

**Magnetron sputtering unit specification list**

**Sample/Substrate: Hollow tube/cylinder two different dimensions as given below.**

**Cylinder I** (Through hole with a blender end of 38 mm ID and another end 110 mm ID):

Kindly check the attached drawings for better clarification.

Material: AISI4140 or EN19 steel alloy,

Outer dia., OD = 140 mm (may vary up to 170 mm along the length),

Inner dia., ID = 130 mm (38 mm nearer to the blender end),

Length, L = 310 mm uniform coating requirement ~274 mm length from open end till the blender end, as per the drawings.

Tube wall thickness, W varies from 6.5, 10, 15 and 20 mm along the length.

- a. Net weight of the tube i.e. sample is ~18 kg (machined) or 25 kg (forged).
- b. Requirement: Diamond-like-carbon coating (DLC) on inner surface of the cylinder.
- c. Substrate temperature should have precise control from room temperature up to 400 °C within  $\pm 2^\circ\text{C}$ .
- d. Interlayer deposition including Ti, Ni etc., required to improve the adhesion property between the DLC coating and the substrate.
- e. Interlayer deposition via sputtering technique with high uniformity <2% variation.

**Cylinder II** (Through hole with uniform ID at both ends):

Kindly check the drawings for better clarification

Material: BSS99G steel alloy

OD = 80 mm,

ID = 76 mm

L = 310 mm (Coating requirement total length)

W = 2 mm (uniform throughout the length).

- a. Net weight of the tube ~ 2 kg.
- b. Requirement: DLC coating on inner surface of the cylinder.
- c. Substrate temperature should be below 200 °C (even during the deposition time).
- d. Interlayer may be required to improve the adhesion property between the coating and the substrate.

**Main features of the system are:**

- All SS 304 construction of vacuum chamber, valves and vacuum plumbing.
- All reputed ‘O’ rings and gaskets or equivalent.
- Turbo molecular pumping system to provide fast initial pump down, clean vacuum and good throttling for process pressure control.
- Closed loop pressure control electronics for precise pressure control during sputtering.
- High vacuum compatible heaters along with PID control and thyristorized power control for precise temperature measurement and control.
- RF supply with Auto Matching network.
- Pulsed dc magnetron sputtering power supplies with advance arc control, pulse width and frequency control.
- DC bias power supply with facility for substrate bias.
- Precision mass flow controllers for process consistency.
- Complete PLC-PC based automation with recipe programming facility, and maintenance management.
- Use of CE certified critical/imported electrical parts.
- Low down time and high reliability.

Requirements	Remarks
<b>VACUUM CHAMBER</b>	
<p>All SS 304 TIG Welded SS Chamber, non-magnetic which is more suitable to accommodate on different size/type of components to be coated</p> <ul style="list-style-type: none"> <li>✓ Front door opening</li> <li>✓ Mechanically lapped from inside</li> <li>✓ 4” Glass view port O’ring sealed with safety shield and shutter</li> <li>✓ He leak tested for leak values better than <math>10^{-9}</math> Torr /Lit.sec.</li> <li>✓ TIG Welded C Channel for Chamber Cooling</li> <li>✓ SS vacuum chamber should be water cooled with, ports provision for view, gauge, Gas Inlet valve, Vacuum Pumping, Sputter source, Heater feedthrough port, mounted on Frame with manual gate valves for view ports, gas inlet valve and arrangement for Nitrogen shower for preventing oxidation of sample while changing targets.</li> <li>✓ All Viton O rings or equivalent.</li> </ul>	
<b>SUBSTRATE HOLDER AND HEATING CONTROL</b>	
<p><b>Substrate Stage with Fixture and Holder to accommodate the following Jobs</b></p> <ul style="list-style-type: none"> <li>✓ Cylinder I [4140 Steel]</li> </ul>	

<p>ID Ø 130 mm dia. and length 310 mm  Net weight: 16-25 Kg</p> <ul style="list-style-type: none"> <li>✓ Cylinder II [BSS 99G]  ID Ø 76 mm dia. Length 304 mm  Net weight: 2-4 Kg</li> </ul> <p>Substrate Holder should be fully isolated from chamber and connected to Bias Power Supply which are required to improve the adhesion of coating property.</p> <ul style="list-style-type: none"> <li>✓ The substrate holder should capable of holding one tube at a time.</li> <li>✓ Substrate fixture rotation should be provided with the variable speed range (i.e., 0-5 RPM with 5% tolerance).</li> </ul> <p><b>Substrate Heater</b></p> <ul style="list-style-type: none"> <li>✓ High vacuum Compatible Substrate Heater with Feedthrough more suitable for Cylinder I and II.</li> <li>✓ It should have Closed Loop PID Control (Ambient to 400°C±1 °C)</li> <li>✓ Plasma Isolated and Flexible K-Type all Stainless Steel Grounded Thermocouple arrangement with Isolation Amplifier for Temperature Measurement (±1 °C).</li> <li>✓ Ferro fluidic or magnetic shaft seal.</li> </ul>	
<b>DESIGN OF THE MAGNETRON SPUTTERING SYSTEM</b>	
<p>Custom design of the magnetron sputtering unit suitable for inner surface coating on the cylinder components should be given with necessary diagrams and figures.</p> <ul style="list-style-type: none"> <li>• If possible, pre-coating parameters such as uniformity can be included.</li> </ul>	
<b>DETAILED DESIGN REVIEW</b>	
<p>The detailed design review shall be made after placement of purchase order by User's Department and subsequent acceptance by the supplier/manufacturer. During the detailed design review, the following points shall be taken into consideration.</p> <ul style="list-style-type: none"> <li>• All technical details, design basis reports and detailed drawings of the proposed system.</li> <li>• Complete drawings of the system's mechanical and electrical layout, as well as control systems, should be provided.</li> <li>• Detailed schedule of execution of work with time line.</li> </ul>	

<ul style="list-style-type: none"> <li>• Supplier should provide above details within four weeks after the receipt of the purchase order.</li> <li>• Supplier shall begin the fabrication of the proposed system only after the approval of design by the User.</li> <li>• Regular communication and coordination has to be made with the User during the manufacturing stage.</li> </ul>	
<b>VACUUM PUMPING SYSTEM</b>	
<p>Ultimate Vacuum [In Clean and Dry System in 50 min]: Atmosphere to <math>\sim 10^{-6}</math> mbar</p> <ul style="list-style-type: none"> <li>• Pump Down Time: 30 minutes for Atm. To <math>\sim 2 \times 10^{-5}</math> mbar</li> <li>• Process pressure during Sputtering: min. <math>1 \times 10^{-3}</math> mbar</li> </ul> <p>Dry Rotary Pump (<b>Reputed Make</b>) 1 no. Model: <b>Reputed Make</b>. Range: Minimum of 10 m<sup>3</sup>/hr or most suitable for design of the chamber.</p> <p>Turbo Molecular Pump (<b>Reputed Make</b>) 1 no. Model: <b>Reputed Make</b>. Range: Pumping speed: Minimum of 250 lit/sec or most suitable for design of the chamber.</p> <p style="text-align: center;"><b><u>VACUUM VALVES</u></b></p> <p><b>Roughing Valve 1 no.</b></p> <ul style="list-style-type: none"> <li>• Right Angle Bellow Sealed</li> <li>• ISO KF 25 Compatible</li> <li>• Electro pneumatically Operated</li> <li>• Micro switch for OPEN/CLOSE indication and Feedback</li> </ul> <p><b>Backing Valve 1 no.</b></p> <ul style="list-style-type: none"> <li>• Right Angle Bellow Sealed</li> <li>• ISO KF 25 Compatible</li> <li>• Electro pneumatically Operated</li> <li>• Micro switch for OPEN/CLOSE indication and Feedback</li> </ul> <p><b>High Vacuum Valve (Reputed Make) 1 no.</b></p> <ul style="list-style-type: none"> <li>• Model: <b>Reputed Make</b></li> <li>• Bellow Sealed Gate Valve</li> <li>• ISO 200 Compatible or CF100</li> <li>• Electro pneumatically operated or motorized for throttling.</li> <li>• Micro switch for OPEN/CLOSE indication and Feedback</li> <li>• Variable conductance valve or Gate Valve suitable for the design.</li> </ul>	

<b>Vacuum Plumbing</b> All SS Hoses and ISO Standard Fittings.	
<b>PRESSURE MEASUREMENT</b>	
<p>Vacuum Gauges [<b>Reputed Make</b>]</p> <p>a. Active Pirani Gauges 1 no. + 1 no. spare Range: Minimum <math>10^{-3}</math> mbar to Atmosphere.</p> <p>b. Cold Cathode Gauge 1 no. + 1 no. spare Range: <math>1 \times 10^{-2}</math> to <math>1 \times 10^{-9}</math> mbar</p> <p>c. Capacitance Gauge I [Range: 0-1 Torr or more suitable range for uniform PVD coating process] 1 no.</p> <p>d. Gauge Controller with digital display with set point control 1 nos.</p> <p><b>CLOSED LOOP PRESUURE CONTROL</b></p> <ul style="list-style-type: none"> <li>• PID Controller along with PID Closed Loop Controllers for Maintaining Process Pressures for PVD.</li> </ul>	
<b>MAGNETRON SOURCES</b>	
<p>Custom designed magnetrons at a constant target-substrate distance more suitable for uniform coating of &lt;2% tolerance on the inner surface of the cylinder along the length should be provided with necessary diagrams.</p> <ul style="list-style-type: none"> <li>• It should be provided for interlayers (Metals, Metal Nitrides, composites: Cr, CrN, Ta, Ti, TiN, TiB<sub>2</sub>, ZrB<sub>2</sub>) and functional (Carbon/diamond-like-carbon) deposition on both cylinders.</li> </ul>	
<b>Sputtering Targets</b>	
<p>Based on the custom design of the magnetron gun, 3 no of highly pure interlayer and functional layer target material should be supplied.</p> <ul style="list-style-type: none"> <li>• Manufacturer is free to decide target size subject to the condition that absolute thickness uniformity better than <math>\pm 2\%</math> for a film thickness of 1 micron on inner surface of the cylinder as per the custom design by the supplier.</li> <li>• Sputtering targets should be provided along with Make &amp; certificate of analysis (CoA).</li> </ul>	
<b>POWER SUPPLY FOR MAGNETRON SPUTTERING</b>	
<b>PROCESS POWER SUPPLIES [Reputed</b>	-

<p><b>Make]</b></p> <p><b>a) RF supply with Auto Matching network</b> <b>1 no</b></p> <ul style="list-style-type: none"> <li>- Minimum of 300 W RF Power Supply</li> <li>- Frequency: Min. 13.56 MHz</li> <li>- Precision power control +/- 1% of set point.</li> <li>- Combined RF Generator including the Automatic Matching Network Controller.</li> </ul> <p><b>b) Pulsed DC Magnetron Sputtering Power Supply [Reputed Make] 1 no.</b></p> <ul style="list-style-type: none"> <li>- Minimum of 5 KW Pulsed DC Power Supplies</li> <li>- Max. Voltage: Upto 800 Volts</li> <li>- Pulse Frequency: Upto 350 KHz</li> <li>- Pulse Width Control: 10 – 90%</li> <li>- Active Arc Suppression and Control with Reset Facility.</li> </ul> <p><b>c) Power supply for Bias 1 no.</b></p> <ul style="list-style-type: none"> <li>- Max. voltage upto 200 V</li> <li>- Max. current of 1 A</li> <li>- Constant voltage</li> </ul>	
<b>GAS INLET SYSTEM</b>	
<p>Mass Flow Controllers [<b>Reputed make</b>]</p> <ul style="list-style-type: none"> <li>• Argon [100 sccm] 1 no.</li> <li>• Hydrogen [500 sccm] 1.no.</li> <li>• Nitrogen (100 sccm) 1 no.</li> <li>• Acetylene [100 sccm] 1 no.</li> </ul> <p>One more as a spare are provided to carryout Magnetron sputtering.</p> <p><b>a) Power Supply Control Electronics</b> for Mass Flow Controllers with Digital Display of Flow rates</p> <p><b>b) Gas Mixing Chamber</b> with provision for 6 gases</p> <p><b>c) Gas lines (Seamless ¼” SS Tubing with compatible Fittings ).</b></p> <p><b>d) GAS INLET VALVE 1 no.</b></p> <ul style="list-style-type: none"> <li>• Straight Through/ Right Angle Type Valve</li> <li>• SS bellow sealed or SS diaphragm valve</li> <li>• KF 16 Compatible</li> <li>• Electro pneumatically Operated Micro switch for open indication and Feedback.</li> </ul>	
<b>SYSTEM CONTROL ELECTRONICS</b>	
<p><b>The control system consists of the</b></p>	

**following elements:**

19” rack housing mains power distribution and control IPC.

Complete PLC-PC based Automation with user friendly graphical interface software for control and data acquisition.

Software consisting of:

- Programmable Logic Controller [PLC] with Digital and Analog Inputs/Outputs
- Ladder based PLC Programming for process sequence and Interlocks
- Process Control by sequential operation to build up a standard recipe for Vacuum Pump Down Control, and Sputtering.
- System Mimic with Status Indication of Each Subsystem
- Recipe programming, Storage and Recall Facility
- Trends for all major process parameters
- Alarm Management with continuous Alarm Logging
- Maintenance Management
- Web enabled remote maintenance possibility
- Independent hard and software interlocks for personal safety issues like high voltages, pressure limits and doors.
- Emergency stop button to shut down.
- Touch screen 15” IPC mounted on a 19” rack.

1 redundant hard disk, ready to use.

- All the process steps starting from rough vacuum to high vacuum pumping and all the deposition parameters will set through IPC and interlocked for operator error.
- Data display and data logs for power supply feedback, position of the magnetron
- Interlock for safety (vacuum interlock, cooling water interlock, rotary stage, compressed air interlock and single phase prevention with audio alarm.

Operation in the following Modes:

- AUTO Mode with Recipe Programming
- COMMISSIONING MODE [Manual Mode with safety Interlocks].

**MAIN FRAME**

**Suitable Chamber Support Frame**

<ul style="list-style-type: none"> <li>- All interlocks for safety operation with audio alarm</li> <li>- Electrical overload protection</li> <li>- Chamber closed interlock</li> <li>- Compressed Air failure</li> <li>- Emergency Stop</li> <li>- Single Phasing Preventer</li> </ul>	
<b>SPARE PARTS</b>	
<ul style="list-style-type: none"> <li>- All O'rings 1 set</li> <li>- Tool Kit 1 no.</li> </ul>	
<b>SITE PREPARATION AND UTILITIES DOCUMENT</b>	
<p>For proper system installation, The site preparation details, e.g., floor plan of the whole system, electrical distribution lines, water and gas lines should be sent by the manufacturer along with the above details, so that necessary arrangements can be made by the User.</p>	
<b>WATER CHILLER UNIT</b>	
<p>Reputed make water chiller unit with recirculation pump, water level indicator, temperature controller along with necessary tubes and fitting.</p> <ul style="list-style-type: none"> <li>✓ Flow rate: 30 litres/min</li> <li>✓ Inlet Temp.: 15 °C</li> <li>✓ Outlet Temp.: 20 °C</li> </ul>	
<b>DOCUMENTATION</b>	
<p>One set of hard copy of following documents should be supplied along with the system:</p> <ul style="list-style-type: none"> <li>One set of operation &amp; instruction manual (Hard copy and soft copy) for operation and maintenance of the system</li> <li>Electrical and mechanical drawings of main equipment's and subsystems along with the foot prints.</li> <li>Service manual with electrical diagrams and troubleshooting procedures.</li> </ul>	
<b>TRAINING</b>	
<p>After installation &amp; commissioning of the system at IITM site, the supplier should provide training to the Department personnels for at least 2 days.</p> <p>Training shall include automated and manual operations of the system, deposition recipe creation, and calibration on a day-to-day basis, replacement of spare parts, preventive maintenance and general troubleshooting.</p>	
<b>WARRANTY</b>	
<p>The entire assembly should have warranty for</p>	



<p>a period of 12 months after installation or 15 months from the date of shipment of the system against any manufacturing defects.</p> <p>Supplier should support the user with all the spares for a minimum period of 10 years.</p>	
<p><b>INSTALLATION &amp; COMMISSIONING</b></p>	
<p>The supplier should install, test and commission the Sputtering system at IITM site within 4 month after receipt of the item in IITM.</p> <ul style="list-style-type: none"> <li>• The site preparation will be done by the User's Department as per requirements provided by the supplier in the site preparation and utilities document.</li> <li>• The inspection &amp; testing of complete system as per specifications shall be again conducted at User's works after installation and commissioning of the machine to the satisfaction of the User.</li> <li>• All the characterization facilities required will be made available by the User's Department during the final acceptance test.</li> </ul> <p><b>AFTER SALES SUPPORT</b></p> <p>Supplier should provide available Tele assistance.</p> <ul style="list-style-type: none"> <li>- For Completely Automated System the graphical interface software should have web enabled and software support can be provided through remote Internet connection.</li> <li>- After sales support for Pumps (TMP, Rotary) is provided by Reputed make through its full-fledged service center available at India.</li> <li>- All other subsystems and parts will be completely serviced and supported by supplier</li> <li>- After completion of Warranty period Annual Maintenance contract should be offered to the customer.</li> <li>- All components / subsystems manufactured by supplier are supported for 10 years from the date of supply.</li> </ul>	
<p><b>INSPECTION AND ACCEPTANCE PROTOCOL</b></p>	
<p>Goods are subject to inspection before dispatch. Pre-dispatch inspection will be witnessed by the Departmental representatives at the manufacturer's site.</p>	

Tests will also be performed at the User's facilities after installation and will constitute the final acceptance test.	
<b>CUSTOMS DUTY</b>	
The custom duty exemption certificate for the imported items can be provided as per supplier's request.	
<b>Payment Terms</b>	
Supplier should provide the payment terms details.	
<b>DELIVERY</b>	
Within 12 – 16 weeks after receipt of confirmed purchase order along with advance. The period is inclusive of the training period (if any) and Acceptance / Inspection Tests to be carried out at IITM works.	
<b>PACKING AND FORWARDING</b>	
Equipment should be packed securely for roadworthy transport. For any damage due to improper packing, supplier shall be responsible.	
<b>PRICE (Ex-Factory, India)</b>	
<b>INR</b>	