

Anlage 3 – Leistungsbeschreibung (in Englisch)

List of specifications for UHV cluster Tool

1. General Information

The TU Munich – Chair of Technical Physics E23/WMI will acquire a **UHV cluster System** for the fabrication of superconducting circuits on 8 inch" wafers. The systems must satisfy the technical specifications required for the deposition of thin films and heterostructures required for the fabrication of these circuits. The systems must provide UHV conditions and has to include a HV load-lock chamber, a central handling chamber, a UHV chamber for the evaporation of Al thin films, a UHV chamber for sputtering of superconductors, a UHV chamber for oxidation, a UHV chamber for Ar ion milling and a flipping station. The system must allow for metallizing both sides of the wafers in situ with minimal particle contamination of the wafer on the backside. The wafers should only be touched on the side (edge gripping). The system will be operated in a research-and-pilot-production environment. It must therefore combine the parameter transparency and process flexibility of a research tool with the wafer handling, uniformity, particle performance and availability of a production tool.

2. System Configuration

General Remarks

The **UHV cluster System** shall be a radial cluster: a central ultra-high-vacuum transfer module carrying a vacuum wafer-handling robot, surrounded by individually isolatable process modules. The system shall be turnkey ready, i.e., fully equipped with all necessary components, control electronics, and software. The system shall be ready for fully automated operation, i.e., the hardware components have to be equipped with appropriate interfaces for computer connection. More details on the required degree of automation are specified in the following sections.

The supplier has to specify the requirements with respect to required space (footprint, ceiling height), electrical appliances, cooling water supply, as well as supply of pure gases. Furthermore, all technical information must be made available to the TUM Chair of Technical Physics required for operation and maintenance as well as for future extension/adaption of the system.

The system must be able to handle substrate wafers up to 200 mm diameter (8 inch). In addition to the mere mechanical handling capability, uniform deposition (<5% non-uniformity), treatment, and cleaning must be possible for this size. Adapters for smaller substrates must be available on request.

Also within the scope of supply: all vacuum pumps and gauging; all gas panels, point-of-use purifiers, filters and all-metal gas lines from the customer termination point; the complete control system, workstations and software licences; the frame, enclosures and bulkhead interface; a second set of chamber shields and liners; all installation materials; documentation; and training.

Key Components

The **UHV cluster System** is requested to consist of different vacuum chambers with automated sample transfer between the subunits. It has to comprise the following key components:

- load-lock chamber (HV)
- central handling robot (UHV)
- evaporation chamber (UHV)
- oxidization chamber (UHV)
- sputtering chamber (UHV)
- Ar ion cleaning chamber (UHV)
- Flipping station (HV)
- accessories and manuals
- control and automation system

The system has to fit into a laboratory room with a **maximum ceiling height of 330 cm**. The **maximum footprint of the total system must be less than 350 cm x 400 cm**.

Load-lock Chamber

The following components/specifications are requested for the load-lock chamber:

- aluminum or stainless steel chamber with large hinged door for easy sample loading
- base pressure $\leq 1 \times 10^{-7}$ mbar
- turbo molecular pump and dry backing pump
- pneumatic gate valve for turbo molecular pump separation, by-pass assembly for pump out from atmospheric pressure consisting of pneumatic valves
- vacuum measurement system down to base pressure
- venting valve (dry N₂) and atmospheric pressure detector
- glove box compatibility
- at least 10 platforms for substrates
- one of the 10 positions should allow for outgassing of the wafer reaching up to 120°C on the wafer to dehydrate the wafer. Heating should be uniform across the wafer with ± 5 degree gradient across 8 inch
- pump down time to 3×10^{-7} within 30 minutes

Central handling robot

The following components/specifications are requested for the radial central handling robot chamber. The robot needs to be capable to be extended in the future with a second handling chamber to allow for additional 4 chambers attached to the cluster system. Additionally backside contamination of the 8 inch wafers from the handler should be minimal either by using a carrier based system or edge gripping.

- base pressure after bakeout $\leq 1 \times 10^{-9}$ mbar
- pumping system allowing to reach the required base pressure
- oil-free backing pump if needed
- pneumatic gate valve for pump separation, by-pass assembly for pump out from atmospheric pressure consisting of pneumatic valves
- vacuum measurement system down to base pressure
- venting valve (dry N₂) and atmospheric pressure detector
- mean time between failures of the handler should be provided for example by submitting the manufacturers reliability datasheet
- typical transfer times between 2 chambers should be stated in the quote

Evaporation Chamber

The following components/specifications are requested for the evaporation chamber:

- UHV stainless steel chamber with large differentially pumped double-sealed door for easy access and maintenance
- pneumatic gate valve separating the evaporation chamber from the handling robot
- viewport with UHV compatible shutter and polarizer
- heat source for chamber baking
- vacuum measurement system down to base pressure
- visualization lamp for chamber lighting
- two sets of stainless-steel shields (chamber liners) preventing direct deposition on the walls of the chamber (easily removable for cleaning, one set provided as spare part)
- 3-4 additional CF flanges for accessories
- pumping system:
 - turbo molecular pump or cryopump with water cooled compressor and ≥ 10 m long He lines
 - oil-free backing pump
 - base pressure at least $\leq 1 \times 10^{-9}$ mbar
 - vacuum measurement system, including differential pumping circuit
 - bypass assembly with pneumatic valves
 - venting valve and atmospheric pressure detector
- electron beam evaporation system
 - distance between the electron beam evaporation source and the substrate in the deposition chamber ≥ 600 mm
 - Deposition rates for aluminum should be controllable between 0.1 to at least 2 nm/min
 - evaporation thickness non-uniformity better than $\pm 5\%$ on a 8 inch substrate without sample rotation (shadow evaporation readiness)
 - UHV electron beam source with ≥ 4 crucibles ≥ 15 cm³) ideally ≥ 8 crucibles or an in situ refill solution to minimize maintenance needed for refilling
 - automatized crucible selection
 - monitoring of deposition rate via quartz crystal microbalance, active rate monitoring and control during deposition process
 - power supply with adjustable high voltage (typically 10 kW, 10 kV)
 - control unit for (i) emission and high voltage, (ii) filament current and (iii) beam motion, including a hand-held remote controller
 - two sets of confinement screens, limiting the deposition to a desired restricted area (1 set as spare part)
 - UHV compatible pneumatic source shutter that blocks deposition on the wafer
 - UHV compatible pneumatic source shutter that blocks deposition on the thickness monitoring system independently from the shutter for the wafer
- motorized substrate holder:
 - designed for substrate carriers that can carry a single 8 inch wafer or several smaller samples
 - the wafer clamping system must have a sufficient thermal inertia to ensure an increase of the substrate temperature of less than 20° C during 100 nm aluminium deposition
 - motor-driven substrate tilt over a range larger than 300°
 - accuracy and reproducibility of the tilt angle better than 0.05°
 - motor-driven spinning (typically 5 rpm) and positioning of the substrate (angle accuracy and reproducibility better than 0.2°)

- the tilt and spinning motions have to allow for a two-angle shadow evaporation technique, both motions must allow for automatic homing and preconfigured positions
- a sensor that accurately detects the home position of the rotation
- all movements must be automatized and programmable
- rotational accuracy is important for double angle shadow evaporation processes. Therefore, an optical or mechanical mechanism that minimizes rotation variations from wafer to wafer is requested and needs to be described in the offer. If possible also the rotation variation from wafer to wafer run should be given.
- substrate heating:
 - 8 inch substrate heater (e.g. resistive heater placed behind the substrate)
 - maximum temperature $\geq 700^{\circ}\text{C}$
 - temperature sensor and controller allowing for automatized and programmable temperature variations
 - compatible and operational with rotation and tilt motions
 - power supply
 - reference measurement with thermocouple on a wafer
- motorized mask to improve uniformity during angled evaporation without rotation. Calibrated for $< 5\%$ nonuniformity over 8 inch wafer at different tilt angles ranging from 10° - 60°
- deposition rate and thickness monitoring system
 - water-cooled crystal sensor head
 - control electronics
 - deposition rate resolution $\leq 0.005 \text{ nm/s}$
 - thickness resolution $\leq 0.01 \text{ nm}$
 - frequency resolution: $\leq 10^{-5} \text{ Hz}$
 - individual shutter

Oxidation Chamber

The following components/specifications are requested for the oxidization chamber:

- UHV stainless steel chamber with large differentially pumped double-sealed door for easy access and maintenance
- viewing port (typically CF 100) positioned at front
- min 2 additional CF flanges for further installation of components and accessories closed with blank flanges
- heat source for chamber baking
- pumping system:
 - turbo molecular pump or cryopump with water cooled compressor and $\geq 10 \text{ m}$ long He lines,
 - oil-free backing pump
 - base pressure $\leq 1 \times 10^{-9} \text{ mbar}$
 - pneumatic gate valve
 - vacuum measurement system
 - bypass assembly with pneumatic valves
 - venting valve and atmospheric pressure detector
- oxidation system
 - capacitive gauge for high pressure range (typically 1 - 1000 Torr)
 - capacitive gauge intermediate pressure range (typically 0.1 - 100 Torr)
 - capacitive gauge for low pressure range (typically 10^{-3} - 1 Torr)
 - gas line with PoU filter, purifier, stop valve and mass flow controller for O_2 (max. flow typically $\leq 50 \text{ sccm}$)

- gas line with PoU filter, purifier, stop valve and mass flow controller for O_2 (max. flow typically ≤ 5000 sccm)
- gas line with PoU filter, purifier, stop valve and mass flow controller for Ar (max. flow typically ≤ 5000 sccm)
- gas line with PoU filter, purifier, stop valve and mass flow controller for Ar (max. flow typically ≤ 200 sccm)
- possibility to select pure O_2 or precise Ar: O_2 mixture
- software control of oxidation process for ensuring high reproducibility of pressure and time of oxygen exposure
- oxidation process must be automatized and programmable
- system must allow for static oxidation from 0.001 to 600 mBar and dynamic oxidation from 5 μ bar to 50 mBar
- motorized, PID controlled throttle valve in front of turbo or cryopump

Sputtering Chamber

The following components/specifications are requested for the sputtering chamber: The sputtering chamber will be used for the deposition of superconducting materials by magnetron sputtering. It has to include four 4 or 6-inch sputtering guns (compatible with DC and RF power) oriented in a confocal sputter up configuration. Deposition rates for Nb, Al, Ta should be controllable between 0.1 to at least 20 nm/min. Uniformity better than $\pm 3\%$ on a 8 inch substrate. Additionally, there should be an option in the software to track and adjust sputtering times depending on the wear of the target. The following components/specifications are requested for the sputtering chamber:

- UHV stainless steel chamber with large differentially pumped double-sealed door for easy access and maintenance
- viewing port (typically CF 100) at front
- CF ports for the installation of the sputtering guns
- min 2 additional CF flanges for the installation of further components and accessories closed with blank flanges
- wall-mounted chamber heaters with measurement control
- motorized distance adjustment between substrate and magnetrons at least between 50 mm to 150 mm
- pumping system:
 - turbo molecular pump with magnetic bearings and oil-free backing pump, including all required backing and bypass valves
 - base pressure $\leq 5 \times 10^{-9}$ mbar
 - pneumatic gate valve between chamber and turbo molecular pump
 - automatic throttle valve for down-stream pressure control
 - vacuum measurement system, including a capacitive membrane gauge for process pressure measurement
 - venting valve and atmospheric pressure detector
- substrate holder:
 - compatible with substrate transfer system and confocal configuration of sputtering guns
 - continuous rotation capability up to at least 10 rpm
 - compatible with RF bias
- sputtering guns
 - four water cooled 4 or 6-inch magnetrons, no water-to-vacuum seal
 - pneumatic shutter for each magnetron

- individual chimney for each sputter gun to avoid cross contamination
- gun orientation providing maximum uniformity over a 8 inch substrate
- compatibility with co-deposition
- compatibility with RF and DC supply
- power supplies for sputtering guns
 - at least two ≥ 3000 W DC power generator capable of running in DC or pulsed DC mode (air cooled, operation in constant power, constant current or constant voltage modes, rapid arc detection and quenching)
 - DC power distribution box
- fast pneumatic shutter in front of the substrate
- substrate heating:
 - 8 inch substrate heater (e.g. resistive heater placed behind the substrate)
 - maximum substrate temperature $\geq 750^{\circ}\text{C}$
 - temperature controller
 - compatible with spinning
 - compatible with oxidizing/nitriding atmosphere
 - power supply
- sputtering gas supply:
 - at least two stain-less steel gas lines each equipped with
 - mass flow controllers (typically 100 sccm for Ar, 50 sccm for N_2)
 - stop valve
 - PoU filter and purifier

Argon Ion milling chamber

The following components/specifications are requested for the ion milling chamber:

- UHV stainless steel chamber with large differentially pumped double-sealed door for easy access and maintenance
- viewing port (typically CF 100) at front
- min 2 additional CF flanges for the installation of further components and accessories, closed with blank flanges
- wall mounted chamber heaters with measurement control
- pumping system:
 - turbo molecular pump with magnetic bearings and oil-free backing pump, including all required backing and bypass valves
 - base pressure $\leq 5 \times 10^{-9}$ mbar
 - pneumatic gate valve between chamber and turbo molecular pump
 - vacuum measurement system, including a capacitive membrane gauge for process pressure measurement
 - venting valve and atmospheric pressure detector
- motorized substrate holder:
 - designed for substrate carriers that can carry a single 8 inch wafer or several smaller samples
 - motor-driven substrate tilt relative to the beam from -90° to $+90^{\circ}$ with a setting accuracy of $\leq \pm 0.5^{\circ}$, and continuous substrate rotation from 0 to ≥ 20 rpm at any tilt angle.
 - The wafer temperature shall remain $\leq 80^{\circ}\text{C}$ after 7 min of milling at 400 V and full beam current. Wafer temperature shall be measured during system acceptance with thermocouple on a wafer.
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- pneumatic substrate shutter, covering the substrate prior to the milling process
- all movements must be automatized and programmable
- ion gun system for homogeneous (etch non-uniformity $\leq \pm 5\%$ across a 190 mm measurement area) substrate cleaning (over full 8 inch diameter) by neutralized argon or oxygen ions:
 - ion gun has to be optimized for minimal contamination with foreign material
 - hollow cathode ion source
 - A filamentless plasma-bridge (RF) neutraliser with an emission current automatically matched to the beam current
 - All beam-line and chamber surfaces subject to sputter deposition shall be protected by removable, replaceable shields of a material compatible with a superconducting-circuit process (no copper, no stainless steel in direct line of sight of the wafer where avoidable). A second complete set of shields shall be included in the scope of supply. The bidder shall describe the measures taken to limit redeposition onto the wafer.
 - source-substrate distance ≥ 200 mm
 - beam current ≥ 100 mA, beam voltage 100 V to at least 1000 V

Flipping station

The following components/specifications are requested for the flipping station:

- flipping station for 200 mm wafers
- edge gripping or a solution that does not contaminate any side of the wafer
- base pressure at least $\leq 1 \times 10^{-7}$ mbar

Substrates

The system shall process 200 mm diameter substrates in accordance with SEMI M1: diameter 200 ± 0.2 mm, thickness 725 ± 25 μ m, notch-referenced (notch depth $1.0 +0.25/-0.00$ mm, included angle $90^\circ +5^\circ/-1^\circ$).

Substrate materials

The system shall handle and process, without modification of hardware: high-resistivity silicon (≥ 10 k Ω ·cm, up to > 20 k Ω ·cm), standard-resistivity silicon, c-plane sapphire, fused silica, and silicon wafers containing through-silicon vias. Handling and clamping concepts that rely on the substrate being electrically conductive (e.g. electrostatic chucking without a compatible mode for insulating substrates) shall not be used unless a fully specified alternative mode for insulating substrates is included.

Edge-grip / minimum backside contact handling

All end effectors and all substrate holders shall use edge-grip or minimum-backside-contact designs. The bidder shall state, for every wafer-contacting element, the contact geometry, the total contact area and the contacting material. Full-area backside contact with a metallic surface is not acceptable.

Resist compatibility

All process modules and all transfer operations shall be compatible with wafers coated with electron-beam and optical resists (PMMA, PMMA/MMA, PMGI, and standard i-line/DUV resists) and with lift-off bilayer stacks. No process step, transfer step or clamping operation shall raise the wafer temperature above 120 °C unless explicitly commanded by the recipe.

Gas lines

All gas lines should be made for 6.0 grade ($\geq 99.9999\%$) gases. The gas line shall be all-metal, electropolished, VCR-fitted, with a bidder-supplied point-of-use purifier on process gas lines delivering ≤ 1 ppb H_2O and ≤ 1 ppb total hydrocarbons at the chamber inlet

Downward compatibility

The system should accept carrier plates enabling processing of 100 mm and 150 mm wafers and of 10 mm $\times$ 10 mm to 25 mm $\times$ 25 mm coupons, using the same automated handling. Carriers for at least 100 mm wafers and for coupons should be included in the scope of supply.

Maintenance contract

An optional service contract for preventive maintenance should be offered for 5 years

Accessories and Manuals

The delivered system has to include the following accessories and manuals:

- all diagnostic connecting cables
- basic system spares kit
- technical documentation
- an estimate of the required power and supplies (like gas and cooling water requirements) as well as weight, dimension of system and dimension of accessory parts should be provided with the offer

Control and Automation System

All control electronics and wiring should be enclosed into a separate cabinet or should be integrated into the system with a mounting scheme allowing for full access to the different parts. The cabinet also should include a main breaker and an emergency switch.

The control cabinet should include an industrial computer with an up to date Operating System, at least two monitors and a RAID 1 disk system for safe data storage. At least 2 TB of storage and 64 GB of RAM.

The control electronics has to allow for fully automated operation of the system. The system must come with a control computer allowing for running the control software. The software must allow for a programmable automation of all operations to support fully automatic, unattended operation on all wafers loaded in the loadlock (movements between chambers, opening and closing of gate valves, substrate holder movement, cleaning procedures, deposition, oxidation, waiting times, pumping etc.). The system must allow to automatically run different processes in different chambers in parallel. If software bugs appear they have to be fixed free of charge during the first 10 years of the operation of the system. If damage occurs to the system during automatic operation due to a fail of the system automatization the damage has to be repaired free of charge by the system provider for the first 5 years of the lifetime of the system.

The specific requirements regarding the software are

- manual, semi-automatic, and fully automatic control from a central computer
- user-friendly and intuitive interface
- easy upgradable or modifiable
- allowing for safety and defect management, data storage
- provision of different user level access
- access for different entities without sharing of recipes and logging data
- service account with full access to the source code
- simple recipe editor
- access to parameter adjustment during automatic process for engineer level

- data logging, I/O history, event logging
- measured values (e.g., temperatures, pressures, thicknesses) must be control parameters for software in the spirit of “if value=x do action y” and “wait until value=x”.
- process and log data shall be exportable in an open, documented format (CSV plus a documented relational or time-series database schema) and shall additionally be available live through a documented API or an OPC UA server, for integration into the Contracting Authority's data infrastructure. No additional licence fee shall be payable for this interface
- an interface of the control software to Python is preferred
- the system shall be fully operable without any connection to the internet or to the bidder's network. Remote diagnostic access shall be possible but shall be initiated and terminated under the Contracting Authority's control, through a documented, auditable mechanism
- the control system shall track every wafer by identifier from the moment it enters the load lock to the moment it leaves, and shall log every location, every transfer, every process step with all setpoints and readbacks, and every alarm associated with it
- on any fault, power loss or emergency-off event, wafers shall be brought to or left in a mechanically safe, defined location. The control system shall provide a guided, recovery procedure that identifies wafer locations and returns them to the load lock without operator entry into the vacuum envelope where this is avoidable

3. Additional requirements

Single point of contact responsibility

The bidder shall assume full technical and commercial responsibility for the complete system, including all subsystems procured from third parties (vacuum robot, ion source, power supplies, glovebox, gas panels, control software). Division of responsibility between the Bidder and its subcontractors shall not be invoked against the Contracting Authority.

Expansion capability

Utilities routing, control system I/O capacity and software architecture shall be dimensioned so that an additional handler with additional process modules can be added later without replacement of the control cabinet or the control software.

Independent module isolation, venting and bakeout

Each process module shall be ventable, openable for maintenance, and bakeable independently of all other modules and of the transfer module, with the remaining system held at base pressure throughout.

Cleanroom bulkhead installation

The system shall be configured for bulkhead ("through-the-wall") installation with the load/unload station and operator interface in an ISO Class 4 cleanroom and the mechanical/electrical service side in an ISO Class 7 grey area. All cleanroom-side surfaces shall be non-particle-shedding, cleanable with IPA, and free of exposed threads, unsealed seams and painted surfaces

CE marking and applicable EU legislation

The System shall be CE marked and shall be accompanied by an EU Declaration of Conformity covering, as applicable: Machinery Regulation (EU) 2023/1230 (or Directive 2006/42/EC where the System is placed on the market before 20 January 2027 — the Bidder shall state which applies

given the offered delivery date), EMC Directive 2014/30/EU, Low Voltage Directive 2014/35/EU, Pressure Equipment Directive 2014/68/EU, and RoHS Directive 2011/65/EU

Exhaust ventilation and electrical design safety

Compliance with SEMI S6 (exhaust ventilation) and SEMI S22 (electrical design safety) shall be documented

Running Cost, Technical Support, After-sales Service

We require a statement of the guaranteed and typical up-time and of the lifetime of the system. We require a statement of the regular service intervals and cost of the individual components (control computer, pumping system, cooling unit, mass flow controllers, valves). We also require a statement on the location and availability of after-sales service and technical support and ask the bidder to add the telephone number, email and persons on the hotline. Ideally the telephone response time is max 30 minutes and the service visit response time max 5 working days.

4. Optional Components

We ask for the separate quotation of the following system components/accessories:

Additional crucibles or refilling system for evaporator chamber to prolong the refilling cycles

NEG getter pumps to enhance hydrogen pumping

Water or cryo-cooled shroud above the e-gun

Cassette load lock

4.1.1. A load lock that accepts a standard 25 wafer cassette shall be offered as an option

Substrate heating in oxidation chamber

- 8 inch substrate heater (e.g. resistive heater placed behind the substrate)
 - maximum temperature $\geq 700^{\circ}\text{C}$
 - temperature controller allowing for automated and programmable temperature variations
 - compatible and operational with rotation and tilt motions
- power supply
- reference thermocouple on substrate holder for temperature control

Remote plasma oxidation

- We request a solution for remote oxygen plasma source for uniform low damage oxidation of 8 inch wafers. Furthermore, this part of the system must be designed such that it can be easily modified. for example by fully replacing the chamber lid to install a different oxygen plasma source during the lifetime of the system

RF power supply for sputtering chamber

We ask for the quotation of an option allowing for RF sputtering in the sputtering chamber.

HIPIMS power supply for sputtering chamber

We ask for the quotation of an option allowing for HIPIMS sputtering in the sputtering chamber.

Oxidation capabilities in the evaporation chamber

- We ask for the quotation of an option allowing for oxidation in the evaporation chamber. Including a large gate valve between the substrate and the e-gun and all components needed to allow for dynamic and static oxidation over a wide pressure range. For example
 - capacitive gauge for high pressure range (typically 1 - 1000 Torr)
 - capacitive gauge intermediate pressure range (typically 0.1 - 100 Torr)
 - capacitive gauge for low pressure range (typically 10^{-3} – 1 Torr)
 - gas line with PoU filter, purifier, stop valve and mass flow controller for O_2 (max. flow typically ≤ 50 sccm)
 - gas line with PoU filter, purifier, stop valve and mass flow controller for O_2 (max. flow typically ≤ 5000 sccm)
 - gas line with PoU filter, purifier, stop valve and mass flow controller for Ar (max. flow typically ≤ 5000 sccm)
 - gas line with PoU filter, purifier, stop valve and mass flow controller for Ar (max. flow typically ≤ 200 sccm)
 - possibility to select pure O_2 or precise Ar: O_2 mixture
 - software control of oxidation process for ensuring high reproducibility of pressure and time of oxygen exposure
 - oxidation process must be automatized and programmable
 - system must allow for static oxidation from 0.001 to 600 mBar and dynamic oxidation from 5 μ bar to 50 mBar
 - motorized, PID controlled throttle valve in front of turbo or cryopump

LN₂ Cooling System

We ask for the quotation of an option allowing for cooling down the substrate holder in the evaporation chamber to cryogenic temperatures while still allowing for the substrate tilt

Active cooling of wafer in Sputtering chamber

We ask for the quotation of an option allowing for cooling down the substrate in the sputtering chamber after a high temperature process. To be able to transfer the wafer quickly after the process and increase throughput of high temperature processes.

Quartz crystal balance in sputtering chamber

We ask for the quotation of an option allowing for measuring the deposition rate in the sputtering chamber before the process.

Argon ion beam diagnostics

A Faraday cup array or equivalent instrument shall be supplied, permitting measurement of the beam current density and the beam profile across the substrate plane as a routine, documented maintenance operation.

Substrate cooling during milling

A solution for substrate cooling during milling shall be offered as an option compatible with rotation and tilt motions

Fast cooling of the wafer after degassing in load lock

We ask for the quotation of an option allowing for fast cooling of the wafer after heating it up for degassing in the loadlock.

Residual Gas Analyzer (RGA)

We ask for the quotation of a RGA consisting of

- a mass spectrometer up to typically 100 amu with Thoriated Iridium filament and detection limit in the 10^{-14} mbar regime
- a Faraday cup and electron multiplier
- control unit/software integrated in the general software

5. Delivery, Final inspection, Testing

Date of Delivery

The delivery time should not exceed 14 months after ordering.

Final Inspection

After installation of the system at the TUM Chair of Technical Physics E23 / Walther-Meißner-Institute the following tests have to be passed:

- vacuum test:
The system reaches all required base pressure levels in the different sub-chambers with all equipment attached
- sample transfer test:
Successful transfer of sample from load-lock to all chambers and back into load-lock including a demonstration of all mechanical manipulations (like rotation, flipping, tilting)
- automated operation test incl. simultaneous processing of several wafers (like sputtering and evaporation in parallel)
- testing of all additional components like Ar ion milling source
- the measured wafer temperature during milling and during aluminium deposition
- uniformity tests for sputtering evaporation and milling
- rotational alignment accuracy in evaporation chamber
- successful control of all relevant deposition parameters over the range guaranteed by the supplier, especially temperature control, pressure control, gas flow control, sample positioning/rotation/tilt as well as deposition rate, homogeneity and thickness control (materials used for the test are aluminum in evaporation chamber and niobium in sputtering chamber).

Documentation

After final inspection, the TUM E23 / Walther-Meißner-Institute obtains full copies (digital and print out) of manuals for each component, a software manual, and a system operation manual. This also includes all technical drawings of the final system.

Payment Terms

100% on order against bank guarantee

Training

Price for system includes training for up to 5 users from the TUM / Walther-Meißner-Institute: Training includes all steps for a full system operation.

Process recipes, parameter sets and process know-how developed on the System by the Contracting Authority, or jointly during commissioning and acceptance, shall remain the property of the Contracting Authority. The Bidder shall not use or disclose them without written consent. Pre-existing Bidder know-how is unaffected.

Warranty

- Warranty runs for at least 24 months after final inspection
- Guaranteed availability of spare parts for at least 10 years

Award Criteria

Contracts shall be awarded on the basis of the award criteria laid down in the following evaluation matrix:

Criterion	Weighting Factor
Cost of Acquisition	40 %
Technical Specifications as defined in the above list (overfulfilment is possible, underfulfilment is possible but will lead to a reduction in points.)	45 %
Delivery Time, After-sales Service and Technical Support	10 %
Three references of similar systems	5 %

Exclusion criteria regarding the technical specifications are:

- maximum footprint must be $\leq 350 \text{ cm} \times 400 \text{ cm}$, maximum height $\leq 330 \text{ cm}$, each component of the system must fit through doors with 250 cm height and 100 cm width
- base pressure in the deposition/oxidation chambers must be $\leq 5 \times 10^{-9} \text{ mbar}$ (desired base pressure: $\leq 1 \times 10^{-9} \text{ mbar}$)
- deposition system must be able to handle a substrate size up to 8 inch and allow for homogeneous deposition and cleaning processes for this maximum substrate size (homogeneity $\leq 5\%$)
- deposition system must allow for automated deposition processes as well as an automated oxidation process in the oxidation chamber.

The optional components can also be taken into account in the evaluation process. Further details can be found in the form sheet "Anlage 2 – Zuschlagskriterien".