ICFO

Finançat per la Unió Europea

Generalitat de Catalunya

SPECIFICATION SHEET

Supply, installation and commissioning of a *Sub-micron Precision Laser-based Flip-Chip System* for the ICFO, financed by FEDER Catalunya 2021-2027

FILE NUMBER: ICFO-2026-031

CLAUSE 1. Object of the contract 1
CLAUSE 2. Needs to satisfy 1
CLAUSE 3. Technical requirements 2
CLAUSE 4. Power distributions and safety 4
CLAUSE 5. System layout and services 4
CLAUSE 6. Transportation, installation, start-up and training 4
CLAUSE 7. Warranty and Follow-on Support 5
CLAUSE 8. Training 5
CLAUSE 9. Delivery and Installation Time 6
CLAUSE 9. Target price 6

CLAUSE 1. Object of the contract

The purpose of this contract is the supply, installation and commissioning of a "***Sub-micron Precision Laser-based Flip-Chip System***" for the ICFO, financed by FEDER Catalunya 2021-2027.

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

PhotonChip is a platform project that will help bring photonic technologies, in particular integrated photonics and photonic chips, from scientific feasibility to prototype stage to be applied in, for instance, communications as 6G transceivers, sensors, quantum computing and technology platforms.

Once operational, PhotonChip will cover the whole photonic chip value chain (design, packaging, testing) and train new experts thanks to dedicated programs.

As part of the Institute of Photonic Sciences (ICFO), PhotonChip will use advanced technologies as quantum technologies for cybersecurity, virtual and augmented reality, artificial intelligence, and machine learning.

In the development of the project, ICFO needs to acquire the supply of a ***Sub-micron Precision Laser-based Flip-Chip System***. The purpose of the system is to provide the ICFO Packaging Line of the possibility to realize chip-to-wafer hybrid bonding with ultra-high accuracy placement, enabling low loss heterogeneous integration of Photonic Integrated Circuits (PICs), while supporting soldering bonding process.

The system must also be compatible with wide range of substrates and dies enabling: chip-to-wafer bonding, chip-to-substrate bonding, lens bonding, etc.

The ***Sub-micron Precision Laser-Based Flip-Chip System*** will be an automatic machine able to support the following bonding technologies with a passive placement precision of ± 0.2µm at 3σ:

- Die bonding and flip-chip bonding using a fast and localized heating source, specifically, a laser based soldering process, compatible with substrates up to 300mm wafers.

- Die bonding and flip-chip bonding using "traditional" thermal hot plate, also compatible with substrates up to 300mm wafers.

CLAUSE 3. Technical requirements

Technical proposal structure - minimum mandatory equipment characteristics

The equipment shall incorporate a high-accuracy motion system and vision system with high-resolution cameras and image recognition capabilities in order to perform, at minimum, the following **functionalities**:

1. Die bonding and flip-chip bonding of dies using localized laser-based soldering.
    a. Compatible with substrates such as dies, substrates of various sizes and materials (ceramic, laminate) or 8inch wafers.
    b. Upgradeable to support 300 mm wafer substrates.
    c. Compatible with die sizes ranging from 100µm to 25mm, minimum.
    d. Adjustable temperature profiles and laser pulse parameters.

2. Die bonding and flip-chip bonding of single chip using wafer compatible thermal hot plate.
    a. Substrate can be a die, substrate of different dimensions and materials or an 8inch wafer.
    b. Upgradeable to support 300 mm wafer substrates.
    c. Compatible with die sizes ranging from 100µm to 25mm, minimum.
    d. Adjustable temperature profiles.

3. The system shall be a standalone machine designed to support both heating technologies (item 1 and 2). The design must allow the operator to exchange the laser heating module and the thermal hot-plate module without requiring specialized service intervention.

4. Passive alignment and placement with a precision ± 0.2µm at 3σ. Proved after bonding accuracy better than ±0.5µm at 3σ (see CLAUSE 6- Process Qualification)

5. The system shall ensure high process stability and reliability through integrated real-time alignment and bonding control. It shall include:
    a. Continuous monitoring and control of the component positioning during alignment and bonding operations.
    b. Automatic placement offset tuning to maximize bonding accuracy and yield, particularly during die-to-wafer processes.
    c. Integrated post-bond inspection and metrology system, giving quantitative post-bonding accuracy results.
    d. Calibration tools and procedures to ensure die and substrate parallelism.

6. High throughput. Cycle time <25sec per die

7. Heated die holding fixtures to maintain component temperature stability and prevent thermal shocks during bonding.

8. Bond force control, programmable in the range of 0.1 to 20N, minimum.

9. Automated operation with manual load and unload of components, including possibility to realize step by step manual operation if required.

To ensure the implementation of the above-mentioned functionalities, the system shall include, at minimum, the following **components**:

10. Granite base and machine housing equipped with vibration damping system to ensure process stability, including also ESD protection and HEPA filtration system.

11. Laser heating system including:
    a. Laser wavelength 808nm
    b. Focusing optics
    c. Integrated pyrometer for temperature control
    d. Temperature capability up to 450ºC (minimum)

12. Chuck compatible with laser-based soldering process, suitable for 8inch wafers, ensuring the entire wafer area can be populated in a single process.

13. Chuck compatible with laser-based soldering process, supporting different substrates sizes.

14. Heating plate compatible with
    a. 8inch wafer substrates (minimum)
    b. Temperature capability up to 200ºC (minimum)

15. Flipping stage enabling automatic 180º die flipping for flip-chip operations, fixtures included.

16. Fixtures to pick up dies from waffle pack, gelpaks and grip rings.

17. Die handling fixtures with high precision motion axes, providing:
    a. Axis resolution: linear 0.1um, rotational 0.001º
    b. Programmable bond force control, with forces ranging (minimum) from 3g to 2kg
    c. Touch sensor first contact detection between chip and substrate.
    d. Heated operation up to 350 °C
    e. Heating controller

18. Fixtures for parallelism calibration.

19. Vision system with high-resolution CCD cameras and advanced pattern recognition software.

20. Software including: wafer or substrate mapping and inspection.

Software requirements

21. The system must include the software required to manage all required functionalities described above and shall be supplied with a permanent (non-expiring) license. (Note items nº 5, 19 and 20)

22. The software shall be installed on a PC included as part of the system.

Technical documentation or manuals to be delivered

A set of documentation shall be provided, covering the following topics:

- Comprehensive system user manual, including both hardware and software descriptions, routine servicing and troubleshooting.

CLAUSE 4. Power distributions and safety

The system shall include:

- Electrical Operation: 230V ±10%, 50 Hz (per UNE-EN 61010-1, Spanish adoption of IEC 61010-1)
- Laser safety: Appropriate enclosure to guarantee compliant laser protection requirements according to European Standards, without requiring specific laser safety area.
- CE-certification.
- Safety interlocks and emergency stop system.

CLAUSE 5. System layout and services

The proposal shall include a set of “system layout and services documentation”, containing the following information:

- System layout, including overall footprint, weight, drawings and detailed description of the different system components.
- Installation and start-up requirements, including required utilities, service connections, and any applicable environmental specification.

CLAUSE 6. Transportation, installation, start-up.

- Contract includes the installation and start-up of the system, including system checking, functional tests and the supply of all those elements necessary for its correct operation

- The proposal will include transportation to ICFO’s facilities including insurance and all export/import and customs duties.

- Any other customs or miscellaneous expenses, unexpected and not covered in the tender, which may arise until the equipment arrives at ICFO, must initially be borne by the Supplier and will be reimbursed by ICFO upon submission of supporting documentation proving the actual incurrence of such expenses.

- The machine will be placed in the designated location by ICFO. The contractor 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 contractor 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

Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) will be required as part of the delivery and acceptance process of the equipment.

It shall include, at minimum, the following tests:

a) Placement capability test. Verification of the placement performance of the machine over a minimum of 200 cycles, demonstrating a placement accuracy of ± 0.2µm at 3σ.
   a. Parts required for this test shall be supplied by the manufacturer

b) Post-bond accuracy test. Laser-based soldering test over a minimum of 15 repetitions, demonstrating a post-bond accuracy of ±0.5µm at 3σ.
   a. Parts required for this test shall be supplied by the manufacturer.
   b. This test is required only for the FAT.

c) Machine parameters verification, including but not limited to motion accuracy, vision system repeatability and any other relevant specifications demonstrating compliance with the specification.

d) Documentation. All test results, reports and data generated shall be included in the documentation delivered to ICFO.

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.

- Spare parts will be available during, at least, 10 years after system supply.

CLAUSE 8. Training

- System training for ICFO personnel shall be included: the number of training days shall be specified in the proposal.

- The training shall ensure proper and safe operation of the system and shall cover basic and advanced functionalities, including process development, programming and automation features.

- The training program shall also provide an overview of basic maintenance procedures, covering routine preventive tasks and essential troubleshooting guidelines.

- Training will take place at the ICFO facilities, scheduled on a mutually agreed date.

CLAUSE 9. Delivery and Installation Time

The machine should be delivered within **10 months starting from tender assignment.**

For the purpose of this tender, delivery time is defined as the period from contract formalization until system delivery at ICFO facilities, including manufacturing, transportation, installation, and acceptance tests.

CLAUSE 10. Target price

- The target price for the system is **990.000 €** (VAT excluded).

- Payment terms: Full payment will be made once the final receipt of supply, installation and commissioning is issued.

Castelldefels, on the date of its digital signature

Prof. Dr. Valerio Pruneri
Optolectronics