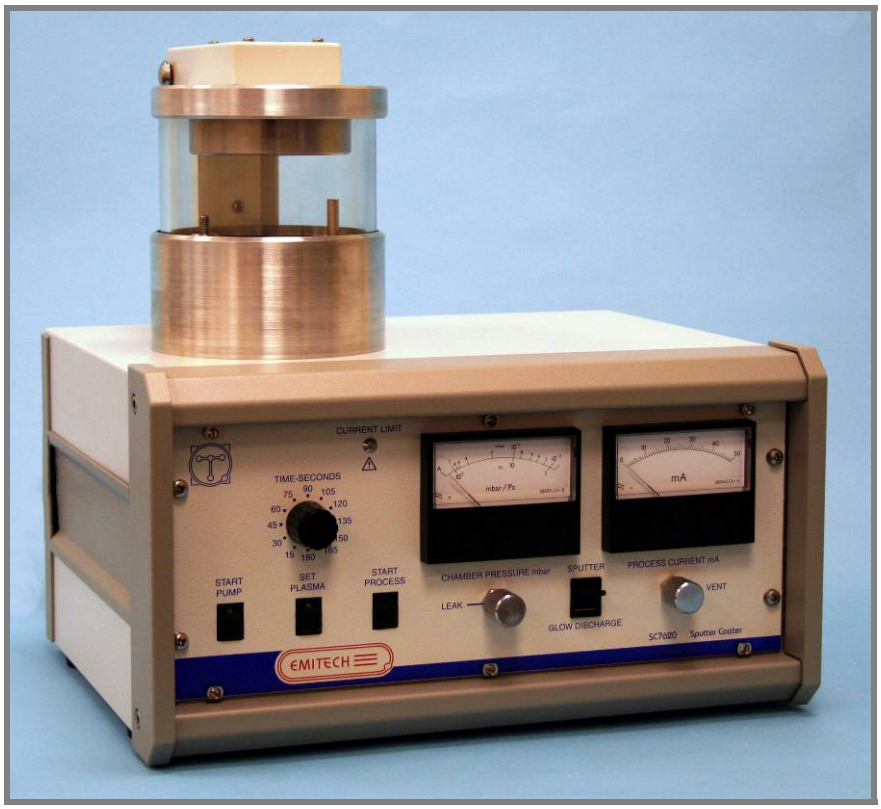
Quorum Technologies

SC7620 Mini Sputter Coater
Operating Manual



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Quorum Technologies Ltd is the owner and manufacturer of the 

range of EM preparation equipment.

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Issue	Date	Details	Revised By
1	12/01/2001	Initial Issue, based on document HA900011	JLS
2	17/08/2005	Manual layout updated	JLS
3	01/09/2007	Current Limit indicator added to front panel	JLS
4	14/01/2010	Glow discharge function added to Machine and introduction of new case	JRM
5	12/05/2011	Platinum and Nickel Targets removed	JLS

Disclaimer

The components and packages described in this document are mutually compatible and guaranteed to meet or exceed the published performance specifications. No performance guarantees, however, can be given in circumstances where these component packages are used in conjunction with equipment supplied by companies other than Quorum Technologies.

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1 Contents

1.1 Manual Layout

This Operating Manual is divided up into the following major sections, each section dealing with specific topics, as follows:

Section 1 - Contents

Section 2 - Health and Safety

General section which applies to all Quorum Technologies Polaron products detailing the very important issues of Health and Safety applicable when using sample preparation equipment.

Section 3 - Introduction

Introduces this manual.

Section 4 - General Description

Identifies each of the equipment items and provides an overview of their functions and how they work.

Section 5 - Installation

Instructions on how this instrument should be installed and the connections which should be made between the equipment items.

Section 6 - Operation

Instructions on how to start-up and run the instrument.

Section 7 - Maintenance

Instructions on how to check the system is functioning correctly, and how to change consumable items. Details of appropriate spare parts.

Section 8 - Fault Finding

Information on how to identify faults in the system and how to rectify these faults.

Section 9 - Agents

List of main agents supporting Quorum Technologies product range

Section 10 - Index

1.2 Section Contents

1.3 List of Figures

1.4 List of Tables

2 Health and Safety

Safety is very important when using any instrumentation and this section should be read by all users of our equipment.

This section of the Manual applies to all surface analysis and surface preparation equipment supplied by Quorum Technologies Polaron range of products, not just the particular instrument for which the manual refers.

Included in this section are details on warning notations, good working practices and information on European Community (EC) legislation regarding **"Control Of Substances Hazardous to Health"** (COSHH) and risk analysis.

2.1 Control of Substances Hazardous to Health (COSHH)

The E.C. legislation regarding the "Control of Substances Hazardous to Health" requires Quorum Technologies to monitor and assess every substance entering or leaving their premises. Consequently any returned goods of whatever nature must be accompanied by a declaration form available from Quorum Technologies, reference number SP-100. Without this declaration Quorum Technologies reserves the right not to handle the substance/item. Also in accordance with E.C. regulations we will supply on request hazard data sheets for substances used in our instruments.

2.2 Safety Policy

This section contains important information relating to all health and safety aspects of the equipment. As such it should be read, and understood, by all personnel using the instrument whether as an operator or in a service capacity.

Quorum Technologies is committed to providing a safe working environment for its employees and those that use it's equipment and conducts its business responsibly, and in a manner designed to protect the health and safety of its customers, employees and the public at large. It also seeks to minimise any adverse effects that its activities may have on the environment.

Quorum Technologies regularly reviews its operations to make environmental, health and safety improvements in line with UK and European Community legislation.

The equipment has been designed as free-standing bench mounted instruments. Quorum Technologies cannot be held responsible for any damage, injury or consequential loss arising from the use of its equipment for any other purposes, or any unauthorised modifications made to the equipment.

All service work carried out on the equipment should only be undertaken by suitably qualified personnel. Quorum Technologies is not liable for any damage, injury or consequential loss resulting from servicing by unqualified personnel. Quorum Technologies will also not be liable for damage, injury or consequential loss resulting from incorrect operation of the instrument or modification of the instrument.

2.3 Conformity

This instrument is supplied in a form that complies with the protection requirements of the EC Electromagnetic Compatibility Directive **89/336/EEC** and the essential health and safety requirements of the low voltage directive **72/23/EEC** both as amended by **92/31/EEC.** Any modifications to the equipment, including electronics or cable layout may affect the compliance with these directives.

2.4 Servicing

2.4.1 Disclaimer

All service work on the equipment should be carried out by qualified personnel. Quorum Technologies cannot be liable for damage, injury or consequential loss resulting from servicing from unqualified personnel. Quorum Technologies will also not be liable for damage, injury or consequential loss resulting from incorrect operation of the instrument or modification of the instrument.

2.4.2 Operators and Service Engineers

A normal operator of the equipment will not be trained in or qualified for service work on the equipment and may cause a hazard to himself/herself or others if such work is attempted. Operators should therefore restrict themselves to the normal operation of the equipment and not by removing covers from the electronic equipment or dismantling of the instruments.

Service Engineers who are suitably trained to assess and isolate electrical, mechanical and vacuum hazards should be the only personnel who access the equipment.

2.5 Hazard Signals and Signs

2.5.1 Hazard Signal Words

The standard three hazard signal words are defined as follows:

- **DANGER** - *imminently* hazardous situation or unsafe practice that, if not avoided, *will* result in death or severe injury.
- **WARNING** - *potentially* hazardous situation or unsafe practice that, if not avoided, *could* result in death or severe injury.
- **CAUTION** - *potentially* hazardous situation or unsafe practice that, if not avoided, *may* result in minor or moderate injury or damage to equipment.

2.5.2 Hazard Labels used on Equipment

Several hazard symbols may be found on the equipment, they are shown below with their meaning:

Caution, risk of electric shock

Caution (refer to accompanying documents)

Easily touched higher temperature parts

Warning, risk of electric shock

Figure 2-1: Hazard Warning Symbols

2.5.3 Hazard Warning Labels used in Equipment Manuals

The international warning signs used in equipment manuals as shown in Figure 2-2.

Figure 2-2: International Warning Symbols

Where appropriate these are used when a specific identifiable risk is involved in either using or maintaining the instrument. These take the form of warning triangles or signs with a graphical description of the hazard.

2.5.4 Instrument Functionality Signs

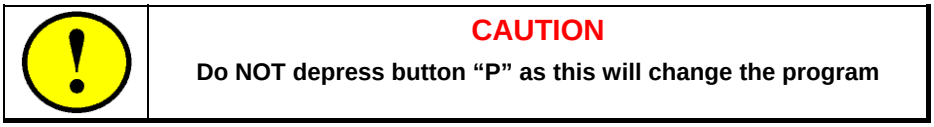

Figure 2-3: Typical Warning sign as shown in this Manual

This typical sign applies to cautions where there is a risk to the functionality of equipment due to incorrect operation. These cautions or warnings will be contained in a box and be accompanied by a circular warning symbol as shown in Figure 2-3.

2.5.5 Serious Damage to Instruments

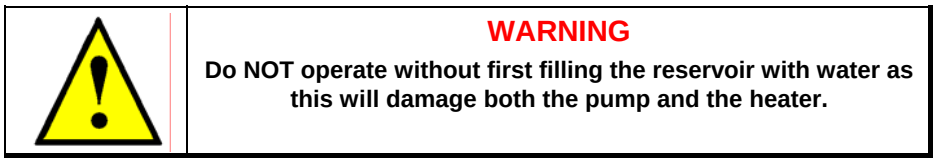

Figure 2-4: Typical Warning sign as shown in this Manual

This typical caution sign is used where serious damage will be caused by incorrect operation of instrumentation. They will follow the same form as functionality warnings but with a triangular warning symbol as shown in Figure 2-4.

2.5.6 Hazard to Operator

Figure 2-5: Typical Warning as shown in this Manual

These warnings will generally occur in relevant installation and maintaining sections where there exists a potential hazard to the engineer working on the instrument. They will take the form of the triangular warning symbol accompanied by an international warning sign and bold type lettering beginning with **"WARNING-HAZARD TO HEALTH!"** as shown in Figure 2-5.

2.6 Risk Analysis

2.6.1 Personal Operational Risks

The following is a list of tasks carried out by both the operator and service engineer where recognised risks have been observed, listed is the personnel protection equipment (PPE) which is suggested for use for various tasks on any surface analysis equipment and systems:

Task	Carried out by	Nature of Hazard	Recommended PPE
Cleaning of parts / samples with isopropanol (IPA)	Operator / Service engineer	Splash hazard to eyes, drying of skin	Protective goggles, protective gloves.
Use of Liquid Nitrogen in sample cooling etc.	Operator / Service engineer	Burn risk	Thermally protective gloves and goggles should be worn.
Lifting of Heavy Items	Service engineer	Dropping on foot.	Protective footware.

Table 1: Personal Operational Risks

2.6.2 Hazard Materials

- **Isopropanol (IPA)**

  For certain service tasks isopropanol is suggested for cleaning components before use in the vacuum system. It should be noted that isopropanol is a flammable liquid and as such should not be used on hot surfaces. In addition it is recommended that protective gloves are worn when using isopropanol.

- **Compressed Air**

  Compressed air can be a potential hazard if handled inappropriately. A compressed air line may be fed from some instruments to the customers supply, and the customer should ensure that this and any other service pipes and cables are maintained in good condition.

- **Nitrogen, Argon and Helium Gas Supplies**

  Instruments may use nitrogen, argon or helium gas supplies for their operation, the customer is responsible for maintaining the supply to the instrument. This supply should be regulated and kept to the lowest pressure and flow rate as is practical to minimise the effects of any leaks.

- **Hazardous Gases**

  Quorum Technologies has no control over the gases used within the system. It is therefore viewed as the customers responsibility to assess the hazards involved and take appropriate precautions when using explosive, toxic or corrosive gases or gases which may result in hazardous products as a result of a chemical reaction.

2.7 Good Working Practices

It is essential that good hygienic working practices are adopted at all times especially in an ultra high vacuum or clean room environment and are generally of the “Common sense” type. Some simple good practice rules are:

- If in doubt don't.
- If in doubt ask.
- When handling solvents wear face mask, gloves, apron and work only in a well ventilated area.
- Mop up any spillages immediately.
- When handling or decanting mineral oils wear protective clothing.
- Aerosols of mineral oils, such as that produced by gas ballasting, can prove to be hazardous and an exhaust is recommended.
- Before attempting to service electrical apparatus, isolate from the mains.
- Treat all unknown substances as hazardous.
- Dispose of substances in an appropriate manner.
- Use the correct tool for the job.
- Keep a straight back and bend from the knees when lifting heavy objects.
- Wear protective clothing when using liquid nitrogen.
- Affix pressurised gas cylinders firmly to walls or racks. Use the correct regulating valves on gas cylinders and always transport cylinders using the appropriate specialist trolley.
- Obey safety regulations regarding lifts, hoists and machine tools.
- Always make sure you understand a procedure well before attempting it for the first time.

2.8 SC7620 Specific Safety Hazards

The following Safety Hazards are specific to the SC7620 Mini Sputter Coater.

WARNING

HAZARD TO HEALTH!

The Power Supply used in the Model SC7620 unit can operate at up to 1200V D.C

HAZARDOUS VOLTAGE OUTPUTS of up to 1200V. D.C.

2.8.1 Contamination

Contamination can seriously affect the sputtering process. To reduce the possibility of contamination by airborne particles, minimise the time the vacuum chamber is open to the atmosphere.

3 Introduction

This manual is intended for all users of the **SC7620 Mini Sputter Coater** manufactured by Quorum Technologies from the **POLARON** range and provides information on the installation, operation and maintenance of the instrument.

Please note that the servicing and maintenance procedures should only be carried out by qualified service personnel and it is essential that all users should read the ***Health and Safety*** section of this manual.

3.1 Return of Goods

If goods are to be returned to Quorum Technologies for repair or servicing the customer should contact their local distributor or the factory direct before shipment. A "Returns Authorisation Number" should be obtained in advance of any shipment. This number is to be clearly marked on the outside of the shipment. Complete the returned equipment report form, number **SP106** with as much detail as possible and return with the goods.

All returned goods are to be accompanied by a completed "Returned Goods Health and Safety Clearance" form **SP-100** attached to the outside of the package (to be accessible without opening the package) and a copy of the forms should be faxed in advance to the factory.

When goods are to be returned under warranty refer to the “Warranty Claim, Repair and Returns Procedure” form number **SP-105**

Copies of all these forms can be found in the documentation pack supplied with the instrument or direct from Quorum Technologies, the details can be found on page two of this document.

3.2 Returns Procedure

Warranty Claim

Electronic and basic servicing capabilities exist at most in-country appointed agents, however all components are sold with a **return to factory warranty** (unless otherwise stated) which covers failure during the first 12 months after delivery.

Returns must be sent carriage paid, Quorum Technologies will cover the return carriage costs. This covers defects which arise as a result of a failure in design or manufacturing. It is a condition of warranty that equipment must be used in accordance with the manufacturers instructions and not have been subjected to misuse. This warranty does not cover consumable items such as sputter coating targets and carbon evaporation material. To make a claim under the terms of this warranty provision contact the Customer Service Department at your local Quorum Technologies Representative in the first instance.

Chargeable Repairs

Always contact your in-country Quorum Technologies Representative in the first instance. They will be pleased to assist you and will be able to provide an estimate of repair costs, many offer local repair facilities.

For routine repairs where down-time is not critical. The target standard return time at Quorum Technologies is 20 working days.

Returns

All returns to Quorum Technologies require the following procedure to be followed:

1. Contact the local Quorum Technologies Representative and request a Returns Authorisation Number.
2. Complete a Returned Goods Health and Safety form and returned equipment fault report form.
3. Attach a copy of the completed form to the outside of the package with the usual shipping documents.

Packaging and Carriage

All goods shipped to the factory **must** be sealed inside a clean plastic bag and packed in a suitable carton. If the original packaging is not available Quorum Technologies should be contacted for advice. Quorum Technologies will not be responsible for damage resulting from inadequate returns packaging or contamination of delicate structures by stray particles under any circumstances. All non-warranty goods returned to the factory must be sent carriage pre-paid, (Free Domicile). They will be returned carriage forward (Ex-Works).

4 Description

4.1 Equipment

Each SC7620 Sputter Coater when supplied as a complete package, includes the basic unit, a Gold Palladium target, a start up kit and operation manual. Items can be ordered as a full package or separately against the following numbers:

SC7620 "Mini" Sputter Coater 220-240V complete, consisting of the following:

- **LA762001D** "Mini" Sputter Coater 220-240V. With Gold/Palladium target
- **SC7620-STARTUP** Start up Kit
- **OM-SC7620** Operation Manual

SC7620/110V "Mini" Sputter Coater 110-120V complete, consisting of the following:

- **LA762002D** "Mini" Sputter Coater 110-120V. With Gold/Palladium target
- **SC7620-STARTUP** Start up Kit
- **OM-SC7620** Operation Manual

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4.1.1 Optional Items

The following optional items are available from Quorum Technologies:

SC502-314A Gold Target
SC502-314B Gold/Palladium Target (1 off supplied with Sputter Coater)
SC502-314E Silver Target
SC502-314G Palladium Target

4.1.2 Accessories

The following accessories are available from Quorum Technologies:

E5005G Rotary Pump, 90 1/m, 110/240 Volt, 50/60Hz, fitted with **E5004** rotary pump exhaust filter.

CA7625 A Carbon Coating Accessory which can be associated with either of the following sputter coaters manufactured by Quorum Technologies is available:

SC7620 or SC7640.

This accessory which makes use of the vacuum pump and vacuum control facilities of the associated sputter coaters, utilises either carbon fibre or carbon rods in the evaporation process.

A 110 volt version is available as part number **CA7625/110V**

CA076F Carbon Fibre Head for use with the CA7625.

For further information about the CA7625 Carbon Coating Accessory refer to operating manual OM-CA7625.

4.2 Overview

The **SC7620 Mini Sputter Coater** is a compact magnetron sputter and glow discharge coater, primarily designed for depositing thin conductive metal coatings on to Scanning Electron Microscopy (SEM) samples and surface cleaning, allowing high efficiency ion etching of the specimen surface to remove, for example, oxide or resist layers. Thickness of metal deposition will be determined by the operator, but will typically be in the region of 1 - 20 nanometers.

The SC7620 uses a basic magnetron sputter head with a simple to replace disc target (gold/palladium is supplied as standard, but others metals are available as options). The head is hinged for easy operation and fitted with electrical safety interlocks. The plasma current is variable by adjustment of the vacuum level using an Argon leak valve; the plasma voltage is pre-set.

The 100mm (4") diameter Pyrex cylinder is mounted on an aluminium collar and sealed with 'O' rings. The small vacuum chamber means pump down times and cycle times are fast; it also allows a small economical rotary to be used. The sample stage is height adjustable over a large range and can easily be removed to accommodate large samples.

For SEM X-ray microanalysis applications the SC7620 can be simply converted to deposit carbon by the addition of an optional carbon evaporation attachment, consisting of a switchable Voltage Carbon Coating Accessory (CA7625) and a Carbon fibre head (CA762F).

The SC7620 comes complete with a one metre of 12mm bore vacuum hose and fittings and requires only the addition of a rotary pump with a capacity of 25 litres / minute or greater (see "options and accessories").

The SC7620 can also be used in a glow discharge mode to produce a Hydrophilic and Negatively charged surface as described below.

4.2.1 Hydrophilisation

Freshly made Carbon support films tend to have a hydrophobic surface which inhibits the spreading of suspensions of particles in Negative staining solutions. However, after Glow Discharge treatment with air, the Carbon Film is made Hydrophilic and Negatively charged, thus allowing easy spreading of aqueous suspensions. With subsequent Magnesium Acetate treatment the surface is made Hydrophilic and Positively charged.

In addition to Glow Discharge treatment using air, other process gases may be used to modify surface properties. For example, if Alkylamine is used as a process gas, the Carbon Film surface will become Hydrophobic and Positively charged. On the other hand, using Methanol as a process gas results in the surface becoming Hydrophobic and Negatively charged.

Such treatments can facilitate the optional absorption of selected biomolecules.

4.3 Technical Specification

4.3.1 SC7620 Mini Sputter Coater Specification

Unit dimensions:	340mm wide x 270mm deep x 340mm high (including vacuum chamber).
Vacuum chamber:	100mm internal diameter x 100mm high.
Weight:	20 kg (44lbs).
Power requirement:	Available for either 230V (13 amp) *or* 110V (15 amp) operation at 50/60Hz.
Target distance:	Normally 45mm (adjustable).
Sputter output:	Normal operation is up to 800V D.C. at 20mA. Maximum output 1200V D.C.
Glow discharge output:	0mA to 50mA adjustable discharge with safety cut-out.
System control:	Manually by a 180 second timer with 15 second resolution.
Pumping requirements:	Pump to evacuate $>10^{-2}$ mbar, capacity of 25 litres/minute.
Sputtering rates:	Refer to Table 6.1, example with a gold/palladium target and current of 25mA a rate of 6nm per minute is achieved.
Coating thickness:	Dependant on time and current, normally between 50 and 300 Angstrom (∑) units for SEM investigations, but will typically be in the region of 1 - 20 nanometers.
Coating uniformity:	Better than 10%.
Gas medium:	Argon.

4.4 Physical Description

The SC7620 Mini Sputter Coater is a simple to operate compact magnetron sputtering system designed to be used for coating Scanning Electron Microscopy (SEM) specimens and cleaning undesirable residues. The system can only be operated in manual mode.

The SC7620 Mini Sputter Coater (see Figure 4-1) is comprised of three main parts:

The Cabinet assembly
The Vacuum chamber
The Sputter head

The cabinet assembly, which supports the vacuum chamber, contains a high voltage power supply, a high voltage safety switch with electronic operating logic PCB. Mounted on the front panel of the cabinet are switches and meters which provide the operator interface to the system. All service connections to the system are made via the rear panel. The cabinet is constructed in a manner so as to comply with the European EMC regulations.

The vacuum chamber is formed by the sputter head top plate assembly, the glass work chamber and the baseplate assembly mounted on the top panel of the cabinet. A safety interlock, conforming to IEC 947-5-1, is also incorporated. The integrity of the vacuum is maintained by circular "O" ring gaskets either end of the vacuum chamber. Rotary pump connection is via a KF10 flange fitting at the rear of the chamber.

The top plate supports the cathode (target) and magnetic deflection system incorporating a dark space shield and a radially magnetised 6 pole magnet which confines the plasma within the target area.

The SC7620 Sputter Coater produces uniform fine grain coating for SEM applications. The sputter head operates at a fixed voltage of 800V DC (variable with plasma current). Coating time is controlled by a 180 second solid state timer with 15 second resolution. The vacuum level and plasma current are monitored by analogue meters.

The standard adjustable height specimen stage is operated by a thumbscrew and may be easily removed to accommodate large samples.

The vacuum work chamber is 100 mm internal diameter x 100 mm high. The target to sample distance is nominally 45 mm (adjustable). The sample holder will locate 6 specimen stubs of the 1/8" pin type or several loosely mounted samples.

The unit is supplied with 1 metre x 1/2" bore vacuum hose (351220430) together with an "O" ring (354371520) and carrier (250102910) and clamp (356801000) and hose adaptor (BE740096A) for connection to the vacuum chamber. Connections are also included for the rotary pump. Argon gas hose 2 metres x 3mm bore (351270380) is also supplied.

Figure 4-1: SC7620 Mini Sputter Coater

4.4.1 Operational Description

The SC7620 Mini Sputter Coater operates at a fixed potential of between 800 and 1200 volts DC dependent on plasma current.

An HV voltage is applied between the Target (cathode) and Baseplate (anode) which is at earth potential. A pressure interlock ensures that the HV supply cannot be activated until vacuum chamber pressure is reduced to 10^{-1} mbar or better. Low pressure gas (argon) is leaked into the vacuum chamber to provide a medium for ionisation. Figure 4-2 shows the principles of the sputtering operation of the SC7620.

Electrons emitted by the cathode, concentrated in the vicinity of the target by the magnetic field, collide with the gas molecules, producing positive ions (due to secondary electron emission). Positive ions attracted by the negative potential of the cathode, bombard the target, causing erosion of the target material. The dislodged target atoms falling toward the sample follow multiple paths due to collisions with the ionized gas, coating the sample on all exposed faces.

A gas discharge glow centred about the cathode is visible.

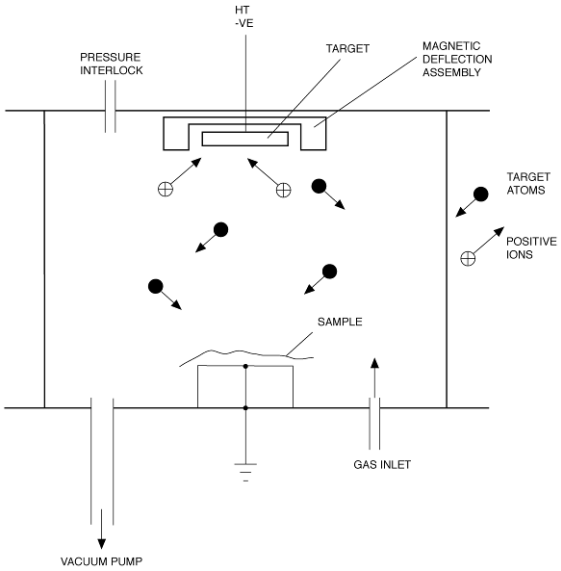

Figure 4-2: Sputter Coater Operation

4.4.2 Pumping Requirements

The work chamber has to be evacuated to $<10^{-2}$ mbar. This can be achieved in a reasonable time (depending on the cleanliness of the chamber) using a floor mounted 50 l/m or 90 l/m two stage rotary pump, alternatively a 30 l/m desk top mounted two stage rotary pump. Preferably incorporating an anti-suck back device and fitted with an oil mist filter on the exhaust port.

4.5 Interlocks

Safety interlocks are incorporated in the SC7620 Mini Sputter Coater to prevent power being switched on with the chamber top plate not in the closed position. Also to cut power to the instrument if vacuum pressure is lost.

	**WARNING** **HAZARD TO HEALTH!** **Potentially lethal voltages are used in this equipment.** **Under no circumstances should interlock connections be over-ridden.**	

4.6 SC7620 Panel Details

The SC7620 Mini Sputter Coater is designed to be bench mounted, it provides 0 - 1.2 kV D.C. output. Process current of up to 0 - 50 mA is available with a 180 second timer to control the process.

4.6.1 SC7620 Front Panel Controls

The controls and indicators mounted on the SC7620 Mini Sputter Coater front panel are described below and identified in Figure 4-3 and described in Table 2.

Figure 4-3: SC7620 Mini Sputter Coater, Front Panel Controls

CONTROL or INDICATOR	DESCRIPTION
TIME-SECONDS	A twelve position rotary switch sets the required process time, between 15 and 180 seconds, in 15 second steps.
CURRENT LIMIT	This LED indicates a fault condition. It Illuminates if the Current flow from the HT transformer becomes excessive this shows the plasma has been inhibited. The system must powered off to reset and the cause removed. See 8 Fault Finding
CHAMBER PRESSURE mbar	This meter provides an indication of pressure within the chamber. The normal readings are: Pressure with leak valve closed 0.04 mbar or better. Pressure with leak valve adjusted 0.06 mbar (approx at 18mA).
PROCESS CURRENT mA	This meter provides an indication of plasma current flow.
START PUMP	A press to operate / press to release switch sets the vacuum pump to ON. After 10-15 seconds a fall in pressure within the chamber will be indicated on the **CHAMBER PRESSURE** meter.
SET PLASMA	This non-latching switch (hold to operate) is used during the setting of the **LEAK** valve, which is adjusted to set the correct plasma current.
START PROCESS	Operation of this non-latching switch initiates the sputtering process, the HV supply is activated, until terminated by the timer.
LEAK	This valve leaks gas into the vacuum chamber to control the plasma current. Used in conjunction with the **SET PLASMA** switch to adjust the correct operating conditions.
SPUTTER / GLOW DISCHARGE	Switches between normal sputtering and glow discharge. Despite being able to change the switch during operation, the polarity of the current will not change once the pump is started.
VENT	This valve is opened to admit gas into the system after a sputtering process has been completed and the vacuum pump has been turned OFF. During the sputtering process the valve must be SHUT (fully clockwise).

Table 2: SC7620 Front Panel Control Descriptions

4.6.2 SC7620 Rear Panel Connections

The connection points and other components mounted on the rear panel of the SC7620 Mini Sputter Coater are described below and identified in Figure 4-4 and described in Table 3.

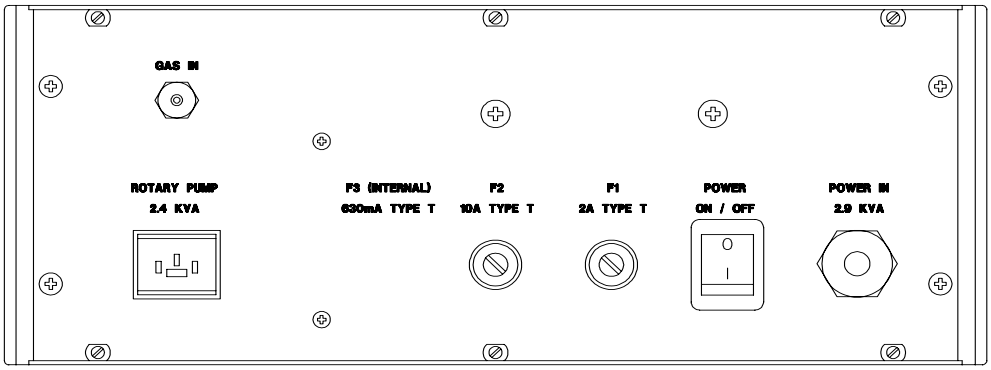

Figure 4-4: SC7620 Sputter Coater, Rear Panel Connections.

CONNECTION	DESCRIPTION
GAS IN	A 3mm nipple provides the gas (argon) input connection point.
ROTARY PUMP	A three-pole mains socket provides power to the rotary pump.
F3 (internal)	The 630mA –A/S HT fuse, Type T *Only accessible when the rear panel is removed.*
F1	Power supply PCB fuse, Type T 2 Amp.
F2	Main supply fuse, Type T (240 Volt, 10 Amp, A/S), (110 Volt, 15 Amp, A/S)
POWER ON/OFF	A vertically operated paddle switch acts as a mains isolator.
POWER IN	A flying lead provides the connection of power to the system.

Table 3: SC7620 Rear Panel Components

An additional connection point on the top of the unit for VACUUM is provided for a 12mm vacuum hose that connects to the vacuum pump.

5 Installation

Quorum Technologies has carefully packed the **SC7620 Mini Sputter Coater** instrument so that it will reach its destination in perfect operating order. Do NOT discard any packing materials until the unit has been inspected for any transit damage and the instrument has been used to the customers satisfaction.

If any damage is found, notify the carrier and Quorum Technologies (or local agent) immediately. If it is necessary to return the shipment, use the packaging as supplied and follow the instructions in this manual for return of goods section 3.1.

5.1 Unpacking Checklist

The Equipment package will normally be despatched from the factory in one box. Inside the box the following will be found, refer and check each item off against the supplied packing list.

- SC7620 Mini Sputter Coater - packed in its own internal packaging (Target fitted in Top Plate).
- SC7620 Glass Cylinder - packed separately.
- SC7620 START-UP kit - packed in a polythene bag.
- Optional Spares - packed individually.
- Documentation - Inserted in a folder, containing the operating manual and a standard forms pack.

5.1.1 Preparation

(a) Ensure that a suitable **mains electricity supply** (110 Vac - 20amps or 240 Vac - 13amps, frequency 50/60 Hz) is available. Check that the voltage label attached to the side of the cabinet is suitable for the local voltage and frequency.

The units are supplied for either 230V or 110V operation at 50/60Hz. The power rating is 250VA excluding the rotary pump. The rotary pump outlet is rated at 230V 10A or 110V at 16A. The 240V pump outlet uses a 3-pin plug (404440310) which is supplied or 110V standard US plug (not supplied).

(b) Ensure that a suitable **gas supply** is available.

Typically: A commercial cylinder of Argon Gas (Zero Grade), fitted with a two stage regulator, in order to deliver gas at a pressure around 5-10 psi (0.5bar).

(c) Ensure that a suitable **vacuum pump** is available.

Where a rotary pump is used, ensure that the rotary pump has been filled with oil, in accordance with the manufacturers instructions. The exhaust should be filtered or expelled to a safe area. All pumps supplied by Quorum Technologies are fitted with an exhaust filter

5.2 SC7620 Installation

	**WARNING** **HAZARD TO HEALTH!** **Potentially lethal voltages are used in this equipment.** Before making / breaking connections to the equipment, ensure power is switched off and that it is safe to proceed.	

	**WARNING** **HAZARD TO HEALTH!** **Precautions to be taken when lifting this equipment.** Weight of unit is 20 Kilograms (44lbs)

(a) Position the Sputter Coater Cabinet on a suitable level working surface, Access to both front and rear of the cabinet are required.

(b) Clean the 'O' ring gaskets using a cloth moistened with isopropanol.

(c) Position the top plate assembly on the glass cylinder.

(d) Position the vacuum pump as close as possible to the Sputter Coater.

5.2.1 Connections

The connections to be made are described below and illustrated in Figure 5-1.

(a) Make the following hose connections to the rear panel of the cabinet.

(i) Connect 3mm bore gas tubing (supplied) from argon cylinder regulator to **(GAS IN)** hose nipple.

(ii) Connect 12mm bore vacuum tubing (supplied) from the rotary pump to the **(VACUUM)** connector. Ensure the minimum length of hose is used.

(b) Make the following electrical connections to the rear panel of the cabinet:

(i) Connect between the sputter coater power outlet **(ROTARY PUMP)** socket and the vacuum pump.

If the rotary pump is supplied with the Sputter Coater a suitable connecting cable is supplied with the pump, otherwise a suitable 3-way plug (which can be wired by the user) is supplied.

(ii) Connect the mains **(POWER IN)** cable via a suitable plug to the local supply, in accordance with the cable colour coding:

Brown	-	Live
Blue	-	Neutral
Green/Yellow	-	Earth

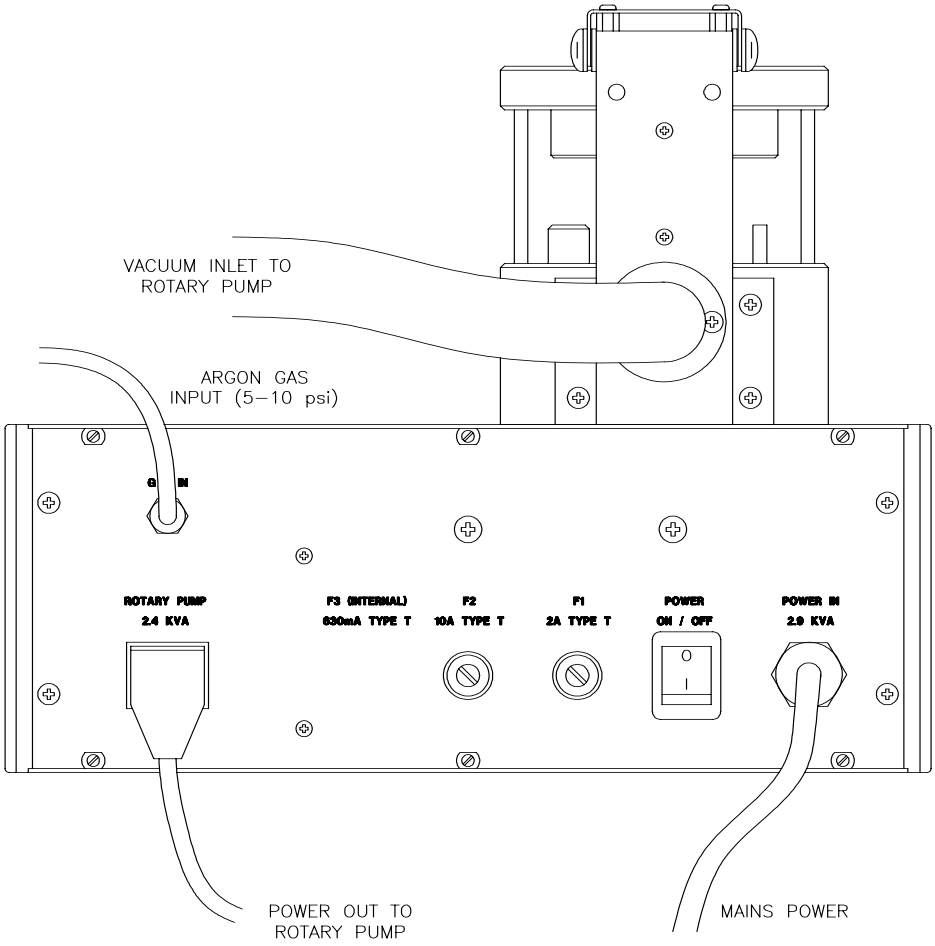

Figure 5-1: SC7620 Connections

6 Operation

The SC7620 Mini Sputter Coater is designed to be durable and has a long lifetime. The Instrument does contain items, primarily the Target that has finite lifetimes, in order to sustain optimum performance it will need replacing periodically. The lifespan of the Target is dependant on a number of factors, including operating in good vacuum levels, contamination and the purity of the gas being used. The Target should be replaced when it starts to become perforated.

6.1 Test Procedure

CAUTION

Contamination can seriously affect the sputtering process

To reduce the possibility of contamination by airborne particles, minimise the time the vacuum chamber is open to the atmosphere.

This test procedure, which checks the system is operating correctly, should be performed at the following times:

After the installation process has been completed.

After any operation that could lead to contamination of the vacuum chamber.

(a) Preparation

(i) Check that **LEAK** and **VENT** valves are closed, (fully clockwise).

(ii) Check the argon cylinder regulator is open. Set pressure to 0.5 bar (5-10psi).

(iii) Set **TIME** control to 15 seconds.

(iv) Check that mains power is available, set the rear panel mounted **POWER ON/OFF** switch to the down position. (ON).

(v) Check sputter option is selected.

(b) Set vacuum pressure.

(i) Operate **START PUMP** switch, the integeral indicator will illuminate and the rotary pump will start.

(ii) After 10-15 seconds (dependant on the size of rotary pump), the vacuum gauge will register a fall in pressure within the chamber. Continue pumping until the chamber pressure reaches 3 x 10^{-2} mbar or better, (indicating there are no major leaks in the system).

(iii) Open the **LEAK** valve (turn knob counter-clockwise, three to four turns) until the vacuum chamber pressure increases to approximately 6 x 10^{-2} mbar.

(c) Set process current

Whilst continuing to adjust the **LEAK** valve, intermittently operate the **SET PLASMA** button, the **PROCESS CURRENT** meter will register the current flow and sputtering will occur. Open or close the **LEAK** valve to adjust the current to 18mA. Release the **SET PLASMA** button.

(d) Adjust discharge current

(i) Operate the **START PROCESS** button, the sputtering process will commence. The current will rise to about 18 mA and a blue or purple discharge glow will be visible, gold-palladium (or other target material) will be sputtered onto the base plate. After 15 seconds, the timer will terminate the process, the discharge will cease and the indicator extinguish.

(ii) Whilst the sputtering process is in progress, outgassing of the system can alter the process current. Use the **LEAK** valve to correct these changes.

(e) Close down the system, as follows:

(i) Close the **LEAK** valve (turn fully clockwise).

(ii) Operate the **START PUMP** button, the indicator will extinguish and the rotary pump will be turned OFF.

(iii) Open **VENT** valve to admit gas to the vacuum chamber. When sufficient gas has entered the chamber, positive pressure will 'pop' the top plate open

(iv) Close the **VENT** valve.

6.2 Coating Process

A metal film of uniform thickness between 50 and 300 Å is generally used for SEM investigations.

Care must be taken to ensure the vacuum chamber is kept clean and free from contamination. Contamination which can arise from the out-gassing of specimens, adhesives (especially Chlorohydrocarbon based solvents) and rubber gaskets will adversely affect the quality and rate of sputtering.

A measure of thickness can be obtained using the following equation: **d = KIVt**

d The coating thickness in Angstrom units.
K An experimentally determined constant based on:
The metal being sputtered,
The gas being used,
45 mm (approx.) target to sample distance.
For gold used with argon, K = 0.17 approx.
For gold used with air, K = 0.07 approx.
I is plasma current, in mA.
V is the applied voltage, in kV, (1 kV).
t is the sputtering time, in seconds.

For a typical sputtering, using gold in argon with a plasma current of 18 mA for 120 seconds:

d = KIVt = 0.17 x 18 x 1 x 120
= 367 Å (approx. 3 Å / second)

The uniformity of the coating thickness within the area of the specimen holder is better than 10%.

6.3 Coating Specimens

(a) Mount specimens

(i) Prepare specimens on stubs, using an approved method.

(ii) Hinge the top plate back and remove the glass chamber.

(iii) Adjust the height of the sample stage. Whilst the most suitable height for a particular application can best be established empirically, 35mm between top of the sample and the target provides a satisfactory general purpose setting.

(iv) Mount the stubs (with attached samples) on the sample stage.

(v) Replace the glass chamber and close the top plate, to enclose the sample. Care to be taken when closing the Top Plate onto the glass cylinder as the glass can easily chip if hit by the Top Plate.

NOTE: *Take care to align the glass chamber as the top plate is closed to avoid chipping the glass sealing surface*.

(b) Preparation

(i) Check that **LEAK** and **VENT** valves are closed, (fully clockwise).

(ii) Check the argon cylinder regulator is open. Set pressure to 0.5 bar (5-10psi).

(iii) Set **TIME** control to required setting, say 120 seconds (the time required is process dependent).

(iv) Check that mains power is available, set the rear panel mounted **POWER ON/OFF** switch to the down position (ON).

(v) Check sputter option is selected.

(c) Set vacuum pressure

(i) Operate the START PUMP button, the rotary pump will start and the reducing pressure will be indicated on the **CHAMBER PRESSURE** meter.

(ii) When the pressure reaches 0.1 mbar, partially open the LEAK valve to flush the vacuum system with Argon. During flushing, allow the pressure to rise to between 0.5 and 1 mbar for 10-15 seconds. Close the LEAK valve and allow vacuum chamber pressure to recover to better than 4×10^{-2} mbar.

(d) Set process current

Open the **LEAK** valve and monitor the vacuum pressure. When the pressure begins to rise, intermittently operate the **SET PLASMA** button continuing to adjust the **LEAK** valve. The **PROCESS CURRENT** meter will register the current flow. Open or close the **LEAK** valve to adjust the current to 18mA. Release the **SET PLASMA** button.

(e) Sputter processing

(i) Operate the **START PROCESS** button, the sputtering process will commence and a blue coloured discharge glow will be visible in chamber. Gold-palladium or other target material will be sputtered onto the samples for the set time period, then the discharge will cease.

(ii) For a thicker coating, repeat (e (i) above).

(f) Remove Specimens

(i) Close the **LEAK** valve to shut off the flow of argon to the chamber.

(ii) Operate the **START PUMP** button, the indicator will extinguish and the rotary pump will be turned **OFF**.

(iii) Open the **VENT** valve to admit gas to the chamber.

(iv) When the chamber pressure returns to atmosphere, close the **VENT** valve, lift the top plate clear of the glass chamber.

(v) Remove the specimens.

(vi) If further specimens are not to be coated immediately, close the top plate to seal the chamber. (See section 6.3(a)-(v))

NOTE: *Take care to align the glass chamber as the top plate is closed to avoid chipping the glass sealing surface.*

6.4 Sputtering Rates

The following sputtering rates have been measured using the FT7690 Film Thickness monitor with a 45mm gap between the targets and the stage crystal holder. The plasma was established using "zero" grade argon gas at the vacuum level required to achieve plasma current. Evacuation of the work chamber was achieved with a 50 l/min two stage rotary pump. Each target was cleaned by sputtering at 25mA for three minutes prior to coating for the measurements.

The graphs show typical sputter rates achieved on a standard instrument under the conditions as specified and are intended only as a guide to coating thickness.

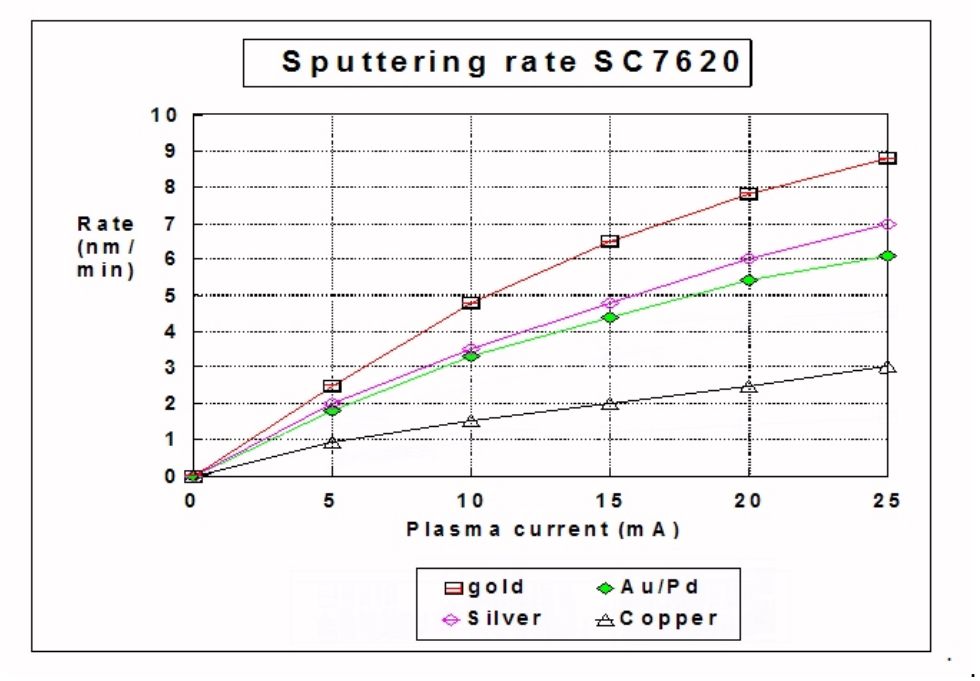

Figure 6-1: SC7620 Sputter Rates

6.5 Glow Discharge Process

(a) Mount specimens

(i) Hinge the top plate back and remove the glass chamber.

(ii) Adjust the height of the sample stage. Whilst the most suitable height for a particular application can best be established empirically, 35mm between top of the sample and the target provides a satisfactory general purpose setting.

(iii) Mount the samples on the sample stage, using approved method.

(iv) Replace the glass chamber and close the top plate, to enclose the sample. Care to be taken when closing the Top Plate onto the glass cylinder as the glass can easily chip if hit by the Top Plate.

NOTE: *Take care to align the glass chamber as the top plate is closed to avoid chipping the glass sealing surface*.

(b) Preparation

(*) When used in glow discharge mode either for surface treatment or etching of surfaces, if a target was previously fitted for sputter coating, this should be removed. See section 7.3.1 **Target Removal** on page 28.

(*) Glow discharge is normally in air, so a process gas is not required.

(i) Check that **LEAK** and **VENT** valves are closed, (fully clockwise).

(ii) Check the argon cylinder regulator is open. Set pressure to 0.5 bar (5-10psi).

(iii) Set **TIME** control to required setting, say 120 seconds (the time required is process dependent).

(iv) Check that mains power is available, set the rear panel mounted **POWER ON/OFF** switch to the down position (ON).

(v) Check **glow discharge** option is selected.

(c) Set vacuum pressure

(i) Operate the START PUMP button, the rotary pump will start and the reducing pressure will be indicated on the **CHAMBER PRESSURE** meter.

(iii) Allow vacuum chamber pressure to recover to better than 4×10^{-2} mbar.

(d) Set process current

Open the **LEAK** valve and monitor the vacuum pressure. When the pressure begins to rise, intermittently operate the **SET PLASMA** button continuing to adjust the **LEAK** valve. The **PROCESS CURRENT** meter will register the current flow. Open or close the **LEAK** valve to adjust the current meter to required current. Release the **SET PLASMA** button.

(e) Glow Discharge process

(i) Operate the **START PROCESS** button, the glow discharge process will commence for the set time period, then the discharge will cease.

(f) Remove Specimens

(i) Close the **LEAK** valve to shut off the flow of air to the chamber.

(ii) Operate the **START PUMP** button, the indicator will extinguish and the rotary pump will be turned **OFF**.

(iii) Open the **VENT** valve to admit gas to the chamber.

(iv) When the chamber pressure returns to atmosphere, close the **VENT** valve, lift the top plate clear of the glass chamber.

(v) Remove the samples.

(vi) If further samples are not to be cleaned immediately, close the top plate to seal the chamber. (See section 6.3(a)-(v))

NOTE: *Take care to align the glass chamber as the top plate is closed to avoid chipping the glass sealing surface.*

7 Maintenance

For technical and applications advice plus our on-line shop for spares and consumable parts visit www.quorumtech.com

7.1 Maintenance – General

WARNING

HAZARD TO HEALTH!

Potentially lethal voltages are used in this equipment.

Before making / breaking connections to the equipment, ensure power is switched off on the the Electronics unit.

(a) The procedures listed in this section should only be done by persons who have had training and who have achieved a satisfactory knowledge of the necessary skills and techniques.

(b) If repairs entail the dismantling of any part of the vacuum system, care must be taken to ensure that it is not contaminated (by dust or fingerprints).

(i) Always wear disposable plastic gloves.

(ii) Do **NOT** handle internal surfaces.

(iii) Whenever possible, cover to protect against dust.

7.2 Cleaning

Use a damp cloth or proprietary equipment cleaner to remove surface grime from the outer surfaces of the cabinet and vacuum chamber. Finish with a dry lint free cloth to remove smearing.

7.2.1 Vacuum Chamber Cleaning

Cleaning of the vacuum chamber is required if the interior of the chamber becomes contaminated, cleaning on a regular basis is unnecessary. The fact that the glass walls of the chamber becomes coated with target material and the sample cannot be seen, should not normally be considered reason to clean the system.

If the system is contaminated by handling or air-bourne pollution, carry out the following procedure.

For cleaning use a nylon abrasive pad (Scotchbrite or similar) and Cleaning fluid (Isopropanol).

(a) Ensure power and gas supplies to the sputter coater are set to **OFF**.

(b) Remove all electrical, gas and vacuum connections from the rear of the instrument. Move the sputter coater to a clean working area.

(c) Lift the Top Plate assembly clear of the vacuum chamber and remove the glass chamber. Unscrew and remove the stage assembly.

(d) Lightly abrade all the accessible interior surfaces of the vacuum chamber to remove any deposits (not the target). Rinse with cleaning fluid. Cover cleaned components to prevent further contamination.

(e) The target is self cleaning in use and should not require attention. If the target is damaged, replace the target, see section 7.3.

(f) The vacuum and gas tubing cannot be readily cleaned, if these items are suspect or showing signs of ageing they should be replaced.

(g) Reassemble the vacuum chamber components.

(h) Reconnect the electrical and gas tubing connections for the Top Plate assembly.

(i) Return the sputter coater to its working position. Reconnect the electrical, vacuum and gas connectors to the cabinet rear panel.

(j) When taking the system back into service carry out the Test Procedure (see section 6.1), this will ensure the system is thoroughly dried out.

7.3 Target Replacement

In normal use, erosion of the target will occur. Initially this will be seen as triangular patterns on the surface of the target. With further use, holes in the target (generally in a triangular pattern) will become apparent. To prevent this occurring prematurely and to maximise the target usage, occasionally rotate the target approximately 15 degrees to even out the wear pattern. When the holes finally appear in the target then the target should be replaced.

7.3.1 Target Removal

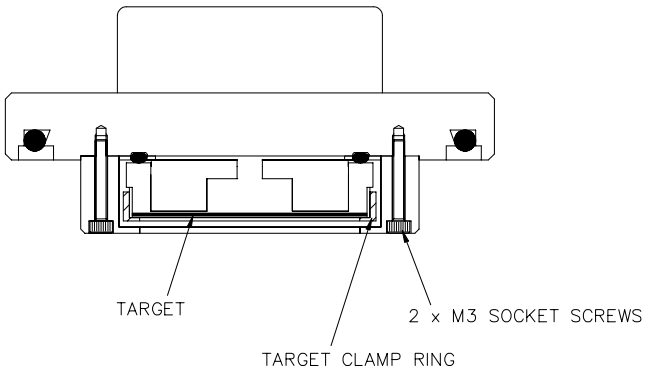

Figure 7-1: Target Replacement

Note: Target removal is required when using the **Glow Discharge** Mode

(a) Ensure power supplies to the Sputter Coater are all set to **OFF**.

(b) Hinge the top plate back, to expose the target assembly.

(c) To release the Shroud, remove 2 x M3 socket screws. Remove the Shroud.

(d) Unscrew and remove the Target Clamp (if the Target Clamp will not unscrew, lubricate lightly with isopropanol). Remove and discard the old target. If necessary clean the Magnet Holder and Target Clamp, using a gentle abrasive material (Scotchbrite), rinse with isopropanol and dry thoroughly.

7.3.2 Refit New Target

For replacement Target type and number, refer to Spares list section 7.5

(a) Position the new target in the Target Clamp Ring, ensure target is lying flat.

(b) Carefully fit the Clamp over the Magnet Holder, tighten until the target is securely clamped.

(c) Re-fit the Shroud and secure using the 2 x M3 socket screws.

(d) Position the Top Plate assembly on the vacuum chamber and reconnect the services previously removed. Care to be taken when lowering the Top Plate onto the Glass Chamber.

(e) When taking the system back into service carry out the Test Procedure (see chapter 6.1), this will ensure the system is thoroughly dried out.

.

7.4 No Discharge Current

If after switching power on, **SET PLASMA** is operated and the Sputter Coater does not respond, check the following:

(a) If **SET PLASMA** indicator is illuminated, ensure the vacuum pressure is 10^{-1} mbar or better, if pressure is above this level check for leaks (check **VENT** is closed).

(b) If **SET PLASMA** indicator is not illuminated check fuse F3 (fitted within the sputter coater).If fuse is blown replace with the correct fuse F3, 630mA anti-surge as follows:

(i) Ensure power supplies to the Sputter Coater are set to OFF.

(ii) Remove all electrical and gas connections to the rear panel.

(iii) Remove 10 screws to release the rear panel, retain the screws for future use.

(iv) Ease the rear panel away from the main assembly.

(v) F3 fuse holder is mounted in the bottom left corner of the PCB assembly.

(vi) Remove the fuse, test and if necessary replace. Discard the blown fuse.

(vii) Reassemble the Sputter Coater.

(c) If **Current limit** interlock LED is illuminated the unit remains interlocked until the power to the instrument is turned off then on again. Please allow between 3 and 5 seconds powered off.

The **Current limit** interlock LED will remain illuminated if there are short circuits to the target see Section 7.3 and Section 8

7.5 Spare Parts

Those parts, which due to wear and tear are more commonly required, are listed in the table as follows.

PART NUMBER	DESCRIPTION	QTY
E5004	Oil Mist Filter	1
SC502-314A	Gold Target	1
SC502-314B	Gold/Palladium Target	1
SC502-314E	Silver Target	1
SC502-314G	Palladium Target	1
351270380A	Argon Gas Tubing	2 metres
351220430	Vacuum Tubing	1metre
405030310	Fuse – 3A Type T $1^1/_4$" (F1- 110V)	1
405020310	Fuse – 2A Type T $1^1/_4$" (F1- 240V)	1
405150310	Fuse – 15A Type T $1^1/_4$" (F2- 110V)	1
405100310	Fuse – 10A Type T $1^1/_4$" (F2- 240V)	1
405006210	Fuse – 630mA Type T 20mm (F3)	1

Table 4: Spare Parts for the SC7620

8 Fault Finding

We hope that you experience the minimum of problems throughout the lifespan of the instrument but inevitably problems may occur. Any known problems associated with this type of instrument have been listed below with the possible cause and suggestions to what to do. If problems continue to occur, for example the fuse blows immediately when a new one is fitted, contact the Sales Department at Quorum Technologies or your local agent, see Section 9 for list of agents.

8.1 Trouble Shooting / Fault Finding

OBSERVATION	POSSIBLE CAUSE	REMEDY	Section
Unit appears dead	- Cable connections not made	- Check all cable connections	5.2.1
	- Fuse blown	- Replace fuse (F1) on back panel 2A 1 1/4 " Anti-surge. - 240V supply *or* 3A 1 1/4 " Anti-surge. - 120V supply	4.6.2
	- Interlock not activating	- Check interlock is operating	-
Rotary Pump not Working	- Unit not switched on	- Check switch on Rotary Pump	-
	- Cable connections not made	- Check all cable connections	5.2.1
	- Fuse blown	- Replace fuse (F2) on back panel 10A 1 1/4 " Anti-surge. - 240V supply *or* 15A 1 1/4 " Anti-surge. - 120V supply	4.6.2
Triangular patterns or holes on Target	Target at end of life	- Replace Target	7.3
No Discharge Current	- Low or No Vacuum Pressure	- Leaks in System or Pipe work	6.3
	- Target short circuit causing current limit or vacuum level dropped quickly during operation	- Clean target and shroud or power the unit off and on	8.2
		- Vent is Open	4.6.1
	- Fuse blown	- Replace fuse (F3) inside unit 630mA 20mm Anti-surge.	7.4

Table 5: Trouble Shooting

8.2 Fault Prevention

It is assumed that with a system in regular use and that the system was installed in a suitable environment and in regular use, faults will be repaired as they occur. To maintain the equipment to the best operating conditions a maintenance schedule is suggested as part of a fault prevention programme, the following items are suggested to be included in such a programme. The frequency of checking will depend on the usage of the equipment.

ITEM	REGULARLY	OCCASIONALLY
Inspect all connections (vacuum, gas and electric) for signs of wear and that they are securely retained in position.	X	
Check all control knobs are secure and operate correctly		X
Check that the lid interlock is operating correctly	X	
Check all earthing cables and connections are secure	X	
Cleaning particularly inside shroud	X	

Table 6: Fault Prevention

9 Agents

List of Agents Supporting Quorum Technologies products.

Oxford Instruments Pty. Ltd P O Box 7 Pennant Hills NSW 1715 **AUSTRALIA** Tel: 61 2 9484 6108 Fax: 61 2 9484 1667 Email: keith.murray@oxinst.com.au	Goffin Meyvis P O Box 251, NI-4870 AG ETTEN LEUR **THE NETHERLANDS** **(**Also covers**, BELGIUM & LUXEMBOURG)** Tel: 31 (0)76 508 6000 Fax: 31 (0)76 508 6086 www.goffinmeyvis.com	Hi-Tech Instruments Sdn Bhd 60 Jalan Ind. PBP 3 Taman Ind Pusat, Bandar, Puchong 47100 PUCHONG, Selangor. **MALAYSIA** Tel: 60 3589 11638 Fax: 60 3589 11639	Monocomp Instrumentacion S.A. C/Virgen de la Fuencisla 25 28027 Madrid **SPAIN** Tel: 34 91 326 74 97 Fax: 34 91 326 76 08 Email: Mi@monocomp.jazztel.es
Labco GmbH Dr - Tritemmel - Gasse 8 A3013 PRESSBAUM **AUSTRIA** Tel: 43 2233 53838 Fax: 43 2233 53176 www.jeoleuro.com	OED Technology Limited 15F Beltrade Commercial Building 3 Burrows Street WANCHAI **HONG KONG, CHINA** Tel: 852 2838 2377 Fax: 852 2838 0091 Email:pjcoomb@HK.Super.NET	Ellipsiz Malaysia SDN BHD No.15B/15C Jalan Kenari 8 Puchong Jaya Selangor Darul Ehsan PUCHONG 47100 **MALAYSIA** Tel: 60 3807 52035 Fax: 60 3807 53104	Leica Microsistemas SA Nicaragua 46 BARCELONA 08029 **SPAIN** Tel: 34 93 49 49530 Fax: 34 93 49 49532 Email: ana.alrcon@leica-microsystems.com
Altmann S/A Importação.e Comércio.Av Nacoes Unidas 13771 Bl.1-7°andar 04794-000 Sao Paulo -SP BRAZIL Tel: 55 11 550 73302 Fax: 55 11 550 74196 www.altmann.com.br	Auro-Science Consulting KFT H-1031 Budapest Varosfal Kos 5 Mail:H1300 Budapest PF 234 **HUNGARY** Tel: 361 242 1390 Fax: 361 242 1391 Email dobak@auroscience.hu	Global Science & Technology Ltd PO Box 101253 North Shore Mail Centre Auckland **NEW ZEALAND** Tel: 0800 734 100 Fax: 0800 999 002 Email: jsmall@globalscience.co.nz www.globalscience.co.nz	Aname C/Jose Fernandex Cuevas 14-B-282244 Pozvelo de Alarcon MADRID **SPAIN** Tel: 34 91 352 3084 Fax: 34 91 352 3322 www.aname.org
Soquelec Limited 5757 Cavendish Building Suite 101 MONTREAL QUEBEC H4W 2W8 **CANADA** Tel: 1 514 482 6427 Fax: 1 514 482 1929 www.soquelec.com	Harley Instruments Plot No. 4, Survey No. 47 Poona Satara Road POONA 411009 **INDIA** Tel: 91 2042 20602 Fax: 91 2042 20843 Email: harleyinstruments@vsnt.net	Nerliens Meszansky AS Kampengaten 18 PO Box 2955 Toyen N-0608 OSLO **NORWAY** Tel: 47 2268 5070 Fax: 47 2267 6506 www.nerliens.no	Atema Instrument PO Box 7075 Gillbostraket 8 S-19207 SOLLENTUNA **SWEDEN** Tel : 46 8626 8365 Fax : 46 8626 8355 Email : berndt.holm@atema.se
Edlin s.r.o Kon vova 141 130 83 PRAHA 3 **CZECH REPUBLIC** Tel: 42 2671 08255 Fax: 42 2671 08335 Email:zemek@edlin.cz	AVBA P.O Box 690, Ramat Gabriel Industrial Park, Migdal Haemek, 10500 **ISRAEL** Tel: 972 (0) 4 644 2575 ext.240 Fax: 972 (0) 4 644 2577	ELO SERWIS Grazyna B. Dudzinksa Ul.Sotta K. “Sokola” 7/2A Pl-02-796 Warszawa **POLAND** Tel: 48 004822 649 8690 Fax: 48 (22) 649 11 85 Email: S.Dudzinkski@medianet.pl	HO-CHAN Technologies Ltd N° 19, Lane 43 His-Tsun Road Dai-Li City TAICHUNG **TAIWAN**, ROC Tel: 886 4393 2897 Fax: 886 4393 2401 Email: zenyan@giga.net.tw
Ax Lab A/S Srandboulavarden 64 DK-2100 COPENHAGEN **DENMARK** Tel: 45 3543 1881 Fax: 45 3543 0073 Email:bodil@ax-lab.dk	Eisenberg Brothers 13 Gush Etzion St GIVAT SHUMEL 54030 **ISRAEL** Tel: 972 3 532 1715 Fax: 972 3 532 5696 www.eisenbros.co.il	Labometer Lda Rue Duque de Palmela No. 30-1° 1200 LISBOA **PORTUGAL** Tel: 351 1353 7284 Fax: 351 1332 4304 Email : Labometeri@mail.telepac.pt	Pondpol HTI Co Ltd 82/32 Kanchanapisek Road Talingchan District Bankok 10170 **THAILAND** Tel : 66 (2) 887 8883 Fax : 66 (2) 887 6330 Email : polsin@pondpol.com
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