TECHNICAL SPECIFICATION- Sputter Coating System

System Description:

This system shall be used for sputter coating of metallic, dielectric and semiconductor thin films used in semiconductor, optoelectronics, sensor and coating technologies under vacuum using RF and DC power supplies. The system will be multi-targeted, fully automated and software-controlled.

1. GENERAL REQUIREMENTS

- The system must be compatible with at least a 4" wafer.
- The system must be able to work with both RF and DC sources.
- At least four separate targets should be connected simultaneously and automatic switching between processes should be possible.
- Automatic gas control, vacuum adjustment and recipe-based process control should be provided.
- Installation, commissioning and training must be provided by the contractor.

2. TECHNICAL SPECIFICATIONS

2.1 Vacuum Chamber and System Chassis

- The vacuum chamber front cover should be easily accessible from inside the vacuum chamber.
- A detachable stainless steel liner must be provided for the interior surfaces.
- There should be an observation window and shutter system (separate for sources and samples).
- The vacuum chamber must be suitable for heating up to at least 120°C for outgassing.
- Preferably, at least two free ports should be provided for future connections.
- The vacuum chamber should be equipped with a calibrated pressure relief valve (Safety Relief Valve) to protect against overpressure.
- For best vacuum integrity and durability, the chamber body should be made of stainless steel.
- The three surfaces of the modular room (including the door) should be easily interchangeable, allowing for easier system upgrades and the addition of additional capabilities (e.g. load lock, analytical instrumentation ports, etc.) in the future.

- The system should include an all-access front door designed to provide safe and ergonomic maintenance, cleaning, and source material replacement.
- A large, shuttered viewport should provide a clear view of the substrate and coating sources.
- There should be a holder for protective foil or glass in front of the viewport (in the vacuum).
- Detachable chamber liner (2 sets) must be provided as standard. It should be dismantling without tools and allow for easy cleaning of the system and reduced downtime.
- The vacuum chamber door must be equipped with overpressure protection with a drop-down lever/handle mechanism.
- The system must support the mechanical and electrical integration of up to six (6) sputter welds to be compatible with a maximum target diameter of 3".

2.2 Vacuum System

- The turbopump capacity must be at least 700 l/h.
- The pre-pump must be dry type and have a capacity of at least 30 m^3/h.
- The ultimate vacuum must be at least 5×10^{-7} mbar.

2.3 Plasma Pressure and Gas Control

- Motorized butterfly valve and high-precision capacitive sensor should be used for pressure regulation.
- The gas supply must contain at least three MFCs (Ar, N_2, O_2), each with an accuracy of ±1% or better over the full range.
- Automatic and manual gas inlet valves should be available.

2.4 System Automation and Control Package

- The control package should include a Real-Time Controller that provides device status and security, a Windows user interface (UI) that provides control and feedback, and a communication Host that separates the dependencies between the controller and the interface.
- The Real-Time Controller must guarantee the execution of automatic recipes, software interlocks, and health tasks at a minimum interval (at least every 250 ms by default). It should provide general-purpose computing flexibility with PLC reliability. The device-

specific UI configuration should be backed up to the controller every time the software is closed and every 24 hours, allowing for recovery in case of a problem with the Windows PC.

- The control platform must use a .NET application running on a Windows PC for the user interface and recipe editor.
- Recipe import/export feature should be available (for recipe transfer between similar systems).
- An unlimited number of prescriptions should be provided with user safety levels. Each recipe step should contain user-changeable values without affecting the master recipe.
- It must have the following characteristics:
    - The system should have a Chart Recorder and data logging infrastructure for monitoring process parameters.
    - The system must support simultaneous graphical representation (plot) of parameters at the same time.
    - The Chart Recorder should be configurable to display all setpoint and feedback parameters.
    - For all recipes, the data for each process step must be automatically recorded.
    - Graph data and user-defined graph configurations must be savable and reloadable.
- The control software should support an unlimited number of users and different user levels. Screen accesses should be user-specific and recipe editing and manual usage authorizations should be assigned on a user basis.
- The control software must provide remote support via a customized version of TeamViewer (with Android and iOS free apps) so that the system can be monitored and diagnosed remotely.

2.5 Control Interface

- The system must support a standard industrial communication protocol (e.g. OPC UA or equivalent) that enables communication with external equipment and higher-level control systems.
- This interface should allow system parameters (e.g. pressure, gas flow, power, temperature, etc.) to be monitored (read) and to check (write) parameters as appropriate.
- The system should allow predefined recipes to be started and stopped via an external control system.

Optional / Preferred Features

- The system must support access to process data (e.g. sensor data, alarm logs, process logs) by external systems.

- The system should have an extensible data access infrastructure to support integration with data analytics, machine learning, or AI-based applications.

2.6 Sputter Cathodes and Power Supplies

- Four magnetron welds must be suitable for a target diameter of at least 2".
- Each weld should include a gas shower ring, shutter, and independent water cooling line, ensuring uniform gas distribution on the target surface.
- The RF power supply must be at least 300 W, 13.56 MHz and include an automatic matching network.
- DC and Pulsed DC power supplies must be able to provide at least 1 kW of output power.
- The pulse frequency should be able to operate in the range of 10–120 kHz.
- The RF/DC selector switch (1 input / 2 output) must be PLC controlled.
- Co-sputtering should be possible with two DC sources.
- Co-sputtering should be possible with a DC and an RF source.
- Reactive sputtering should be possible with O_2 gas.

2.7 Thickness Measurement System

- The system should have an integrated **film thickness monitoring system** that allows the coated thin films to be monitored during the process.
- The thickness measurement system must operate with accuracy and repeatability suitable for the process conditions used and must be able to measure continuously in a vacuum environment.
- The thickness measurement system should integrate with recipe-based process control and support shutter opening/closing and process termination functions using thickness monitoring data.

2.8 Substrate Area and Heating

- For a minimum of 4" wafers, the turntable should be adjustable in the range of 0–30 rpm.
- The wafer/sample temperature should be PID controlled up to 800°C, and the maximum deviation should be ±1°C.

2.9 Electrical Cabinet and Software

- There should be a touch screen and PLC control.
- Vacuum, gas, temperature and film thickness should be able to be managed automatically.
- At least 100 different prescriptions should be able to be written, and each should contain at least 50 steps.
- It must be user-defined.
- Data recording (CSV/log) should be possible.
- There should be an emergency stop button in the operator area.

3. PERFORMANCE CRITERIA

- The base vacuum should be $\leq 5 \times 10^{-7}$ mbar or better.
- The film thickness deviation should not be more than 5%.
- The heating temperature deviation should not be more than ±1°C.

4. WARRANTY AND SERVICE

- The system should have a warranty of at least 12 months, preferably 24 months.
- Technical support (spare parts and labor) should be provided for 10 years.
- In the event of a failure, documentation must be provided showing that remote support can be provided within 2 days and on-site support within 10 days.
- Training and installation services should be covered by the offer.

5. SAFETY, QUALITY AND STANDARDS

5.1 Security

System:

- It should have a fully enclosed system electronic cabinet.
- It should allow all electrical components to be safely contained.
- It should have emergency stop (EMO) protection.
- The proposed system should include an isolation transformer and safety interlocks (interlock systems).

- The proposed system must have CE marking and comply with the following European Union directives:
    - Machinery Directive (2006/42/EC, May 2006)
    - Electromagnetic Compatibility Directive (2014/30/EC, May 2014)
- It is preferable for the manufacturer to be able to provide a Declaration of Conformity stating compliance with the requirements of the following European standards:
    - EN ISO 12100:2015 – Safety of machinery – General principles for design – Risk assessment and risk reduction
    - EN ISO 13849-1 – Safety of machinery – Safety-related parts of control systems – Part 1: General design principles
    - EN ISO 13850:2015 – Safety of machinery – Emergency stop function – Design principles
    - EN 60204-33 – Safety of machinery – Machine electrical equipment – Part 33: Requirements for semiconductor manufacturing equipment
    - EN 61000-6-2:2005/AC:2005 – Electromagnetic compatibility (EMC) – Part 6.2: Immunity standards for industrial environments
    - EN 55011:2017/A1:2018 – Industrial, scientific and medical equipment – Radio frequency jammer characteristics – Limits and measurement methods

5.2 General

System:

- The system should have centralized power distribution infrastructure, ensuring a safe and regular supply of electrical components.
- In order to protect critical components, interlocked flow sensors (flow switches) should be available on the relevant lines.
- The system should be in a fully enclosed chassis structure with detachable panels to facilitate maintenance and servicing.
- Access to the vacuum chamber should be unobstructed and ergonomic, facilitating maintenance, cleaning, and parts replacement.
- The system should be equipped with caster wheels for ease of positioning.
- The system should include leveling pads to ensure stability during operation.

5.3 Types

- The proposed system must be manufactured in an ISO 9001 certified facility.
- All process gas lines/manifolds must be orbital welded.

- All systems must be checked and tested prior to shipment.

6. DELIVERY AND TRAINING

- Device installation, testing, and first user training must be provided by the contractor. On-site training after installation should be at least 2 days.
- The delivery time should not exceed 10 months.
- Training documents, user manuals and maintenance documents must be in Turkish and/or English.