

SPECIFICATION SHEET

Supply, installation and starting-up of a Plasma Enhanced Chemical Vapour Deposition system for the Pilot Line PIXEurope at ICFO

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CLAUSE 1. Object of the contract

The purpose of this contract is the “Supply, installation and starting-up of a Plasma Enhanced Chemical Vapour deposition 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

The system will be used as a deposition system of high-quality films of SiO_2 and SiN_x for the PIXEurope Pilot line at ICFO.

The deposition is especially critical for low temperature deposition (between 80 to 100°C) in order to maintain electronic and photonic properties of active material used at ICFO within the project.

The system will be used for the following applications:

- Fabrication of dielectric and passivation layers for photonic devices
- Development of multilayer thin-film stacks
- Research on SiO_2 and SiN_x stress control and interface quality
- Surface passivation and encapsulation of optoelectronic devices

For these applications the system must allow to perform:

- Gas based chemical vapour deposition of SiO_2 and SiN_x .
- Liquid based chemical vapour deposition of SiO_2 and SiN_x .

The system must allow high uniformity, high repeatability, and precise control of film properties such as thickness, refractive index, and intrinsic stress.

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.

Machine / Process overview

The system will be used for chemical vapour deposition and whose characteristics should show:

- PECVD deposition of SiO_2 , SiN_x using gas and liquid precursors
- RF plasma source with a wide range of power
- Ability to deposit good quality films at temperatures down to 80°C
- Very good uniformity and reproducibility on substrates up to 200 mm diameter
- Possibility to control the stress of the deposited film.
- Process automation with programmable multi-step recipes

It should allow to process different sample forms and size, from small square samples (few millimetres large) up to 8" wafers, thus requiring an adaptive sample handling.

The processes should be reproducible with time, and uniform within the sample area.

To comply these requirements the machine should show a precise control on the power (electrode) over the whole range and on the gas flows and a temperature control system to keep temperature of sample constant and uniform during deposition.

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.

1. Electrode RF power generator

- 1) The RF Generator must operate at a frequency of 13.56 MHz.
- 2) The electrode RF power generator must have a maximum delivered power of equal or major than 300 W, or more. The normal use will be 10–90% of the maximal value.
- 3) The RF generator must have an automatic matching unit.
Plasma source
- 1) A plasma source to produce high density plasma by coupling RF into plasma, with a frequency of RF power supply of 13.56MHz, and an automatic matching unit.
- 2) A cooling system is installed to cool the source while the plasma source works. Air-cooling type will be considered as acceptable.
- 3) Possibility to measure and visualize forwarded and reflected power to monitor them.
- 4) A second power source with a different frequency can be applied. A second power source with a different frequency will be considered as a desirable option, allowing for extended process control. If provided this second source must have a power of at least 300W.

2. Chamber and loadlock

- 1) Chamber made from aluminium.
- 2) Valves for vacuum system: butterfly auto pressure control valve (motor-driven, variable conductance type) for the reaction chamber, and a gate valve between the load lock and the reactive chamber.
- 3) A protective shield made of aluminium, with an automatic movement to enable it, synchronized with transfer arm.
- 4) A loadlock allowing a fast introduction of the sample into the processing chamber.
- 5) The loadlock operation should handle different sample size and shape, from small wafers/coupons up to 8" wafers. Their handling will be detailed in the corresponding section.
- 6) The loadlock should have a programmable purging cycle to ensure operators safety and chamber cleanliness.
- 7) A viewport with RF shield for visual inspection of the reaction chamber inside.

3. Cassette

- 1) A vacuum cassette must be implemented with tray-based wafer handling, with 10 trays, or more, and that will allow the processing of small wafers/coupons and/or 8" wafers.
- 2) The cassette must be made of metal.
- 3) The cassette chamber must be pumped down.

4. Electrode

- 1) Electrode structure will be parallel plate geometry. The upper electrode made of aluminium and the lower electrode of aluminium or stainless steel. Their diameter must be at least 260 mm, or more, in order to ensure a uniform deposition over 200mm diameter surface
- 2) Possibility to control the temperature of the electrodes by heating with resistive heater. Temperatures must reach a temperature of 200°C, or more, for the upper electrode and 400°C, or more, for the stage with a dynamic control of the set temperature and with temperature stability ± 1 K.
- 3) Allow to process samples of the following geometries:
 - Round wafers from 1inch to at least 8 inches diameter
 - Square samples from 10mm to 60mm side size and of 0.1mm to 1mm, or more, thickness
 - Rectangle substrates with length ranging from 10mm to 80mm and of 0.1mm to 1mm, or more, thickness.
- 4) Tray-based sample holder design, construction material and other details will have to be clearly specified in the proposal.

5. Vacuum pumping

- 1) Turbomolecular type main vacuum pumps properly sized for the characteristics of the main chamber, the pressure to be reached and the processes to be run. Automatic and safe controlled N₂ venting when doing a 'process chamber venting' or in case of a power cut. Manufacturer, model and full technical specifications will be included with the proposal.
- 2) Dry, low-noise backing pumps properly sized for the characteristics of the main chamber and the loadlock and for the processes to be run. With shut valve, exhaust silencer and hour counter. Manufacturer, model and full technical specifications will be included with the proposal.
- 3) The vacuum gauges will be a combination of Pirani and capacitance manometer with a range from 1×10^5 to 5×10^{-3} Pa or below.
- 4) The base pressure will be below 5×10^{-3} Pa.
- 5) Complete and safe venting of the main chamber has to be possible within ten minutes maximum after starting a 'process chamber venting'.
- 6) Complete and safe venting of the load lock chamber has to be possible within two minutes (2 min) maximum after starting a 'load lock venting'.
- 7) All pumps will have to operate with standard single phase 230V 50 Hz or 3x400V 50Hz electrical supply. Power transformer, if needed, will be accepted.

6. Gas delivery system

- 1) A minimum of 8 gas lines entries for the gas supply system, including bypass lines.
- 2) The system must have at least six MFC-controlled gas lines with particle filter and cut-off valve.
- 3) The system must have at least 2 bypassed gas lines for SiH₄ and NH₃.
- 4) The process lines will be orbitally welded stainless steel electropolished lines (1/4" diameter) coupled with VCR stainless steel connectors.
- 5) A system allowing purging the toxic gas lines should be included.

7. Liquid sources

- 1) A TEOS liquid source must be available for SiO₂ deposition. The tank to fill with precursor will be provided. ICFO will fill the tank through local material supplier.
- 2) A second liquid source must be available for SiN_x deposition. The tank to fill with precursor will be provided. ICFO will fill the tank through local material supplier.

8. Chiller

- 1) A chiller allowing to cool down the system to a temperature in the range of 20-25°C.
- 2) Cooling water supply may be needed for dry pumps also in the range of 20-25°C.

9. System control

- 1) Operation with software-controlled system via PC or by PLC (programmable logic controller).
- 2) System visualization of vacuum system, wafer presence, gas flows and all process settings. Recipe editor and manual and automatic process control allowing operation of the tool.
- 3) All functions will be interlocked to prevent unsafe operation or damage to the system, even during a power cut.
- 4) The software must allow the creation and edit of recipes setting the deposition parameters.
- 5) A log registry allowing to keep and save process data and to get a quick and comprehensive overview of all the process information.
- 6) A full description of the software (including a full user manual, screen captures, etc.) will have to be supplied with the system.

10. Chemisorber

- a. A chemisorber for the corrosive and hazardous gases that will be installed on the machine will be provided through another tender.
- b. The machine must be prepared to adapt to the future chemisorber

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. ICFO may take care of uncrating, unpacking, move-in, utility preparation and hookup. Before installation the provider will give clear specifying connection type, tubing materials, pressures, flows, etc, for the specific configuration of the offered system.
- The provider will dispatch engineers for system commissioning/training. During the installation process, instruction should be provided on proper procedures for operation and maintenance of the system.
- A set of documentation should be delivered in English 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/USB).

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 the provider of by ICFO. When applicable, the machine will be equipped with its own wheels to facilitate transportation and with levelling pads to ensure a stable and properly levelled position once installed.
- The allowable dimensions for the system are the following:

* for the main machine, including the liquid source cabinet: 2.6m (width) x 4m (length) x 2.4m (height). It must include the access necessary for maintenance to service engineer.



(the table on wheels on the picture can be removed)

* other components, such as dry rough pumps, or eventually power transformers, chillers can be placed on the service area and does not have to be included in this area.

- Depending on the size, machine crate may need to be disassembled outside ICFO building. The contract winner will be responsible to check compatibility of transportation route outside and inside ICFO. ICFO will provide dimensions info of building for system move-in. 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.
- Installation and start-up of the system, including system checking, functional tests and process qualification

- ICFO will take care of 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:

300 nm thick SiH₄-based SiO₂ film deposition on 8" diameter bare silicon wafers

- **Within-wafer thickness uniformity**

Criteria: within +/- 5% (edge exclusion = 5 mm)

- **Wafer-to-wafer thickness uniformity (ten consecutive runs)**

Criteria: within +/- 5% (based on average value of within-wafer uniformity)

The measurements should be done on 9 points:

1 : center

6, 7, 8 and 9: wafer edges (edge exclusion = 5 mm) on crossed diagonal lines (not on orientation flat)

2, 3, 4 and 5: middle points between wafer center and wafer edge spots

CLAUSE 7. Warranty and Follow-on Support

- **3-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 (while operated and maintained according to provider instructions), 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. The consumables will not be covered by the warranty.
- System lifetime support:
 - By phone and e-mail with a response within 3 hours, in business days
 - Emergency visit after a system breakdown within 10 working days, as soon as the provider and customer agree that onsite visit is needed.
 - 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 when available at provider side. If current spare parts model is discontinued, the provider must offer alternative.
- An estimation of the cost of a warranty extension or available support contract options after warranty period will be included

CLAUSE 8. Training

- The contracting company will be obliged to provide two days of training. Training will cover both system operation and process use for ICFO users at ICFO facilities, as well as specific maintenance and advanced service training for ICFO lab technicians.

CLAUSE 9. Delivery and Installation Time

The machine should be delivered within **EIGHTEEN (18) MONTHS** starting from the formalization of the contract.

CLAUSE 10. Target price

- The target price for the system is 690.000,00 € (VAT excluded).
- Payment terms:
 - Optional payment on order - 30% total price. This payment is optional for the contratist, but in case the contractor requests a payment of 30% of the contract, he will have to constitute a guarantee for an amount equivalent to the amount that was advanced. The payment of this amount does not imply conformity in the equipment, is an advance payment that the contractor must return in the event of non-compliance or deficient compliance.
 - 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 11, 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

Prof. Dr. Valerio Pruneri

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