Operating Manual

Cressington 108

Sputter Coater for
standard SEM/EDX applications

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Section 1: **General**

1.1 Operational Features

The Cressington 108 Sputter Coater is designed primarily for sputtering conducting gold layers onto samples to prevent charging effects in the scanning electron microscope. It uses a planar magnetron sputter target configuration to give efficient high rate sputtering with minimal specimen heating.

The Cressington 108 is designed as an integrated vacuum system with its desktop pumping system matched to the coating unit for optimum performance. The quality of coatings produced by the system relies on the gas handling characteristics in the range 0.01mb to 0.1mb. The high pumping speed of the system in this pressure range naturally results in rapid pumpdown performance from atmosphere and short cycle times.

In the past, sputter coaters for SEM have used the gas pressure control valve to adjust the sputtering current. The Cressington 108 does not operate in this way: Gas control and current control functions have been separated. This allows the user to independently adjust operating pressure *(mb)* and sputter current *(mA)* to obtain the best sample conformity and minimum grain size. The adjustable height sample table allows further optimization of the coating (see Section 5.2 *Coating Difficult Samples).*

The Cressington 108 sputter coaters can be factory fitted (or retro-fitted) with the optional MTM-10 thickness monitor system.

1.2: Services Required

The 108 sputter coater requires a single phase AC electrical supply from a standard laboratory power point. It is available in 100/120V and 200/240V versions.

The serial number label on the back panel of the control unit is marked with the supply voltage requirement.

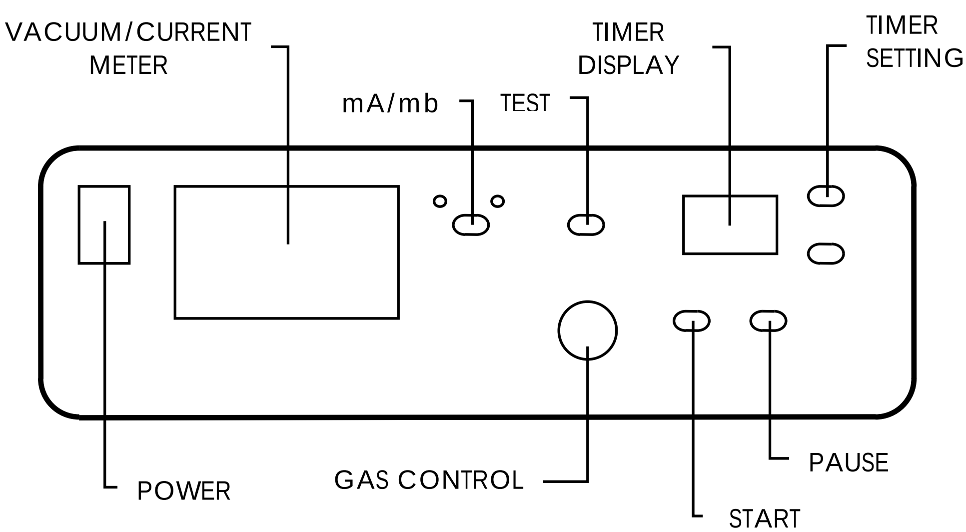
The coater requires a supply of argon gas from a high pressure gas container. The gas purity must be at least *"arc welding grade"* and its supply pressure reduced to 0.3-0.6bar (5-9psi) by using a pressure reducing regulator valve. Connection requires clear plastic hose (6.0mm internal diameter).

Section 2: **Description**

2.1 Control Panel

The main *POWER* switch turns on the pumping system and the vacuum gauge*.* At pressures above 0.4mb the sputter supply is disabled and the *mb* light will flash until a pressure below 0.4mb is achieved.

The vacuum chamber pressure (*in mb)* is indicated on the lower scale of the meter. Meter scale changing is automatic and the upper scale will indicate sputter current *(in mA)* when the sputtering supply is energized*.* A manual over-ride switch *(mA/mb)* is used for momentary change-over between the scales; indicator lights show which scale is selected.



Rotating the gas control knob in a counterclockwise direction allows gas to enter the sputter chamber through a gas metering valve. Sputtering is usually carried out between 0.05mb and 0.10mb (see Sections 5.1/5.2). Power output can be checked before starting the coating cycle by pressing *TEST.* Power adjustment is on the rear panel (see next page).

Sputtering, for the preset time indicated on the timer display, is initiated by pressing *START.* It can be temporarily halted using *PAUSE* and the light above *PAUSE* will flash. To restart press *PAUSE* again.

The preset sputtering time is adjusted (before pressing *START*) by pressing *PAUSE* and toggling the timer setting switches with *PAUSE depressed.*

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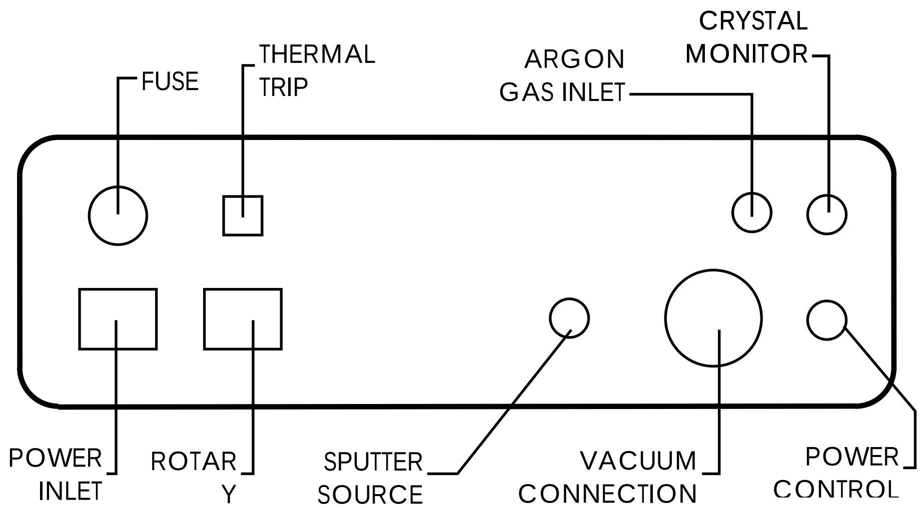
2.2 Rear Panel

Electrical power to the coater is via the *MAINS POWER INLET* socket. A power cable is provided. The *FUSE* protects the control unit but not the rotary pump (which is separately protected).

The rotary pump is powered from the *ROTARY PUMP POWER* connector port. It is protected by a resettable *THERMAL TRIP.* The pumping port is marked *ROTARY PUMP VACUUM CONNECTION* and has the standard KF16 format to accept the stainless steel flexible hose.



The high voltage power cable from the rear panel *(SPUTTER SOURCE)* to the sputtering head is permanently wired for safety. The output is also controlled by a protection circuit linked to the Pirani vacuum gauge: The high voltage output cannot be energized until the vacuum is better than 0.4mb. (If the Pirani gauge becomes faulty the supply will not energize and the fault condition will be indicated by the *mb* light flashing and the vacuum meter needle being off-scale in either direction).

The 108 sputter coater is fitted with a variable power output control. The control knob is fitted in the port marked *"needle valve adjustment, auto models"*. Power output is at maximum when the control is fully clockwise (viewed from rear).

The rear panel *ARGON GAS INLET* is connected internally to the gas control valve. The argon passes from the control valve to the chamber inlet under the baseplate. The *ARGON GAS INLET* should be connected externally (using a 6.0mm internal diameter plastic hose) to a regulated supply of argon (see Section 3.2.5).

A rear panel vent gas inlet is not fitted on this model as a manual air vent is fitted on the chamber top-plate.

A rear panel connector position is provided to allow the optional *CRYSTAL MONITOR* to be fitted.

2.3 Vacuum Pumping System

The rotary vacuum pump is sited to the rear of the control unit on a vibration isolated base. It pumps the internal vacuum system via a short stainless steel flexible hose. External vacuum connections are made using the international KF system.

The pump exhaust is filtered to prevent oil mist droplets from diffusing into the laboratory environment.

Inside the control unit, directly underneath the chamber baseplate, is a vacuum manifold with three ports. These ports accept: (1) the Pirani vacuum gauge head, (2) the argon gas supply from the gas control valve, and (3) the pumping line from the rear panel.

The pumping path from the pump inlet to the sputtering chamber has an unusually high conductance. This gives a very rapid pumpdown from atmosphere (less than 2 minutes under test conditions). It also results in efficient argon gas handling in the pressure range 0.1mb to 0.01mb.

2.4 Chamber and Specimen Table

The cylindrical vacuum chamber (Ø120mm OD x 120mm high x 7.0mm wall) is made from high quality glass. After processing it is annealled to relieve manufacturing stresses. The vacuum seals at each end of the glass cylinder are made by O-rings recessed into the baseplate and top-plate.

The chamber top-plate is attached by a bracket to a support pillar. The bracket is hinged to allow the top-plate to be lifted for access to the chamber. The top-plate incorporates an efficient magnetron sputter source with a 57mm diameter metal foil target (usually gold). Electrical connection to the sputter head is underneath the painted cover.

The chamber is vented (after switching off the power) by rocking the valve in the top-plate (to the right hand side of the cover).

A sample table is mounted on a threaded pillar screwed through the center of the baseplate clamping disc. The table is raised or lowered by loosening the lower locking nut and rotating the table (1 turn equals 1mm).

The baseplate contains a feedthrough port suitable for mounting a thickness monitor feedthrough . If the optional thickness monitor is not supplied this port is blanked.

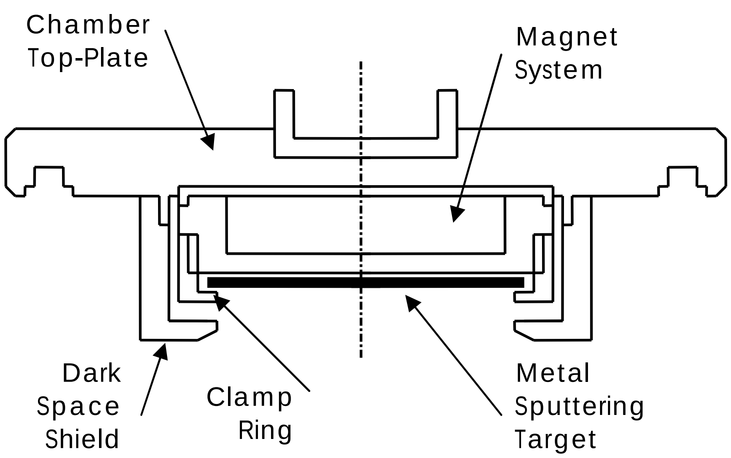
The sample table has a larger hole for mounting the crystal monitor head of the optional thickness monitor system.

2.5 Magnetron Sputter Head

In a diode sputtering system the deposition material is electrically connected to be the cathode of a gas discharge. The discharge current is carried by both gas ions and electrons. Positive gas ions are accelerated in the electric field towards the negative sputter target. When they strike the target the gas ions eject target atoms by momentum transfer. This process is called *sputtering.* The sputtered target atoms then diffuse away from the target and will deposit on any nearby surface.

Sputtering has the specific advantage for coating SEM samples that, if a suitable gas pressure is chosen, the sputtered material arrives at the sample with random direction. This gives the coating good conformity to the sample surface without the use of sample stage movements.

Modern sputtering systems use target arrangements, which include magnetic circuits to enhance the intensity of the discharge and keep the electrons captive in the target area (to reduce heating effects at the sample).
The Cressington planar magnetron sputtering source is shown above. The metal foil target



(57mm dia x 0.1mm thick) is held by a threaded clamp ring. The dark space shield must be removed before the target can be changed.

In a magnetron arrangement the sputtering is most intense where the magnetic field is most concentrated. The *effective size* of the present target is about 30mm.

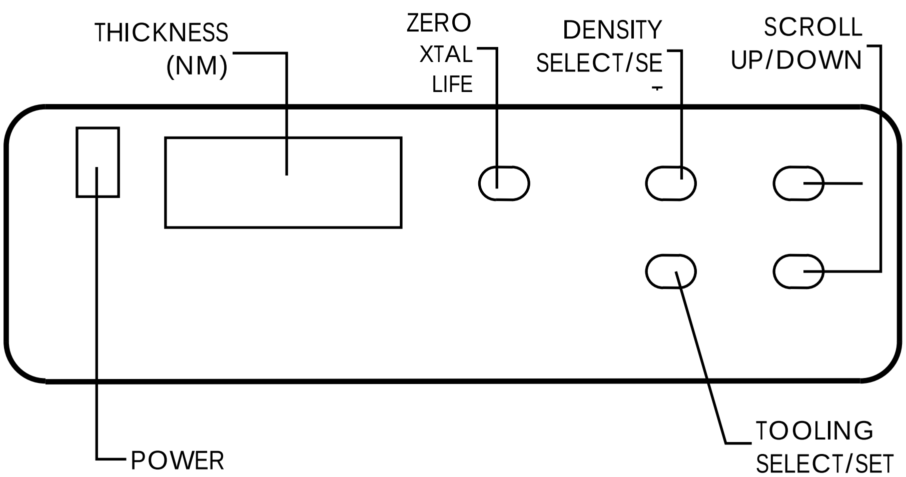
The most efficient operating pressure for the head (in terms of *amount of material deposited*) is around 0.05mb but this is not the pressure for optimum sample coating by gas scattering. In order to allow a choice of operating conditions the Cressington sputtering supply has been designed to give *constant sputter current independent of gas pressure.*

The nature of the coating will also depend on distance between target and sample. For this reason the Cressington 108 has the facility to raise and lower the sample table.

2.6 Quartz Crystal Thickness Monitor

The MTM-10 thickness monitor works on the principle of the *quartz crystal microbalance.* When sputtered material is deposited on an oscillating quartz crystal its frequency is decreased in relation to the mass of material deposited. The frequency change can be used to calculate the film thickness if the density *(gm/cm^3)* of the material is known.

The complete thickness monitor outfit comprises: (1) a crystal head mounted in a special sample table, (2) a vacuum feedthrough mounted in the chamber baseplate, (3) an oscillator unit mounted under the baseplate, (4) connecting cables and adaptors, (5) an MTM-10 control box. The front panel of the control unit is shown below.



The thickness monitor calculates the thickness of deposit every tenth of a second and displays the result in nanometers on the digital *THICKNESS* display. It detects the frequency shift and uses the *DENSITY* and *TOOLING* values stored into memory. Four sets of values can be stored under *DENSITY* and *TOOLING.*

To display the currently selected value of material density or tooling factor, press the relevant key and the value will appear on the *THICKNESS* display. To select another of the four values scroll up or down to the other values using the scroll keys. To adjust that value, hold down the relevant key for two seconds until the period flashes and scroll up or down using the scroll keys.

The measuring crystal can only accept a finite amount of sputtered material before becoming overloaded. The amount of offset from its original frequency (6.0MHz) is displayed (in KHz) when X*TAL LIFE* is pressed for two seconds. The expected life of a crystal will depend on the material and the level of stress in the sputtered deposit. When the crystal ceases to oscillate the display shows *"FAIL".* To reset the thickness between runs press *ZERO*.

The thickness of film required to prevent charging is very dependant on the sample and the operating voltage in the SEM. A thickness of between 3nm and 5nm will usually prevent charging. The thickness monitor is a valuable aid for standardizing the conditions for obtaining the optimum coating: Thin enough not to obscure fine detail but thick enough to prevent charging.

Target material	Atomic number	Density in gm/cm^3
Pt/Pd (80/20) (Cressington)	78/46	19.52
Au/Pd (80/20) (Cressington)	79/46	17.84
Au/Pd (60/40)	79/46	16.38
Pt	78	21.45
Au	79	19.30

Table 1. Density values for target materials.

The Tooling Factor is used to correct the measured thickness on the crystal head to the actual deposited thickness on the sample. The measured thickness can be different for a variety of reasons:
- the density of thin layers is mostly lower than for solid block material.
- there might be a difference in distance to the target for the crystal head and the sample.
- there might be a difference in angle for the crystal head and the target.

If the crystal head is further away from the target, the thickness on the sample is most likely more than measured: use a tooling factor > 1.

Independent calibrated measurements with either step height (AFM) or cross section (SEM) are recommended to determine the correct Tooling Factor for sputtering processes.

Section 3: Installation

3.1 Unpacking

The complete system, (control unit and pumping system) occupies a bench area 420mm wide x 600mm deep (18 x 24”) on a standard laboratory bench. The vacuum pump is sited behind the control unit. After clearing the designated area, unpack the control unit and place it on the bench. Remove the packing materials from the sputter chamber baseplate and top-plate.

IMPORTANT
DO NOT ALLOW ANY PACKING MATERIAL TO ENTER THE BASEPLATE PUMPING PORT. TAKE EXTRA CARE WHEN UNPACKING AND HANDLING GLASS CHAMBER COMPONENTS.

Unpack and identify the components of the pumping system:

(1) Rotary pump on anti-vibration base (typical Pfeiffer DUO 2.5);
(2) Stainless steel flexible hose;
(3) KF10 O-ring seals and clamps;
(4) Exhaust mist filter; and
(5) Vacuum pump oil.

3.2 Assembly

3.2.1 Pumping System

Unscrew the hose fitting from the rotary pump exhaust and screw in the exhaust filter.

Fill the rotary pump with oil (according to the manufacturers instructions).

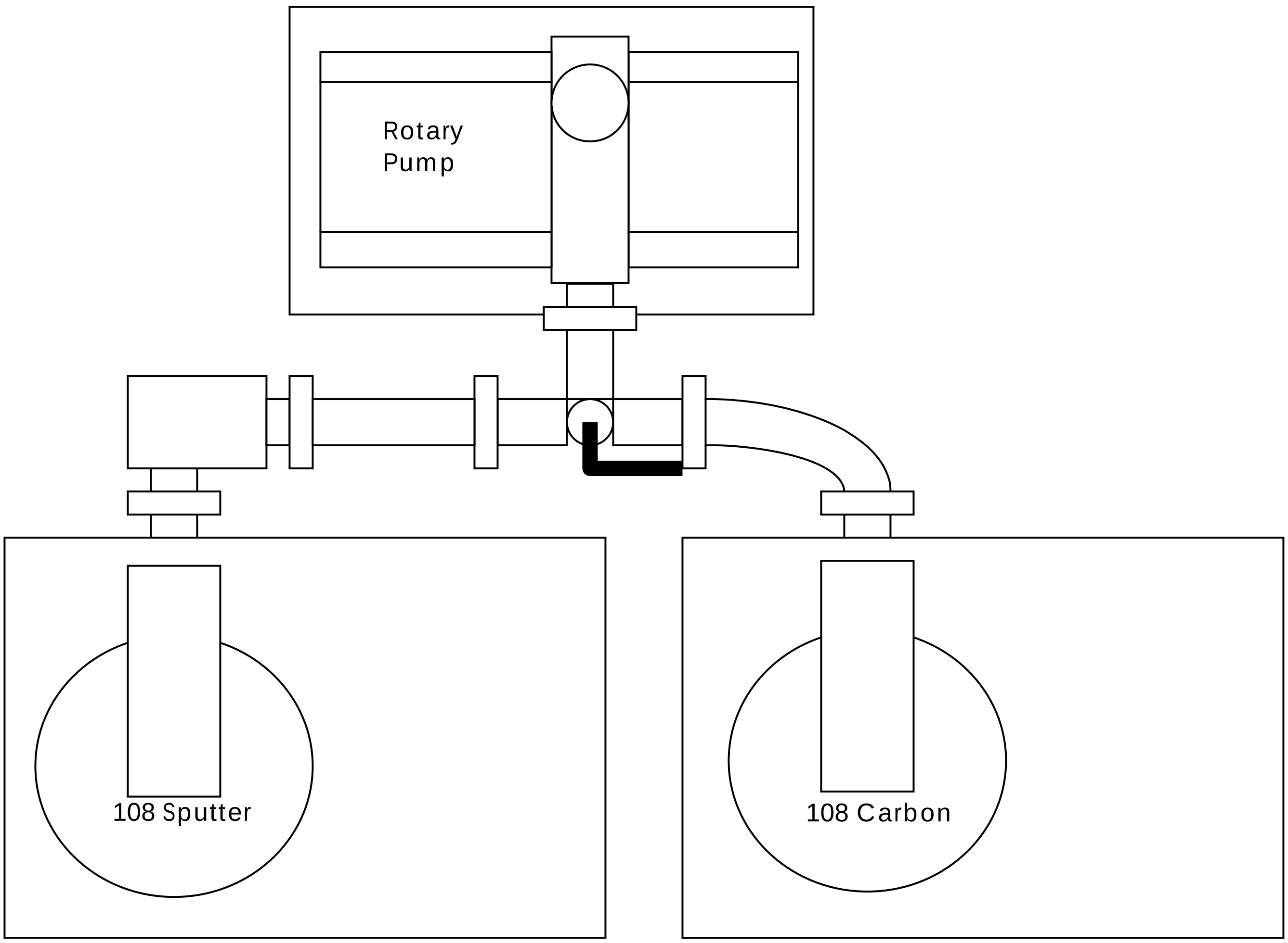
Position the pump behind the control unit with the motor to the left.

Remove the blanking cap from the rear of the control unit. Check that the sealing surfaces and KF16 seals. Connect the rear pumping port of the control unit to the rotary pump inlet using the stainless steel hose (curved into an *"S* " shape) and the two KF16 o-ring carriers and clamps. Ensure that the hose is not under stress when in its final position. Make sure that the power switch on the pump is in the “ON” position.

3.2.2 Dual Pumping System

Place the 108 Auto (sputter coater) to the left of the 108 Carbon Auto with the rotary pump placed centrally behind the two coaters. Connect the ball valve to the rotary pump with the lever opposite the pump inlet. Connect the rear pumping ports of the control units to the remaining ports on the ball valve using the stainless steel hoses and the elbow with the 108 Auto (illustrated on next page).

Plug the 108 Auto control unit into the socket on the back of the 108 Carbon Auto control unit. Plug the rotary pump power cord into the socket on the back panel of the 108 Auto control unit. Plug the power cord for the 108 Carbon Auto control unit into a suitable power socket.



3.2.3 Sample Preparation Chamber

Wipe the insides of the glass cylinder with a lint free tissue (or cloth) that has been moistened with alcohol. The top-plate, which is already fitted with a target, can now be gently lowered. The system is now ready for pumping.

IMPORTANT
BEFORE LOWERING THE TOP-PLATE
(1) CHECK THE POSITION OF THE GLASS CYLINDER. IF THE CHAMBER COMPONENTS ARE NOT CENTRERED, THE TOP-PLATE COULD CHIP THE GLASS.
(2) CHECK THE POSITION OF THE SHUTTER. IF NOT CENTRED IT COULD CHIP THE GLASS.

3.2.4 Electrical Connections

Unpack the thickness monitor or control unit (if supplied) together with the electrical cables.

Place the monitor/controller on the main control unit (to the right of the baseplate). It derives its signal(s) from the main unit.

Identify the following loose electrical leads (if supplied):

(1) Power to main control unit (IEC to mains wires);
(2) Power to thickness monitor/controller;
(3) Thickness signal to thickness monitor/controller (BNC connectors); and
(4) Control signal to thickness controller (D connectors).

Plug the rotary pump power cord into the labeled socket on the back panel of the control unit.

Connect the remaining cables as appropriate.

Fit a suitable 3-pin plug to the power cord for the control unit (and the thickness monitor/controller if supplied).

IMPORTANT
THE POWER CORD FOLLOWS THE EUROPEAN CONVENTION. THE PLUG SHOULD BE WIRED AS FOLLOWS: *LIVE* = BROWN; *NEUTRAL* = BLUE; *GROUND* = GREEN / YELLOW.

IMPORTANT
BEFORE SWITCHING ON CHECK THE LABELS ON THE CONTROL UNITS AND ROTARY PUMP TO ENSURE THAT THE SUPPLY VOLTAGE IS SUITABLE.

3.2.5 Argon Gas Supply

IMPORTANT
EXPERT ASSISTANCE SHOULD BE SOUGHT WHEN DEALING WITH HIGH PRESSURE GAS CYLINDERS.

Position a cylinder of pure argon gas close to the 108 sputter coater system. The cylinder should be fitted with a pressure reducing regulator valve. The regulator gauge must indicate pressure (not FLOW) and be adjustable in the range up to 1 bar. (It will need to be adjusted to give 0.3/0.6 bar (5-9 psi) during “flushing").

Connect the regulator outlet to *ARGON INLET* on the back panel of the control unit using 6.0mm (internal diameter) clear plastic hose. The hose between the regulator valve and the *ARGON INLET* should be as short as possible. Care should be taken to ensure that the hose has no leaks, which might admit atmospheric air.

IMPORTANT
ALTHOUGH GOLD CAN BE SPUTTERED USING AIR IT IS AN INEFFICIENT PROCESS AND LEADS TO LARGE GRAIN AND SAMPLE HEATING. WHEN SPUTTERING ANY OTHER TARGET MATERIAL ARGON MUST BE USED.

Section 4: **Test**

4.1 Vacuum System

IMPORTANT
<u>BEFORE SWITCHING ON</u> CHECK THE LABELS ON THE CONTROL UNITS AND ROTARY PUMP TO ENSURE THAT THE SUPPLY VOLTAGE IS SUITABLE.

Connect the main power cord to the control unit. Check the chamber is correctly closed and that the gas control knob is rotated fully clockwise (CLOSED). Switch on *POWER* on the front panel of the control unit. The vacuum pump will start to pump down the chamber.

The pump has a high rotational speed (3000rpm @ 50Hz or 3600rpm @ 60Hz) and under cold conditions (below 60°F/15°C) the pump may not reach full speed immediately. Confirm that the chamber is pumping down and allow the pump to warm up for 5 minutes before testing the pumping performance.

Switch off *POWER* and vent the chamber by rocking the vent valve on the top-plate. Lift and replace the top-plate to confirm that the chamber has been fully vented. Switch on *POWER* and check the pumping time to 0.1mb. This should be about 30 sec.

IMPORTANT
THE PRESENCE OF SOLVENTS OR CONTAMINANTS WILL LENGTHEN THE TIME TAKEN TO REACH A GIVEN PRESSURE. IF A LEAK IS SUSPECTED THE GLASS CYLINDER SHOULD BE REMOVED AND THE TWO O-RING SEALS INSPECTED FOR DEFECTS OR SMALL OBJECTS.

Continue to pump for and additional 5 minutes and verify that the vacuum is around 0.01mb. Switch off the control unit and vent the chamber using the vent valve on the top-plate.

4.2 Argon Gas System

Pump the vacuum chamber to a pressure lower than 0.05mb.

Open the regulator valve on the argon cylinder until the pressure reads 0.3bar (5psi) and then slowly open the gas control valve on the front panel (control knob is marked *"set*"). Allow the chamber pressure to rise to more than 0.4mb and let argon flush through the system for about a minute.

Partially close the gas control valve and set the pressure to 0.08mb. Reset to 0.1mb and then to 0.06mb.

Close the gas control valve, switch off the unit and vent the chamber.

4.3 Sputter Supply

Check that the sputter output power control (knob on rear panel, see page 4) is turned fully clockwise (viewed from rear) to give maximum power.

Pump the chamber, flush with argon and-adjust the chamber pressure to 0.08mb as described in the previous section. Now press *TEST*.

The *mb* light will go out and the *mA* light will come on showing that the meter is now reading the sputtering current (nominal 45mA). A glow discharge will be visible in the chamber. Release *TEST.*

Close the gas control valve, switch off and vent the chamber.

4.4 Coating Cycle

Raise the top-plate and remove the glass cylinder. Loosen the table support pillar locking nut and adjust the *target to table distance* to about 40mm. Place a clean glass microscope slide on the table and replace the cylinder and top-plate.

Switch on and pump to lower than 0.05mb. Open the gas control valve and flush at 0.4mb for 10/20 seconds. Reset to 0.08mb and press *TEST*. Adjust the power (control on rear panel) to 30mA and release *TEST.*

Press *PAUSE* and keep depressed while alternately pressing the *timer setting* keys. Adjust the *TIMER DISPLAY* to read 30 sec.

If a thickness monitor is fitted, switch *ON* and select *DENSITY* and *TOOLING* following the directions in section 2.6. Set the density to 19.30 (the density of the gold target material). Set a *tooling factor* of 1.50. The tooling factor corrects for the surface of the quartz crystal being closer to the target (about 32mm) than the surface of the microscope slide (about 39mm).

With the (1) chamber argon pressure, (2) sputter power level, (3) process time, (4) table height, and (5) thickness monitor all adjusted the system is ready to coat the microscope slide. Zero the thickness monitor and press *START*.

When the coating cycle is complete the timer will reset to :30. Close the gas control valve, (note the thickness monitor reading), switch off the power, vent the chamber, lift the top-plate and remove the microscope slide.

IMPORTANT
THE THICKNESS AND DISTRIBUTION OF THE GOLD COATING ON THE MICROSCOPE SLIDE IS A FUNCTION OF *(1) Chamber argon pressure; (2) Power setting; (3) Coating time; and (4) Target to table distance.*
WHEN COATING REAL SAMPLES THE THICKNESS AND DISTRIBUTION OF THE COATING REQUIRED WILL DEPEND ON THE NATURE OF THE *SAMPLE* AND THE OPERATING CONDITIONS TO BE USED IN THE *SEM.*

Section 5: **Operating Procedure**

5.1.1 Routine Sample Coating (without thickness monitor)

The following procedure will result in a satisfactory gold coating in the majority of cases. When difficult samples are encountered the procedure will need to be modified (see 5.2).

(1) Check that the sample has been mounted on a stub suitable for use on the coater sample table. Any solvent-based adhesive should have been allowed to dry out thoroughly. The sample should be a suitable shape to allow a conducting path to form during coating.

(2) Check that the valve on the argon gas supply is open and that the regulator gauge is reading about 0.3bar (see 4.2).

(3) Check that the sample table height in the coater is suitable for the sample. Adjust if necessary (see 4.4). (For initial tests a target-to-sample distance of around 35mm can be used. This value might need to be adjusted later to suit the sample, see 5.2 *Coating Difficult Samples*).

(4) Place the sample on the table and close the top-plate.

(5) Pump to a chamber pressure lower than 0.05mb.

(6) Check the timer value on the digital display. If necessary, press *PAUSE* and reset the process time. Release *PAUSE*. (For initial tests use a value of 40 secs and adjust later as required to obtain the desired thickness).

(7) Adjust the gas control valve on the front panel *(SET*) to give an argon gas pressure in the chamber of more than 0.4mb. Allow to flush for at least 10 seconds.

(8) Readjust the valve to give the desired operating pressure. (For initial tests use 0.08mb and adjust later if necessary, *see 5.2*).

(9) Press *TEST* to check the sputter current. If necessary, adjust the current using the rear panel control. Release *TEST*. (For initial tests use 30mA and adjust later if necessary, *see 5.2*).

(10) Press *START.*

(11) When the timer resets the coating is complete. Close the gas control valve and switch off the unit. Vent the chamber and lift the top-plate to remove the sample.

(12) If the coating thickness is unsuitable, change the <u>process time</u> for future samples. In the first instance do not adjust power, table height or gas pressure.

5.1.2 Routine Sample Coating (with thickness monitor)

The following procedure will result in a satisfactory gold coating in the majority of cases. When difficult samples are encountered the procedure will need to be modified (see 5.2).

(1) Check that the sample has been mounted on a stub suitable for use on the coater sample table. Any solvent-based adhesive should have been allowed to dry out thoroughly. The sample should be a suitable shape to allow a conducting path to form during coating.

(2) Check that the valve on the argon gas supply is open and that the regulator gauge is reading about 0.3bar (see 4.2).

(3) Check that the sample table height in the coater is suitable for the sample. Adjust if necessary (see 4.4). (For initial tests a target-to-sample distance of around 35mm can be used. This value might need to be adjusted later to suit the sample, see 5.2 *Coating Difficult Samples*).

(4) Check that the thickness monitor parameters (density, tooling factor) are suitable. Adjust if necessary (see 4.4).

(5) Check the timer value on the digital display. If necessary, press *PAUSE* and reset the process time to 200 seconds (or some value longer than the expected coating time). Release *PAUSE*.

(6) Place the sample on the table and close the top-plate.

(7) Pump to a chamber pressure lower than 0.05mb.

(8) Adjust the gas control valve on the front panel *(SET*) to give an argon gas pressure in the chamber of more than 0.4mb. Allow to flush for at least 10 seconds.

(9) Readjust the valve to give the desired operating pressure. (For initial tests use 0.08mb and adjust later if necessary, *see 5.2*).

(10) Zero the thickness monitor.

(11) Press *TEST* to check the sputter current. If necessary, adjust the current using the rear panel control. Release *TEST*. (For initial tests use 30mA and adjust later if necessary, *see 5.2*).

(12) Press *START.*

(13) When the thickness monitor reading reaches the desired value press *PAUSE* to stop coating. Check the value and press *START* to terminate the cycle.

(14) Close the gas control valve and switch off the unit. Vent the chamber and lift the top-plate to remove the sample.

5.2 Coating Difficult Samples

(If the procedure outlined in 5.1 above results in poorly coated samples the following techniques can be investigated).

5.2.1 Tall Samples

Problem: If the sample has large vertical dimensions, the coating will be biased towards the top of the sample and coating may be too thin towards the base. The problem is caused by the relatively large differences in distance from the target of the various parts of the sample. The problem can be exaggerated by sputtering at low argon pressures (below 0.05mb) when the sputtered gold is inadequately scattered.

Solution: Position the sample table close to the baseplate. Sample-to-target distances (top/bottom) are now similar. Also, use a relatively high argon pressure (say 0.10mb to 0.15mb) to give good scattering and coating from a wider range of angles.
Note that *long distance* plus *high scattering* will give *slow coating* so the process time will need to be longer.

5.2.2 Porous Samples

Problem: If a sample is very porous, pumping the chamber will be slow. Sputtering while the sample is still degassing may result in poor coating. The sample surface can "repel" the gold coating by gas scattering. Also, failure to pump to a suitably low pressure for good argon flushing will result in large grain size and stress cracking in the gold coating.

Solution: Longer pumping times and repeated flushings are required. If coating into the pores is a problem use the techniques in *5.2.3.*

5.2.3 Woven or Tangled Samples

Problem: Coating at pressures which are "thickness efficient" for magnetron sputter heads (around 0.05mb) can cause inadequate penetration of the coating in this type of sample. The problem is caused by insufficient scattering of the sputtered gold.

Solution: Operate at a relatively high argon pressure (0.10mb - 0.15mb) to improve scattering. If a fine grain coating is required it may be necessary to operate at lower power than usual (10mA - 15mA). Table height will depend on the size of the sample *(see 5.2.1).*

5.2.4 Samples with Fine Detail

Problem: Grain structure in the gold coating may obscure some of the fine detail in certain types of sample.

Solution: The gold coating will need to be as thin and as fine-grained as possible (while still remaining conducting). This implies using relatively low gas pressures (less than 0.05mb) and low powers (10mA - 15mA). Unfortunately, the use of low gas pressures can result in poor coverage of the sample.

The alternative is to change the target material from gold to gold/palladium or platinum. These materials give a coating, which has a smaller grain-size.
Care is needed when using Au/Pd or Pt targets as they can both form oxides in a plasma. This can result in stress cracking by oxidation of the coating if argon handling is not scrupulous. Careful flushing must be used to sweep out any residual oxygen or water vapor from the sputter chamber.

Section 6: **Routine Maintenance**

6.1 Cleaning the Chamber

(1) Switch off the system and vent the chamber.
(2) Lift the top-plate and remove the glass cylinder. Take care that the top-plate does not fall forward. The target can be damaged by striking the sample table.
(3) Remove the gold deposit from inside the glass cylinder by wiping with a lint-free tissue or cloth, which has been moistened with a vacuum compatible solvent.
A 50:50 mixture of acetone and isopropanol is suitable. Do not use solvents, which will attack, pump oil. Wear gloves to avoid contact of solvent with skin. Work in a well ventilated area or in a fume hood. The majority of gold deposit can be removed by rubbing with a cloth or tissue. Any gold resisting this treatment may be removed by rubbing a linf-free cloth and PELCO Belljar Kleen™.
(4) Remove any loose deposit from metal surfaces (sample table, baseplate, dark-space shield) by rubbing lightly with a Scotchbrite scouring pad.
Do not use abrasive cleaning pastes on these aluminum alloy surfaces.
(5) Check the surfaces of both chamber o-ring seals for damage and replace if necessary.
(6) Make sure that all surfaces are dry and free from loose material before replacing the glass chamber.
(7) Repump the system and check the pumpdown time as in Section 4.1.

6.2 Target Changing

(1) Switch off the system and vent the chamber.
(2) Lift the top-plate and remove the glass cylinder. Take care that the top-plate does not fall forward. The target can be damaged by striking the sample table.
(3) Remove the dark space shield (see diagram page 7) by loosening the M3 cap screw using a 2.5 hexagon key.
(4) Unscrew the clamp ring with the top-plate close to the horizontal position.
Using this position allows the target to remain in the clamp ring when it is completely removed from the target holder.
(5) Remove the clamp ring and target.
(6) Remove the target from the clamp ring and replace with the new target.
(7) Re-screw the clamp ring to the target holder and replace the dark space shield.
(8) Check the surfaces of both chamber o-ring seals and check that the vacuum chamber surfaces are free from loose material before replacing the glass cylinder. Clean as in 6.1 if necessary.
(9) Repump the system and check the pumpdown time as in Section 4.1.

6.3 Quartz Crystal Changing

When the thickness monitor crystal is either overloaded *or* loaded with stressed material *it will cease to oscillate and the display will read "FAIL". At this stage it will need to be changed.*
(1) Switch off the system and vent the chamber.
(2) Lift the top-plate and remove the glass cylinder.
Take care that the top-plate does not fall forward. The target can be damaged by striking the sample table.
(3) Remove the feedthrough-to-crystal-head cable at the crystal head end. Use a straight pulling action.
(4) Completely remove the M4 screw which secures the crystal head in the sample table. Remove the head from the sample table.
(5) Invert the crystal head on a clean surface. Loosen the 2 small screws in the side of the head. This will allow the base of the head to be separated from the crystal holding cap.
(6) Remove the crystal from the cap and replace it with a new crystal. Shake to ensure the crystal is correctly seated in the cap.
(7) With the cap inverted, replace the base of the crystal head and push to compress the spring. Retighten the small screws.
(8) Replace the head in the table and re-connect the cable.
(9) Check the surfaces of both chamber o-ring seals and check that the vacuum chamber surfaces are free from loose material before replacing the glass cylinder. Clean as in 6.1 if necessary.
(10) Repump the system and check the pumpdown time as in Section 4.1.

6.4 Changing the Oil Mist Filter

The oil mist filter fitted to the exhaust port of the rotary pump should be changed when it shows signs of saturation.
(1) Switch off the system and vent the chamber.
(2) Unscrew the oil mist filter and replace with new filter.

6.5 Changing the Rotary Pump Oil

The rotary pump oil must be changed if its appearance in the sight glass at the end of the pump becomes dark. The maximum period between oil changes should be 6 months if the system is in regular use and not to exceed 12 months.
(1) Drain the oil from the pump and replace according to the manufacturer's instructions as provided.
If the style of pump base fitted makes it difficult to remove the drain plug, the pump may be inverted and drained through the filler cap.

Section 7: **Trouble shooting**

7.1 Sputtering

Problem: START is selected but plasma does not strike.

Solution: Argon pressure in specimen chamber too high.
Reduce pressure below 0.1mb.

Problem: Meter shows selected sputter current (mA) but no plasma visible.

Solution: Short circuit between target and dark space shield.
Remove dark space shield and clean target clamping ring and target adaptor ring.

7.2 Thickness Monitor MTM-10

Problem: MTM-10 display shows *FAIL.*

Solution: 1 - Change crystal.
2 - Check SMB cable connections.
3 - Replace Oscillator.

Problem: MTM-10 display shows "or".
Reason: Thickness has exceeded measurable limits.
Measurement >999.9nm (or less than -99.9nm).

Solution: 1 – Press "ZERO".

7.3 Vacuum System

Problem: Rotary pump doesn't start.

Solution: 1 - Check cable.
2 - Press Thermal Trip on rear panel (viscosity of the rotary pump oil is low due to low temperature).
3 - Make sure ambient temperature is not below 15^{0}C (60°F).

Problem: After 2 minutes of pumping pressure is not better than 0.5 mb.

Solution: 1 - Check O-ring seals.
2 - Check if top-plate seals on glass chamber.
3 - If sample has high porosity, reduce sample size or accept long pumping times.
4 - If sample is outgassing, bake or accept long pumping times.

Section 8: **Spares and Options**

8.1 Consumables

91110	Gold Target (∅57 x 0.1mm)
8071	Gold Target (∅57 x 0.2mm)
91114	Platinum Target (∅57 x 0.1mm)
91112	Gold / Palladium Target (∅57 x 0.1mm)
91111	Gold / Palladium Target (∅57 x 0.2mm)
91129	Silver Target (∅57 x 0.3mm)
8079	Copper Target (∅57 x 0.3mm)
896	PELCO Belljar Kleen™

8.2 Thickness Monitor

93004	MTM-10 Thickness Monitor System (complete kit)
93006	MTM-20 Thickness Controller System (complete kit)
93008	Thickness Monitor Crystals, pkg/3
93009	Thickness Monitor Crystals, pkg/10

8.3 Specimen Chamber

9608	Replacement Glass Chamber (∅120 x 120mm)
9607	Replacement Chamber O-rings (∅120mm / Pk 2)

8.4 Vacuum System

7010	Rotary Pump, 115VAC, anti-vibration table, all-metal, integrated coupling system
7030	Dual-Vacset Conversion Kit (allows connecting two sputter coaters or one sputter coater and one carbon coater to be connected to one vacuum pump)
9609	Oil Mist Filter (for Prod. No. 7010 Rotary Pump)

8.5 Carbon Coater

9602	Automatic Carbon Coater 108carbon/A, 115VAC
9602-220	Automatic Carbon Coater 108carbon/A, 220VAC
9603	Automatic Carbon Coater 108carbon/A-SE, 115V
9603-220	Automatic Carbon Coater 108carbon/A-SE, 220V

Section 9: **Specifications**

9.1 Sputter Coater 108 control unit

Specimen Chamber	Ø120 mm OD x 120mm height
Sputter target	Ø57 mm diameter x 0.1 mm thick, Gold fitted as standard
Sample Stage	Static table Height adjustable 65mm
Sputter supply	Adjustable analog control 5 - 45 mA Constant current control Safety interlocked
Sputter head	Low voltage planar magnetron Quick target change Wrap-around dark space shield
Analog Metering	Vacuum: Atmos - 1 x 10^{-3} mbar Current: 0 – 50mA
Control Method	Digital timer 0-300 seconds Full manual control of all functions

9.2 Pumping System (typical)

Rotary Pump	High Speed direct drive, 2 stage rotary pump
Pumping Speed	41.6 / 50 ltr/min (50 / 60Hz)
Chamber Pumpdown	30 sec to 0.1mb
Ultimate Pressure	5 x 10^{-3} mbar
Desktop System	Rotary pump mounted on desktop compatible anti-vibration table

9.3 Thickness Monitor

MTM-10	Microprocessor based 4 digit display Push button zero 6Mhz crystal with lifetime check
Memory	Four settings storing Density and Tooling factor
Update rate	10 Hz
Thickness range	0.0 - 999.9nm
Resolution	Better than 0.1nm
Density range	0.50 - 30.00 gm/cm^3
Tooling factor range	0.25 - 8.00
Error Messages	Fail / or

9.4 Required Services

Power for 6002	100-120VAC, 50/60Hz, 120W max.
Power for 6006	220-240VAC, 50/60Hz, 120W max.
Gas (recommended)	Argon 99.9 min. purity Pressure regulated to 5 - 9 PSI (0.3 - 0.6bar) 6mm ID hose