

Specifications for NRL NanoScience Institute LPCVD System

1.0 Scope-

This specification describes the minimum technical requirements and the minimum acceptable performance standards for a Low Pressure Vapor Deposition (LPCVD) and Wet Oxidation System to be installed by the contractor at the Naval Research Laboratory (NRL), Washington, DC. The system will be placed in a multiple user facility and must provide ease of operation and safety to those in the facility.

2.0 Installation Site-

The contractor shall install the system in Bldg. 250, Naval Research Laboratory, Washington DC 20375, at a specific location to be designated by the Contracting Officer's Representative (COR). The laboratory space will have 208/240V 3 phase electrical power, cooling water, exhaust and gases required for the processes described below. The offeror must identify any additional facilities that the offered system will require in the technical proposal; NRL will estimate the cost of adding those facilities to the existing room and add that cost to the offeror's price. The contractor shall hook up the system to plumbing, gas and electrical fixtures available in the designated location. The contractor shall install the system in a manner consistent with typical clean-room operating procedures.

3.0 Description and Primary System Components-

The system must consist, among other things, of two process tubes. One of which must be capable of depositing low stress silicon nitride (Si_3N_4), stoichiometric Si_3N_4 and poly Silicon (poly-Si) on silicon wafers. The other tube must be capable of high temperature (at least 1200 °C) wet and dry oxidation of silicon wafers. Both tubes must handle wafers of at least 6.0" diameter. The system is intended for use by multiple users and therefore it must be user friendly with computer control via menu-driven software as indicated in the Control System section of this document.

4.0 REQUIRED SYSTEM FEATURES – a high and low temperature two unit furnace system for 6" wafers must be configured as follows:

4.1 FURNACE SECTION must be configured as follows:

- Welded frame construction with painted or stainless frame
- Units are to be free standing with leveling feet and capable of being used in a stacked or back to back configuration
- Front access to elements and thermocouples (TC's) through removable panel
- External stainless steel scavenger with at least 2.00" diameter exhaust tube
- Type "R" spike and profile TCs for temperature control and redundant excess temperature interlock
- Lock out tag out main breaker
- 208/240 V 3 phase

4.2 REQUIRED TUBE SPECIFICATIONS

Tube Level	Process	Thermal Flat Zone	Max Temp	MAX TUBE OD
1	Wet Oxidation	12.00"	1200°C	235 mm
2	LPCVD	12.00"	800°C	235 mm

4.3 HEATING ELEMENTS

- 3 zone element configuration
- Industry standard APM wire must be used
- Element low temp. (200°C - 800°C) thermal flat zone uniformity specification:
 - +/- 1.0°C for range of 200°C to 650°C
 - +/- 0.5°C for range of 651°C to 800°C
- Element high temp. (350°C - 1250°C) thermal flat zone uniformity specification:
 - +/- 1.0°C for range of 350°C to 650°C
 - +/- 0.5°C for range of 651°C to 1250°C
- Insulation/Energy Kit must be included and sized for a 235 mm OD process tube and configured as follows:
 - Ceracoat or equivalent hard shell coating on Load End Block
 - Ceracoat or equivalent hard shell coating on Source End Block with fixed plug
 - Nextel™ or equivalent tube collar

4.4 SYSTEM SHUT-DOWN SAFETY INTERLOCKS -system must have the following safety features

- Emergency machine off (EMO)
- At least one redundant excess temperature interlock per zone

4.5 CONTROL SYSTEM – must include the following:

- Capability of storing at least 9 process recipes
- Setpoint and ramping of gas
- 3-zones of temperature control
- Cascade and Ratio temperature control
- Alarm and abort sequences
- At least one 5" graphical color display per tube
- Safety Interlocks
- High noise immunity
- Color Graphic Screen
- Standard displays on screen to include:
 - Text and graphical trends
 - Alarms/digital status
 - Digital text and animated graphic of gas values
 - System must allow for user inputs of:
 - Temperature and gas flow setpoints
 - Alarm deviation values
 - Selection of digital events
 - 3.5" Floppy Drive is be included for collection of data
 - Statistical Data Acquisition Software for reading captured data

4.6 LPCVD GAS CONTROL MODULE must include:

- Capability of controlling at least 8 mass flow controllers
- Set point and feed back display per channel
- Manual, automatic or direct digital control
- 10 digital inputs/outputs (I/O)
- 10 analog I/O
- 24 volt power supply for pilot valves
- LPCVD safety interlocks

4.7 GAS CABINET ENCLOSURE

- #4 Finish gas cabinet enclosure must be mounted on furnace source end
- Cabinet enclosure will have (Qty 1) Lexan or equivalent transparent swing panel at end
- All preplumbing connections must enter through the top of unit
- Exhaust port must be at top center

4.8 WET OXIDATION 3-LOOP, TUBE LEVEL 1 - must consist of the following:

Note: A loop is a valve, plumbing & mass flow controller (MFC) assembly for one gas

- Quartz process tube to accommodate wafers of at least 6" diameter
- Contiguous 25 slot quartz wafer carriers, one each for 3" and 4" wafers
- Three junction, source entry, profile thermocouple
- Manual insulated quartz door
- Manual quartz sled designed to hold 2 quartz wafer carriers

4.81 Wet Oxidation Gas Tray Design - must include the following features:

- Each flow loop must include 1/3PSI check valve at main inlet, 0.03 μ m Point Of Use Filter (POUF), MFC and pneumatic valve
- Plumbing assembly must be constructed of 316L electropolished stainless steel tubing (1/4" - R_a 10) orbital welded with Microfit fittings in lieu of bends
- All plumbing must be assembled in a class 100 cleanroom environment
- Two MKS analog mass flow controllers (MFCs) with range of at least 20 standard liters per minute (SLPM) must be provided for this application, both must be soft start and must be calibrated respectively for:
 - Nitrogen (N₂)
 - Oxygen (O₂)
- Gas connections to process tube must be included
- An additional N₂ loop with a fixed orifice and a normally open valve must be provided for purging in case a of power failure

4.82 Wet Oxidation Steam Generator With Auto Refill- must be configured as follows:

- 2000 CC Quartz Flask with temperature controlled heating mantle
- Steam trap to allow drain without losing steam pressure
- 3 way 3/4" Teflon valve to direct steam to vent or process
- Deionized water autofill through needle valve
- All plumbing components necessary for installation are to be supplied by offeror

4.9 NITRIDE- POLY 4 LOOP, TUBE LEVEL 2 - must consist of the following:

- Domed quartz process tube
- Front flange- flangeless type constructed as follows:
 - hinged door for manual loading.
 - water cooled with rotometer
 - high water flow cooling bypass
- (2), 25 slot contiguous quartz carriers, (1) each for 3" & 4" wafers
- Three junction source entry profile thermocouple
- Manually operated quartz sled designed to hold 2 boats

4.91 Nitride- Poly 4 Loop Gas Tray Design - must include the following features:

- Each flow loop must include:
 - A 1/3PSI check valve at main inlet,
 - A 0.03 μ point of use filter
 - MFC and pneumatic valve
- Plumbing assembly must be constructed of 316L electropolished stainless steel tubing (1/4" - R_a 10) orbital welded with Microfit Fittings in lieu of bends
- All plumbing must be assembled in a class 100 cleanroom environment
- Analog mass flow controllers (MFCs) must be provided for each of the following gases, all are soft start with the ranges indicated and calibrated respectively for:
 - Nitrogen (N₂), (carrier gas) 2-5 SLPM
 - Silane (SiH₄), 200 standard cubic centimeters per minute (sccm)
 - Dichlorosilane (SiH₂Cl₂), 200 sccm
 - Ammonia (NH₃), 100 sccm
- Process and carrier gasses are to be introduced to the load end flange through 3 deposition lines, one for SiH₂Cl₂, one for SiH₄ and one for NH₃.
- Two N₂ MFC's must be split between the two deposition lines for purging.
- Provisions are to be provided for purging upstream, downstream and through the MFCs of the reactive gasses
- A needle valve must be included for low flow nitrogen purge w/o using a MFC

4.92 Nitride- Poly 4 Loop Foreline assembly - must include the following:

- Modular 2" foreline with KF 50 or equivalent connections
- Heated isolation valve with integral soft start
- Heated closed loop pressure control through butterfly throttle valve and controller
- Water cooled trap with rotometer
- Two heated vacuum gauges with maximum readings of 1000 torr & 1 torr
- Flex bellows and tube adapter
- Heated foreline from system to pump. Maximum length, 10'
- Edwards QDP80 Drypump or equivalent
- Gas module
- Emergency shut off switch

5.0 System must be equipped with the following process related Safety Interlocks:

- Door Switch to interlock isolation valve
- Atmosphere switch to interlock door and foreline
- Pressure switch to interlock gas flow

6.0 DOCUMENTATION - with each unit must be included:

- (2) complete sets of operating, maintenance/calibration instructions,
- all vendor manuals
- facility and electrical drawings
- spare parts listing (in English) on CD.

7.0 FILM SPECIFICATIONS - the system must meet or exceed the following film requirements:

<u>Process</u>	<u>Deposition Rate</u>	<u>Uniformity - 3 sigma, 6" wafers, 6mm edge exclusion</u>		
		<u>Within wafer</u>	<u>Wafer to wafer</u>	<u>Run to run</u>
Poly-Si	50 - 100 Å/min	2.5%	2.5%	2.5%
Silicon Nitride	30 - 55 Å/min	3.5%	2.5%	2.5%
Wet Oxidation	30 - 200 Å/min	2.5%	3.0%	2.5%

8.0 OPTIONS to be offered by offeror:**8.1 Automatic Loading System with a minimum of the following features:**

- Twin Rod design for both atmospheric and LPCVD processes
- Quartz door and stainless steel door assembly
- Brushed stainless steel frames and covers
- Must fit in existing furnace footprint, and add no more than 6" to overall height
- Head assembly must allow for X-Y-A, pitch and yaw adjustments
- At least two profile linear bearings are to be used
- Moving parts are not to generate particulates
- Must permit local and remote modes of operation through the system controller
- All interconnecting cables are to be provided
- In/Out adjustable limit switches are to be provided
- System can be belt driven with drive clutch
- A position/speed potentiometer must be provided
- Status indicator lights for in / out and run complete must be incorporated

8.2 Spare Quartz Kit for Atmospheric and LPCVD process - manual load

- 235mm OD Domed quartz process tube with 25/35mm ball joint and a TC stem for oxidation processes (Atmospheric)
- 235mm OD Domed quartz process tube with 75/50 mm ball joint and a TC stem for LPCVD processes
- 25 slot quartz boats for 2",3",4", & 6" wafers
- Quartz sleds designed to carry above boats
- Insulated quartz door

8.3 PC based supervisory type control package -For more extensive recipe management, data collection & storage a computer must be offered. At a minimum it must consist of the following -

- PC Hardware:
 - An IBM compatible 800 MHz Pentium III or equivalent PC, 256 MB Ram Memory, 1.44 MB diskette drive, 20GB hard drive, 10/100 ethernet card, CD-R/RW, 17 inch flat screen color monitor, APC 500VA or equivalent uninterruptible power supply (UPS), V905/56k or equivalent internal modem for remote system support, keyboard and mouse.

- Software features must provide ability to:
 - Search and browse complete logs of all system and user events.
 - Display detailed real-time status for each process chamber.
 - Store and edit engineering and production recipes.
 - Fully control process configuration and recipe downloading.
 - Capture, graph and compare real-time data, archived data and recipes.
 - Automatically profile without operator assistance.
 - Control user access through multiple security levels.
 - Remotely control supervisors and back up recipes over the network
 - Allow user to use power output setpoints via supervisor.

8.4 Hoods for removal of cooling fan exhaust air- to be fabricated as follows:

- Constructed of stainless steel
- One hood fitted to bottom of unit and to supply air from outside the cleanroom
- One hood fitted to top of unit for exhausting air to outside of the cleanroom
- Hoods to have tubular connections of sufficient diameter to accommodate a flow of at least 600cubic feet per minute (CFM) from furnace exhaust fans

9.0 Installation and Training:

Vendor shall hook up the system to the required facilities available at the designated location and provide the necessary training for complete operation and routine maintenance of the tool to a minimum of five NRL researchers.