fluids and selective treatment, applicable to each of the materials or parts that comprise it. The manual must include a table summarizing, expressed as a percentage by weight, the expected fate of the materials that make up the equipment at the end of its useful life, according to the following options: reuse (including recovery and recycling), energy recovery, and rejection/disposal.

- For the transport, installation, and commissioning of the equipment covered by the contract, the contractor will implement waste minimization measures and, should any waste be generated, will be responsible for its removal and management.

Castelldefels, on the date of its digital signature

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