

Quorum Technologies

CC7650 Carbon Coater

Operating Manual

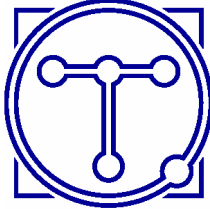


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Quorum Technologies

Quorum Technologies Ltd is the owner and manufacture of the preparation equipment.



range of EM

Unit 15A
Euro Business Park
New Road
Newhaven
East Sussex
U.K.
BN9 0DQ
Email :

tel: ++44(0) 1273 510535
fax: ++44(0) 1273 510536

sales@quorumtech.com
<http://www.quorumtech.com>

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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.



1 Contents

1.1 Manual Layout

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

Chapter 1 - Contents

Chapter 2 - Health and Safety

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

Chapter 3 - Introduction

Introduces this manual.

Chapter 4 - General Description

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

Chapter 5 - Installation

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

Chapter 6 - Operation

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

Chapter 7 - Maintenance

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

Chapter 8 - Fault Finding

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

Chapter 9 - Agents

List of main agents supporting the Quorum Technologies product range

Chapter 10 - Index

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2 Health and Safety

Safety is very important when using any instrumentation and this chapter 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 chapter 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:

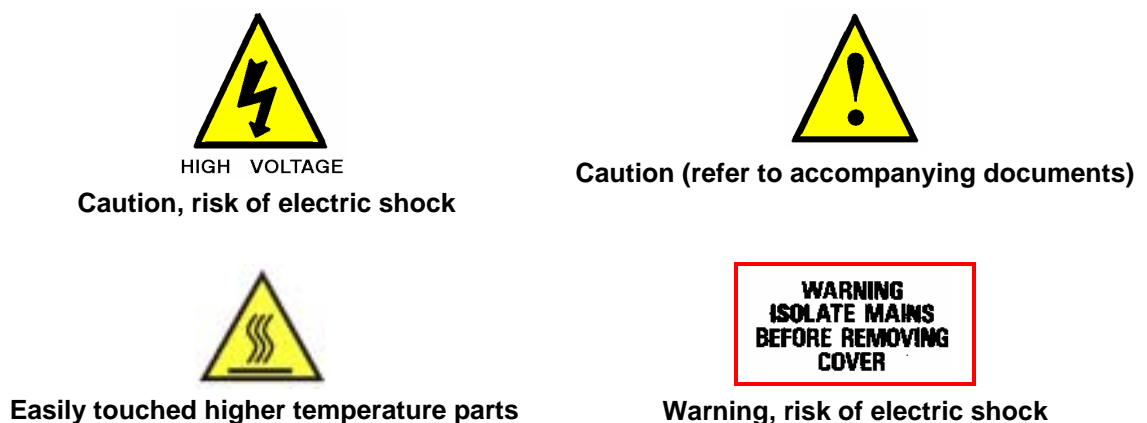


Figure 2.1 - Hazard Warning Symbols

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

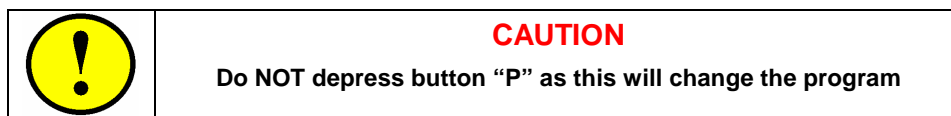


Figure 2.3 - Typical Warning sign as shown in this Manual

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

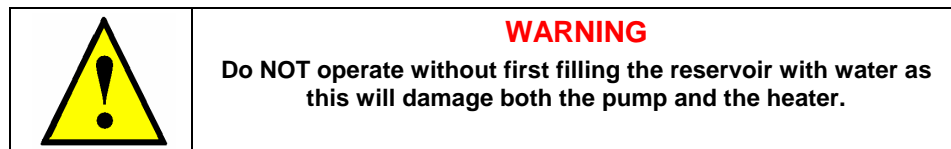


Figure 2.4 - Typical Warning sign as shown in this Manual

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 footwear.

Table 2.1 - Personal Operational Risks

2.6.2 Hazardous 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 cleanroom 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 CC7650 Specific Safety Hazards

The following Safety Hazards are specific to the Quorum Technologies CC7650 Carbon Coater.

	<p>WARNING</p> <p>HAZARD TO HEALTH!</p> <p>The Power Supply used in the Model CC7650 unit can operate at up to 10V A.C at 100A or 20V A.C at 50A. HAZARDOUS AMPERAGE OUTPUTS of up to 100Amp</p>	 HIGH VOLTAGE
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2.8.1 Contamination

Contamination of the vacuum chamber can be very detrimental to the carbon evaporation process. Over a period of time the inner surfaces of the vacuum chamber can become coated with a layer of carbon, which will absorb water from the atmosphere. The desorbing of water vapour during the coating process combining with the residual air and oxygen in the vacuum chamber will result in low levels of deposition, due to the conversion of carbon to carbon oxides during the vaporisation process.

3 Introduction

This manual is intended for all users of the **CC7650 Carbon Coater** manufactured by Quorum Technologies 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 three 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 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 CC7650 Carbon Coater when supplied as a complete package, includes the basic unit, and an operation manual. Items can be ordered as a full package or separately against the following numbers:

CC7650 Carbon Coater with Power Supply 220-240V complete, consisting of the following:

LA765002D	Carbon Power Supply 220-240V.
CC7650-STARTUP	Start up Kit
CA076F	Carbon Fibre head (standard)
OM-CC7650	Operation Manual

CC7650/110V Carbon Coater with Power Supply 110-120V complete, consisting of the following:

LA765003D	Carbon Power Supply 110-120V.
CC7650-STARTUP	Start up Kit
CA076F	Carbon Fibre head (standard)
OM-CC7650	Operation Manual

4.1.1 Optional Components

The following are optional components available from Quorum Technologies.

CA076R Carbon Rod head as an alternative to the Carbon Fibre Head..

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

4.1.2 Optional Accessories

The CC7650 Carbon Coater is available with two optional stage accessories, only one of which may be fitted at a time. These accessories will normally be factory fitted at the time of ordering, the required option must be stated at this time. If more than one of these options are ordered the others will be supplied as kits. Alternatively, the Carbon Coater can be returned to the factory for upgrading. Methods of fitting these units can be found in the Installation Section, Paragraph 5.3.

Rotary Planetary Stage

The standard stage can be replaced with a rotary planetary stage. The power supply for the rotary stage is built into the system as standard.

RC7606 A kit of parts to add a rotary planetary specimen stage to a CC7650 Carbon Coater, the kit contains: Rotary Planetary Stage, Motor, Drive Components and Fixings.

Water Cooled Stage

The standard stage can be replaced with a water-cooled stage. Cooled water can be circulated to lower the stage temperature. This reduced temperature should be kept above the Dew point to avoid condensation of atmospheric moisture whilst the stage is open to the atmosphere. This will result in excessive pump down times on re-evacuation and possible sample damage.

WS7608 A kit of parts to add a water-cooled specimen stage to a CC7650 Carbon Coater, the kit contains: Water Cooled Stage, Inlet and Outlet Connectors, Piping and Fixings.

4.2 Overview

The CC7650 Carbon Coater is a simple to operate carbon evaporation system used for coating Scanning Electron Microscopy (SEM) specimens.

The CC7650 is a fully integrated bench top carbon 'flash' evaporation system designed to coat up to six SEM samples for EDS and WDS applications. It is also ideal for coating samples to be imaged by back scattering detection systems. Rapid and reproducible results are assured.

In its standard format the CC7650 is supplied with a carbon fibre head. A carbon rod head is an option. Both types of head are carefully designed to make loading and unloading of carbon evaporation material easy. Manual operation of the system ensures total control of carbon source out gassing prior to flash evaporation.

The variable power supply is switchable between 10V/100A (for carbon rod evaporation) or 20V/50A (for carbon 'flash' evaporation). A standard height adjustable stage allows samples of varying heights to be positioned at optimal distances from the carbon source. For samples with very irregular surfaces an optional "Rota Cota" stage will help to ensure a more even coating. A water cooled stage option is available.

4.3 Technical Specification

4.3.1 CC7650 Carbon Coater Specification

Unit dimensions:	342mm wide x 320mm deep x 310mm high
Weight:	14 kg (31lbs).
Vacuum Chamber	150mm internal diameter x 135mm high.
Power requirement:	Available for either 230V (10 amp) <u>or</u> 110V (15 amp) operation at 50/60Hz.
Power supply output:	1KVA output switchable, either 10VAC x 100Amp or 20VAC x 50Amp on 2 high current terminals. Guaranteed 10% duty cycle resistive load.
Vacuum Requirements	Pump to evacuate $<2 \times 10^{-2}$ mbar.
Operating Temperature:	+5°C to +40°C
Storage Temperature:	-10°C to +70°C
Gas medium	Argon or Nitrogen
Interlock:	4 pin DIN for evaporation head protection.

4.4 Physical Description

The CC7650 Carbon Coater is a simple to operate carbon evaporation system used for coating Scanning Electron Microscopy (SEM) specimens.

The Carbon Coater (see Figure 4.1) is comprised of two main parts:

- A CC7650 power supply
- A vacuum chamber

The power supply cabinet which contains the variable low voltage output power supply, vacuum manifold and gauging, supports the associated vacuum chamber. Mounted on the front panel of the power supply are the switches and meters which provide the operator interface with the system.

The vacuum chamber is formed by; the top plate assembly, the glass cylinder and the base-plate (part of the upper surface of the carbon coater cabinet). The integrity of the vacuum chamber is maintained by 'L' section gaskets which separate the principle vacuum chamber components.

The top plate assembly supports the carbon source (either rod or fibre). Two heavy duty screw terminals mounted on the upper surface of the plate provide the connection points to the carbon source.

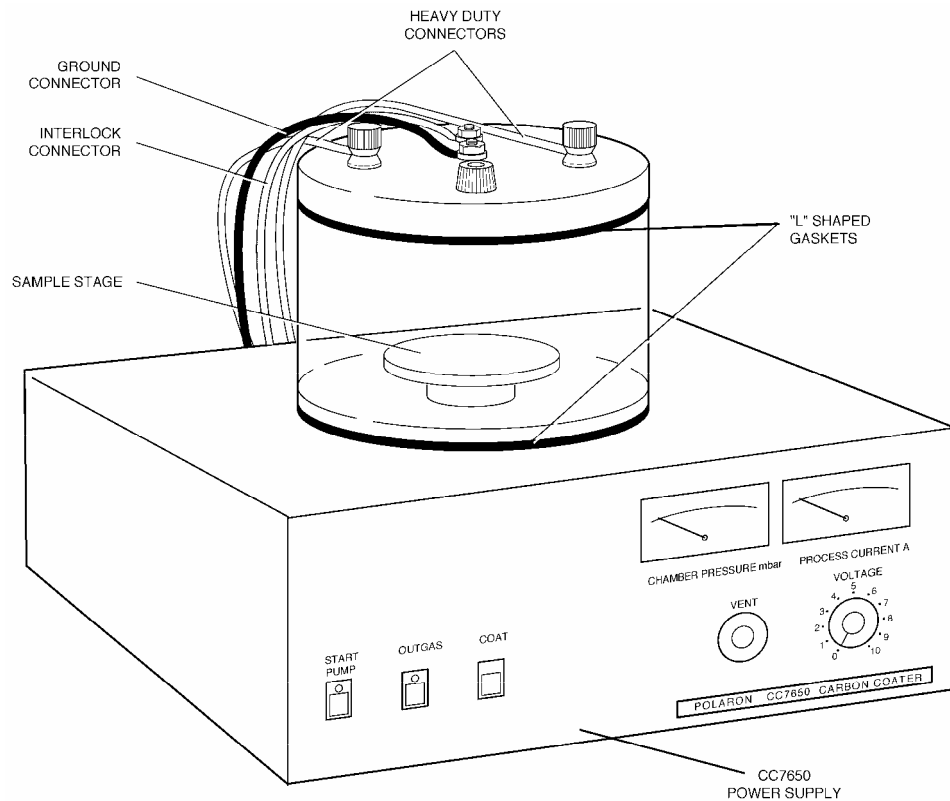


Figure 4.1 CC7650 Carbon Coater

4.5 Interlocks

Safety interlocks are incorporated in the CC7650 Carbon Coater to prevent power being switched on with the chamber top plate not in the closed position.

	<p>WARNING</p> <p>HAZARD TO HEALTH!</p> <p>Potentially lethal voltages are used in this equipment. Under no circumstances should interlock connections be over-ridden.</p>	 <p>HIGH VOLTAGE</p>
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4.6 CC7650 Panel Details

The CC7650 Carbon Coater is designed to be bench mounted, it provides switchable 10VAC x 100A or 20VAC x 50A on 2 x high current terminals to supply the coating head.

4.6.1 CC7650 Front Panel Controls

The controls and indicators mounted on the CC7650 Carbon Coater front panel are described below and identified in Figure 4.2 and described in Table 4.1.

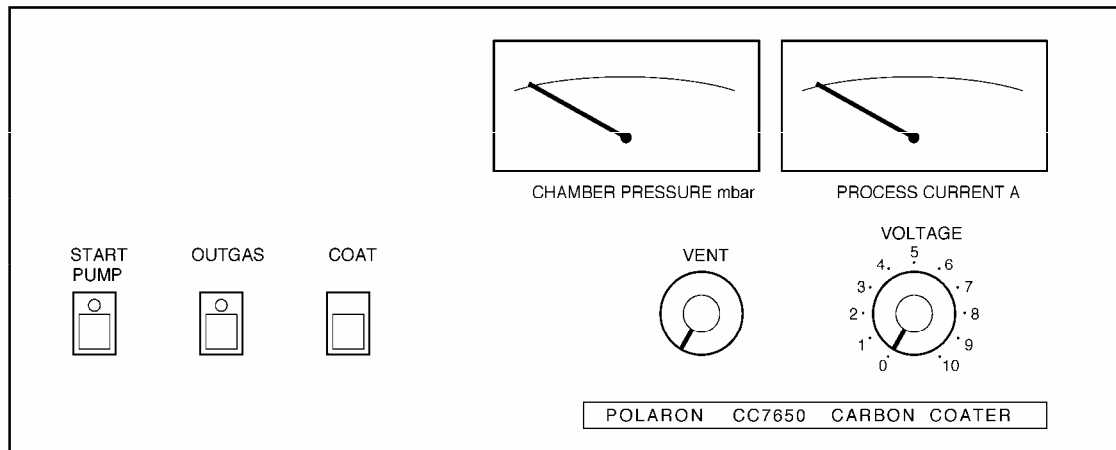


Figure 4.2 – CC7650 Carbon Coater, Front Panel Controls

CONTROL or INDICATOR	DESCRIPTION
START PUMP	This press to operate / press to release switch, which has an integral indicator, controls the power supplied to the rotary pump. When set to ON, the indicator illuminates.
OUTGAS	This press to operate / press to release switch which has an integral indicator, activates the power supply output during the outgassing procedure. When the output is activated, the indicator illuminates. When the outgassing procedure has been completed the control must be operated to set the power supply to OFF.
COAT	This non-latching switch (hold to operate) activates the power supply output during coating operations, when released the power supply output is deactivated.
CHAMBER PRESSURE mbar	This meter provides an indication of pressure within the vacuum chamber.
PROCESS CURRENT A	The current flow through the carbon (fibre or rod) elements is monitored by this meter.
VENT	The vent valve is opened to admit air or gas (if used) into the vacuum chamber after a coating process has been completed. During the coating process, the valve must be SHUT (fully clockwise).
VOLTAGE	A rotary control varies the output voltage, to the coater head. When the electrode switch (on the rear panel) is set to 1 (for carbon rod) the voltage output will cover the range 0 - 10V. When the electrode switch is set to 2 (for carbon fibre) the voltage output will cover the range 0 - 20V.

Table 4.1 – CC7650 Front Panel Control Descriptions

4.6.2 CC7650 Rear Panel Connections

The connection points and other components mounted on the rear panel of the CC7650 Carbon Coater are described below and identified in Figure 4.3 and described in Table 4.2

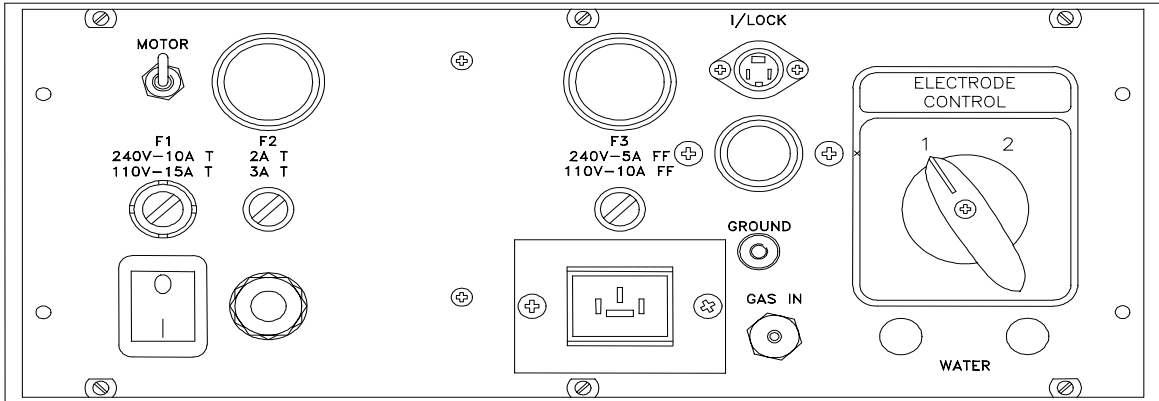


Figure 4.3– CC7650 Carbon Coater, Rear Panel Connections.

CONNECTION	DESCRIPTION
MOTOR	This switch sets the rotating sample stage motor ON/OFF, when set down the motor is ON. On systems not equipped with a Rotary Planetary Stage (RC7606), this switch has no effect.
OUTPUT	Two large terminals provide the low voltage output to the carbon source.
F1	Rotary Pump supply fuse, (240V, 10A T), (110V, 15A T).
F2	Mains supply fuse, (240V, 2A T), (110V, 3A T).
POWER ON/OFF	This switch provides mains isolation when set to OFF.
POWER IN	A flying lead provides for the connection of power to the system.
I/LOCK	4-pin DIN low voltage interlock for coating protection.
VACUUM	A 20mm vacuum hose connector provides a connection to the rotary pump.
F3	Control PCB fuse, (240V, 5A FF), (110V, 10A FF).
GROUND	Earth connecting point, from the top plate assembly.
ROTARY PUMP	A 3-way mains outlet socket, provides power to the rotary pump.
GAS IN	A 3mm nipple provides the gas (argon or nitrogen) input connection point.
ELECTRODE CONTROL	A two position switch selects the output voltage range. 1 Output range 0-10V, use with carbon rod source. 2 Output range 0-20V, use with carbon fibre source.
WATER	Two 6mm nipples provide Inlet and Outlet connections for cooling water supplies. On systems not equipped with water cooling, panel cut-outs are fitted with blind grommets.

Table 4.2 – CC7650 Rear Panel Components

4.7 Coating Heads

CA076F A simple Carbon Fibre evaporation head suitable for the production of carbon coatings for EDX and WDX applications. The carbon fibre is easily clamped between two spring loaded high current terminals, a shutter enables sample protection when the fibre is 'outgassed'. The CA076F Carbon Fibre Head is supplied complete with a glass chamber (to replace the Sputter Coater chamber) and 2 x 'L' gaskets, 2 x high current connecting leads and 1 metre of carbon fibre cord.

(For use with the SC7610 and SC7640 Sputter Coaters and CC7650 Carbon Coaters)

CA076R A simple Carbon rod evaporation head suitable for the production of carbon coatings for EDX and WDX applications. The carbon rods are easily clamped between a fixed and a pre-tensioned high current terminals, a shutter enables sample protection when the rods are 'outgassed'. The CA076R Carbon Rod Head is supplied complete with a glass chamber (to replace the Sputter Coater chamber) and 2 x 'L' gaskets, 2 x high current connecting leads and 1 packet of 10 shaped carbon rods.

(For use with the SC7610 and SC7640 Sputter Coaters and CC7650 Carbon Coaters)

5 Installation

Quorum Technologies has carefully packed the **CC7650 Carbon 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 paragraph 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.

- ◆ CC7650 Carbon Coater - packed in its own internal packaging.
- ◆ CC7650 Glass Cylinder - packed separately.
- ◆ CC7650 START-UP kit - packed in a polythene bag.
- ◆ Cables - packed separately.
- ◆ Evaporation Head - packed individually.
- ◆ 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 1500VA max 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) If gas is to be used for venting the system, ensure that a suitable **gas supply** is available.

Typically: A commercial cylinder of high purity Argon Gas or Nitrogen Gas, fitted with a two stage regulator, in order to deliver gas at a pressure around 5-10 psi (0.7bar).

- (c) Ensure that a suitable **cooling water supply** is available,.

This service is not required, unless the water-cooled stage option is fitted.


Ensure that a suitable supply of cooling water is available, a flow rate of 1 - 3 litres / minute of clean water is required. If a closed circuit recirculating chiller is used, avoid operating below dew point.

- (d) 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 CC7650 Installation

	<p>WARNING HAZARD TO HEALTH!</p> <p>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.</p>	 HIGH VOLTAGE
---	---	---

	<p>WARNING HAZARD TO HEALTH!</p> <p>Precautions to be taken when lifting this equipment. Weight of unit is 14 Kilograms (31lbs)</p>
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- (a) Position the CC7650 Carbon Coater cabinet on a suitable level working surface. Access to both front and rear of the cabinet are required.
- (b) Clean the 'L' section gaskets using a lint free tissue moistened with isopropanol.
- (c) Fit the two 'L' section gaskets to the glass cylinder, then position the glass cylinder centrally on the base plate (mounted on the cabinet).
- (d) Position the Top Plate assembly on top of the glass cylinder.
- (e) Position the vacuum pump as close as possible to the Carbon Coater.

5.2.1 Connections

- (a) Make the following hose connections to the rear panel of the cabinet:
 - (i) Connect from the argon (or nitrogen) cylinder regulator to **GAS** hose nipple.
 - (ii) Connect the rotary pump to the (**VACUUM**) connector using 20mm bore vacuum tubing, secure using hose clips or tie-wraps. Ensure the minimum length of hose is used.
 - (iii) If the system is fitted with water cooling, make connections to the **WATER** hose nipples using 6mm bore tubing.
- (b) Connect the two heavy-duty cables between the Carbon Coater **OUTPUT** terminals and the Carbon Coater Head. There is no polarity requirement.
- (c) Connect the earth connector (attached to the Carbon Coater Head) to the Carbon Coater **GROUND** connector.
- (d) Connect the interlock connector (attached to the Carbon Coater Head) to the Carbon Coater **INTERLOCK** connector.
- (e) Connect (**ROTARY PUMP**) power out to the vacuum pump. If a rotary pump is ordered with the Carbon 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.
- (f) Connect the CC7650 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

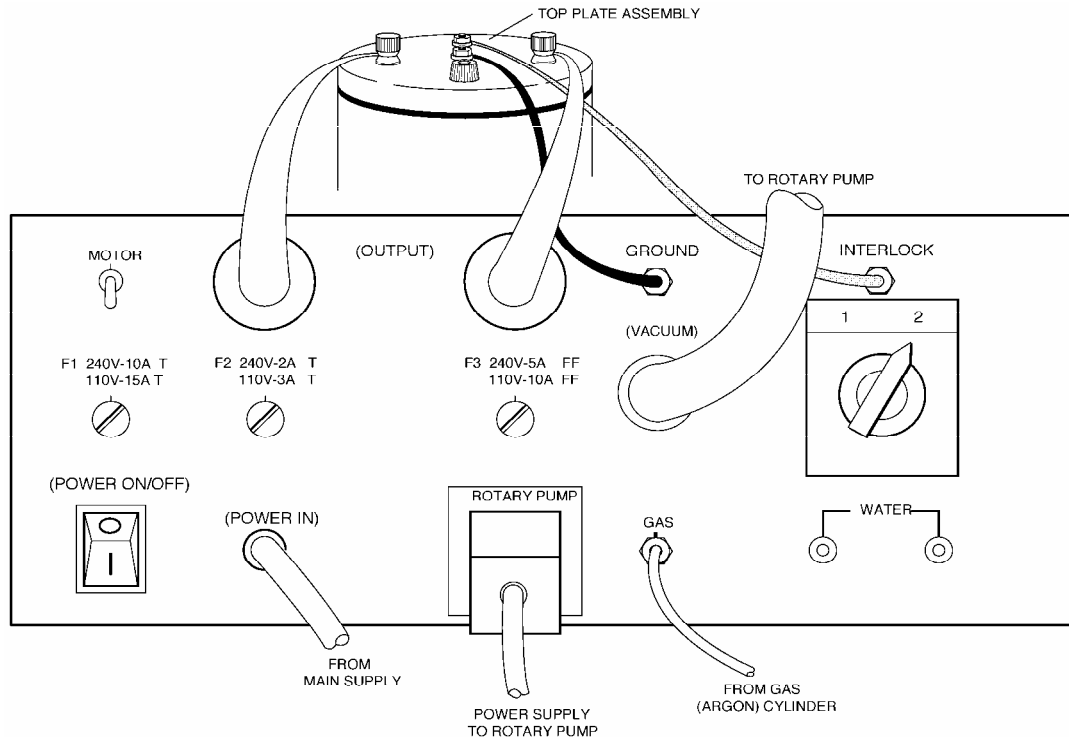


Figure 5.1 – CC7650 Carbon Coater Installation

5.3 Installation of Optional Accessories

The CC7650 Carbon Coater is available with two optional stage accessories, only one of which may be fitted at a time. These accessories will normally be factory fitted at the time of order in the priority:

- (1) RC7606 Rotary Planetary stage
- (2) WS7608 Water Cooled stage

Any of the stage options may be retro-fitted by a user as follows:

- (a) Isolate the CC7650 Carbon Coater from the mains power by removing the power lead from the laboratory supply.
- (b) Remove all services and connections to the rear panel.
- (c) Remove the rear panel by unscrewing 8 x M2.5 captive screws along the top and bottom edges of the panel. Unscrew and remove 4 x M4 screws at the left and right hand edges of the panel. Unscrew and remove 2 x M4 screws around the vacuum connection. The rear panel will be captive to the control unit by the wiring loom, move the panel to allow access into the control unit.

5.3.1 RC7606 Rotary Planetary Stage

- (a) Remove the standard adjustable height stage from the base plate by unscrewing and removing 3 x M4 cap head screws. The stage may now be lifted from the base plate, a compressed 'O' ring in the stage flange provides the vacuum seal.
- (b) Insert the RC7606 Rotary Planetary Stage into the base plate ensuring the 'O' ring seal is clean and lightly greased. Retain the RC7606 stage to the base plate using the 3 x M4 screws provided. Connect the flying lead from the RC7606 motor to the coiled flying lead located on the control unit chassis below the base plate.
- (c) Re-fit the rear panel and connect all the removed services. On/off control of the RC7606 stage is provided by the MOTOR switch located on the rear panel.

5.3.2 **WS7608 Water Cooled Stage:**


- (a) Remove the standard adjustable height stage from the base plate by unscrewing and removing 3 x M4 cap head screws. The stage may now be lifted from the base plate, a compression 'O' ring in the stage flange provides the vacuum seal.
- (b) Insert the WS7608 Water Cooled stage into the base plate ensuring the 'O' ring seal is clean and lightly greased. Retain the WS7608 stage to the base plate using the 3 x M4 screws provided. Remove 2 x blanking covers located on the rear panel '**WATER**' legend. Insert the two water fittings into the exposed holes and retain with the nuts provided.
- (c) Prior to re-fitting the rear panel and services, test the liquid path of the stage to ensure there are no leaks by connecting the water fittings to a water supply.
- (d) Re-fit the rear panel and connect all the removed services.

6 Operation

The carbon fibre (optionally, carbon rod) source, mounted in the vacuum chamber head, is heated by the current drawn from the CC7650 Power supply. When heated to a high temperature the carbon rapidly evaporates, nominally from a point source and carbon atoms condense onto the sample below.

An interlock (pressure switch) mounted in the Top Plate ensures that the power supply output is disabled unless the vacuum chamber pressure is below 10^{-2} mbar.

6.1 Test Procedure

	<p>CAUTION</p> <p>Contamination can seriously affect the coating process To reduce the possibility of contamination by airborne particles, minimise the time the vacuum chamber is open to the atmosphere.</p>
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This procedure is applicable to Coaters fitted with both Carbon Fibre or Carbon Rod sources. Where necessary variations in the procedure will be indicated.

(a) Preparation.

- (i) Check the carbon fibre is not broken and is not taut between the clamps. (Check the carbon rod is under maximum pressure and the tip is correctly shaped.)
- (ii) Check the **VENT** valve is closed (fully clockwise).
- (iii) For carbon fibre source, set the **ELECTRODE CONTROL** to position **2**. (For carbon rod, source set to position **1**.)
- (iv) Check **VOLTAGE** control is set to zero (fully counter clockwise).
- (v) If a dry process gas (argon or nitrogen) is to be used for flushing the system, check the gas cylinder regulator is open. Set pressure to 0.7bar (5psi). (The use of argon or nitrogen for flushing is not obligatory, it will however reduce the time taken to pump down to the required pressure.)
- (vi) Set the shutter to shield the sample stage from the carbon source.
- (vii) Set the rear panel mounted **POWER ON/OFF** switch to ON.

(b) Evacuate the work chamber.

- (i) Operate the **START PUMP** button, the rotary pump will start and the reducing pressure will be indicated on the **CHAMBER PRESSURE** meter.
- (ii) If gas flushing is to be implemented, when the pressure reaches $<3 \times 10^{-2}$ mbar, partially open the **VENT** valve for 5 - 10 seconds to flush the vacuum system. During flushing, the pressure will rise. Close the **VENT** valve and allow the system to recover to the best possible vacuum ($<2 \times 10^{-2}$ mbar).

(c) Out gassing.

- (i) Check the **VOLTAGE** control is at zero.
- (ii) Operate the **OUTGAS** button, the indicator will illuminate.
- (iii) Whilst monitoring the **CHAMBER PRESSURE** meter, turn the **VOLTAGE** control slowly clockwise to increase the voltage applied to the source. The carbon source will become hot. Increase the voltage until the source is heated to a red-orange glow. As the carbon heats up, the pressure will rise due to the carbon outgassing.

(d) Close down the System

- (i) Set the **VOLTAGE** control to zero.
- (ii) Operate the **OUTGAS** button, the indicator will extinguish.
- (iii) Operate the **START PUMP** button, the indicator will extinguish and the rotary pump will stop.
- (iv) Open the **VENT** valve, to admit air (process gas) to the vacuum chamber.
- (v) When the chamber is completely vented, close the **VENT** valve.

6.2 Sample Coating

6.2.1 Coating with Carbon Fibre Source

When heated the carbon fibre becomes fragile and generally breaks after a single evaporation. With care the fibre can be re-used but more generally will have to be replaced after each run. For details to replace the Carbon fibre refer to the maintenance section 7 of this manual.

(a) Mount the specimen(s)

- (i) Prepare specimens on stubs, using an approved method.
- (ii) Lift the glass cylinder (with top plate in position) clear of the cabinet and place aside on a clean surface.
- (iii) Adjust the height of the sample stage as low as possible.
- (iv) Mount the stubs (with attached samples) on the sample stage.
- (v) Position the glass cylinder on the coater cabinet, to enclose the sample.

(b) CC7650 Preparation

- (i) Lift the coater head clear of the vacuum chamber and check the carbon fibre is not broken and is not taut between the clamps.
- (ii) Replace the coater head on the vacuum chamber.
- (iii) Check the **VENT** valve is closed (fully clockwise).
- (iv) Set **ELECTRODE CONTROL** switch (on rear panel) to **2**, (for carbon fibre source).
- (v) Ensure **VOLTAGE** control is set to zero, fully counter-clockwise.
- (vi) If a dry process gas (argon or nitrogen) is to be used for flushing the system, check the gas cylinder regulator is open. Set pressure to 0.7bar (5psi). (The use of argon or nitrogen for flushing is not obligatory, it will however reduce the time taken to pump down to the required pressure.)
- (vii) Set the shutter to shield the sample from the carbon source.
- (viii) Set the rear panel mounted **POWER ON/OFF** switch to ON.

(c) Evacuation of coater work chamber.

- (i) Operate the **START PUMP** button, the rotary pump will start and the reducing pressure will be indicated on the **CHAMBER PRESSURE** meter.
- (ii) If gas flushing is to be implemented, when the pressure reaches $<3 \times 10^{-2}$ mbar, partially open the **VENT** valve for 5 - 10 seconds to flush the vacuum system. During flushing the pressure will rise. Close the **VENT** valve and allow the system to recover to the best possible vacuum ($<2 \times 10^{-2}$ mbar).


(d) Out gassing

- (i) Check the **VOLTAGE** control is at zero.
- (ii) Operate the **OUTGAS** button, the indicator will illuminate.
- (iii) Turn the **VOLTAGE** control slowly clockwise to increase the voltage applied to the source. The carbon source will become hot. Increase the voltage until the source is heated to a bright orange glow.
- (iv) When the temperature glow is achieved, observe the **CHAMBER PRESSURE** meter. The pressure in the chamber will rise as outgassing of the carbon takes place. When outgassing is complete the vacuum will begin to recover.
- (v) As soon as the vacuum pressure begins to recover, operate the **OUTGAS** button, the indicator will extinguish.
- (vi) Allow the chamber to pump down until no further improvement in vacuum pressure is noted (2×10^{-2} mbar or better).

(e) Coating

- (i) Turn the shutter control, so that the sample is no longer shielded from the carbon source.
- (ii) Set the **VOLTAGE** control to between 7 and 8 (on the scale).

Note: *The voltage control value given above is typical and may vary with different grades of carbon.*

	<p>WARNING</p> <p>HAZARD TO HEALTH!</p> <p>Do NOT look directly at the source during the evaporation process. The bright light could cause eye damage.</p>
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- (iii) Press and hold the **COAT** button. The fibre will reach white heat and flash evaporate to deposit carbon on the samples. Coating will be complete within 3 to 5 seconds, release the **COAT** button.

(f) End Coating

- (i) Turn the **VOLTAGE** control to zero.
- (ii) Operate the **START PUMP** button, the indicator will extinguish and the rotary pump will stop.
- (iii) Open the **VENT** valve to admit air (process gas) to the chamber.
- (iv) When the chamber is completely vented, close the **VENT** valve.

(g) Retrieve the sample

	<p>WARNING</p> <p>HAZARD TO HEALTH!</p> <p>The carbon source will be very HOT. Avoid contact with the heated surfaces.</p>	
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- (i) Disconnect the two heavy duty cables from the rear of the coater.
- (ii) Lift the glass cylinder (with head in position) clear of the sample, place aside on a clean surface.
- (iii) Remove the sample.
- (iv) Re-position the glass cylinder and top plate on the base plate as soon as possible.

6.2.2 Coating with Carbon Rod Source

(a) Mount the specimen(s)

- (i) Mount the specimen on stubs, using an approved method.
- (ii) Lift the glass cylinder (with head in position) clear of the cabinet and place aside on a clean surface.
- (iii) Adjust the height of the sample stage as low as possible.
- (iv) Mount the stubs (with attached samples) on the sample stage.
- (v) Position the glass cylinder on the sputter coater cabinet, to enclose the sample

(b) Preparation

- (i) Check the carbon rod is under maximum pressure and the reduced diameter tip is not damaged.

Note: *If the carbon rods are not correctly shaped, the complete source assembly will be heated, resulting in the tempering of the spring.*

- (ii) Check the **VENT** valve is closed (fully clockwise).
- (iii) Set the **ELECTRODE CONTROL** switch on rear panel to **1**, (for carbon rod source).
- (iv) Ensure **VOLTAGE** control is set to zero, fully counter-clockwise.
- (v) If a dry process gas (argon or nitrogen) is to be used for flushing the system, check the gas cylinder regulator is open. Set pressure to 0.7bar (5psi). (The use of argon or nitrogen for flushing is not obligatory, it will however reduce the time taken to pump down to the required pressure.)
- (vi) Set the shutter to shield the sample from the carbon source.
- (vii) Set the rear panel mounted **POWER ON/OFF** switch to ON.

(c) Evacuate the work chamber

- (i) Operate the **START PUMP** button, the rotary pump will start and the reducing pressure will be indicated on the **CHAMBER PRESSURE** meter.
- (ii) If gas flushing is to be implemented, when the pressure reaches $<3 \times 10^{-2}$ mbar, partially open the **LEAK** valve for 5 - 10 seconds to flush the vacuum system. During flushing, the pressure will rise. Close the **VENT** valve and allow the system to recover to the best possible vacuum, ($<2 \times 10^{-2}$ mbar).


(d) Out gassing

- (i) Check the **VOLTAGE** control is at zero.
- (ii) Operate the **OUTGAS** button, the indicator will illuminate.
- (iii) Whilst observing the **PROCESS CURRENT** meter, turn the **VOLTAGE** control slowly clockwise to increase the voltage applied to the source. The carbon source will increase in temperature and the current reading will rise. Increase the voltage until a red-orange glow is achieved only at the shaped end of the rod.
- (iv) When the temperature glow is achieved, observe the **CHAMBER PRESSURE** meter. The pressure in the chamber will rise as outgassing of the carbon takes place. When outgassing is complete, the vacuum will begin to recover.
- (v) As soon as the vacuum pressure begins to recover, operate the **OUTGAS** button, the indicator will extinguish.
- (vi) Allow the chamber to pump down until no further improvement in vacuum pressure is noted, (2×10^{-2} mbar or better).

(e) Coating

- (i) Turn the shutter control, so that the sample is no longer shielded from the carbon source.
- (ii) Set the **VOLTAGE** control to between 7 and 8 (on the scale).

Note: *The voltage control setting given above is typical and may vary with different grades of carbon.*

	<p>WARNING</p> <p>HAZARD TO HEALTH!</p> <p>Do NOT look directly at the source during the evaporation process. The bright light could cause eye damage.</p>
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- (iii) Press and hold the **COAT** button. The rod tip will reach white heat and evaporate rapidly to deposit carbon on the samples. Press and release the **COAT** button several times, to pulse the coating process. When coating is acceptable (5 to 10 seconds is long enough), release the **COAT** button.

Note: *if higher resistance carbon rods are used, it may be necessary to increase voltage or time. the most satisfactory combination of voltage/current and time, is best established by the user. The rod tip should be completely evaporated within 5 - 10 seconds.*

(f) End Coating

- (i) Turn the **VOLTAGE** control to zero.
- (ii) Operate the **START PUMP** button, the indicator will extinguish and the rotary pump will stop.
- (iii) Open the **VENT** valve to admit air (process gas) to the chamber.
- (iv) When the chamber is completely vented, close the **VENT** valve.

(h) Retrieve the sample

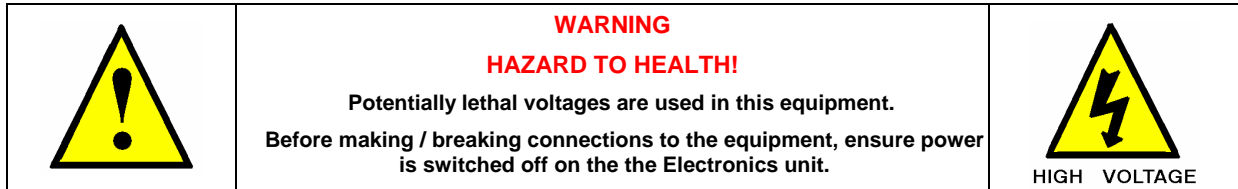
	<p>WARNING</p> <p>HAZARD TO HEALTH!</p> <p>The carbon source will be very HOT. Avoid contact with the heated surfaces.</p>	
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- (i) Disconnect the two heavy-duty cables from the coater rear panel.
- (ii) Lift the glass cylinder, complete with source clear of the sample, place aside on a clean surface.
- (iii) Remove the samples.
- (iv) Re-position the glass cylinder on the base plate as soon as possible.

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



- (a) The procedures listed in this chapter 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

The vacuum chamber requires cleaning if the interior of the chamber becomes contaminated. Over a period of time, the inner surfaces of the vacuum chamber can become coated with a layer of carbon. This layer of carbon will absorb water from the atmosphere. The desorbing of water vapour during the coating process can interfere with the coating.

For cleaning use a nylon abrasive pad (Scotchbrite or similar), Cleaning fluid (Isopropanol or menthyl alcohol) and lint free tissues.

- (a) Ensure power to the Carbon Coater are set to **OFF**.
- (b) Ensure that gas and water supplies, if connected to the Carbon Coater are set to **OFF**.
- (c) Remove all electrical, gas and vacuum connections from the rear the instrument. Move the instrument to a clean working area.
- (d) Lift the Carbon Coater Head assembly clear of the vacuum chamber and place aside.
- (e) Disassemble the glass cylinder and "L" shaped gaskets from the cabinet assembly
- (f) Lightly abrade all the accessible interior surfaces of the vacuum chamber to remove any carbon deposits. Finish with a lint free tissue moistened with cleaning fluid. Cover cleaned components to prevent further contamination.
- (g) The vacuum and gas tubing cannot be readily cleaned. If these items are suspect or showing signs of ageing, they should be replaced.
- (h) Reassemble the vacuum chamber components.
- (i) Return the instrument to its working position. Reconnect the electrical, vacuum and gas connectors to the cabinet rear panel.
- (j) Re-fit the heavy duty cables, between the Carbon Coater supply and the Coater Head.

7.3 Carbon Sources

7.3.1 Carbon Fibre Sources

	<p>WARNING</p> <p>HAZARD TO HEALTH!</p> <p>The carbon source becomes extremely HOT during coating operations, and takes time to cool down after switching off. If the system has been in use, take care to avoid contact with the heated surfaces.</p>	
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When heated the carbon fibre becomes fragile and generally breaks after a single evaporation. With care the fibre can be re-used but more generally will have to be replaced after each run. The principal components of the carbon fibre source are identified in Figure 7.1.

- (a) Disconnect the two heavy-duty cables attached to the coater head.
- (b) Remove the coater head from the vacuum chamber, place on a clean working surface with the source exposed.
- (c) Insert the new carbon fibre and secure between the clamps. Ensure the Carbon fibre is not taut, leave 2-3mm of slack in the fibre between the clamps. Use scissors to trim any excess fibre.
- (d) Seat the coater head on the vacuum chamber and re-connect the heavy-duty cables (polarity is immaterial).

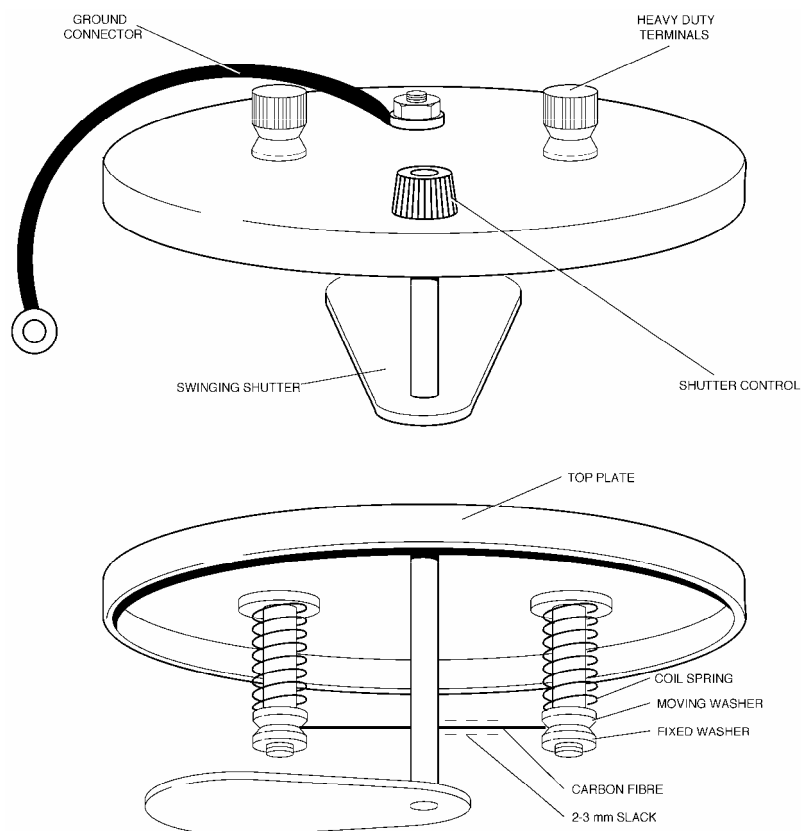


Figure 7.1 – Carbon Fibre Source

7.3.2 Carbon Rod Sources

During use the tip of the carbon rod will erode. The rods should be inspected after each run, if none of the reduced diameter tip remains, the rod must be reshaped or replaced (commonly after each run). The principal components of the carbon rod source are identified in Figure 7.2.

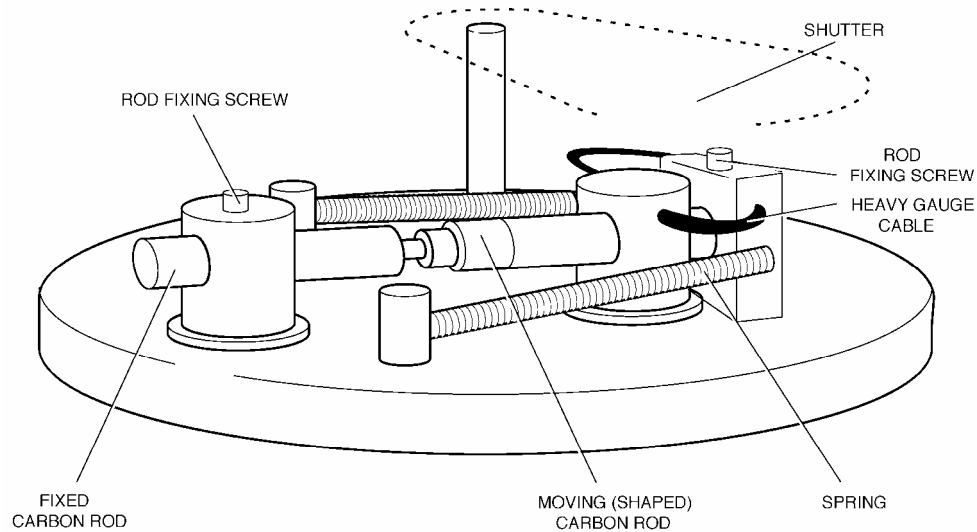


Figure 7.2 – Carbon Rod Source

- Disconnect the two heavy-duty cables attached to the coater head.
- Remove the coater head from the vacuum chamber, place on a clean working surface with the source exposed.
- Slacken the two screws to release both the fixed and moving carbon rods, remove and reshape (see Figure 7.3) or discard the old rods.
- Insert a new shaped carbon rod in the fixed pillar and secure in position, the screw must not be over-tightened. Insert a new carbon rod in the moving block and secure in position, the screw must not be over-tightened. Ensure the carbon rods are under maximum tension.
- Seat the coater head on the vacuum chamber and re-connect the heavy duty cables (cables are not polarity dependant).

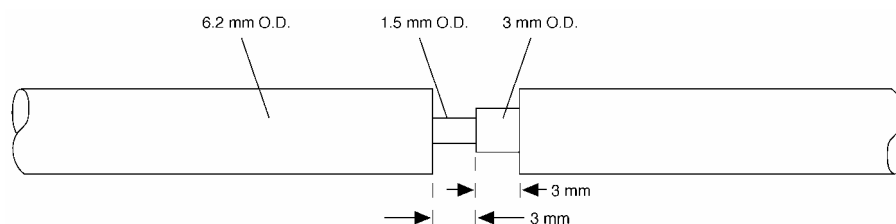


Figure 7.3 - Carbon Rod, preferred shape

7.4 CA076F, Compression Springs

If the compression springs are tempered by the heat from the carbon fibre source, they must be replaced.

7.4.1 Spring Removal

- (a) Ensure power supplies to the carbon coater are set to OFF.
- (b) Ensure that gas supplies (if connected) to the coater are set to OFF.
- (c) Disconnect the two heavy-duty connections and the ground connections from the Carbon Fibre Head.
- (d) Lift the Carbon Fibre Head clear of the vacuum chamber and position on a suitable working surface.
- (d) Remove the screw to release the contact components, see Figure 7.4. Retain the screw, fixed contact and sliding contact for future use, discard the spring.

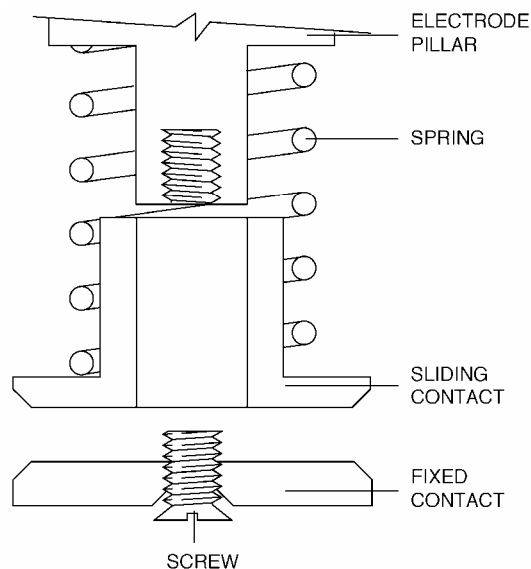


Figure 7.4 – Spring Replacement

7.4.2 Spring Replacement

- (a) Slip the new spring (Part No. 331157265) onto the electrode pillar.
- (b) Compressing the spring, assemble the sliding and fixed contacts to the electrode pillar and secure using the retained screw.
- (c) Fit the Carbon Fibre Head to the vacuum chamber and reconnect the two heavy duty connectors and the ground connector to the head assembly.

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
A0816	Carbon Fibre Cord	1 metre
A0819	Carbon Fibre Cord High Purity	1 metre
331157265	Spring (used on CA076F Carbon Fibre Head)	1
A0830A	Carbon rods (6.2mm x 100 mm)	1 (pk of 10)
A0832A	Shaped Carbon rods (6.2mm x 50mm) High Purity	1 (pk of 10)
351270380A	Argon Gas Tubing	2 meters
351220320	Vacuum Tubing	1 metre
E5004	Oil Mist Filter	1
405150310	Fuse – 15A Type T 1 ¹ / ₄ " (F1- 110V)	1
405100310	Fuse – 10A Type T 1 ¹ / ₄ " (F1- 240V)	1
405032210	Fuse – 3A Type T 20mm (F2- 110V)	1
405020210	Fuse – 2A Type T 20mm (F2- 240V)	1
405100240	Fuse – 10A Type FF 20mm (F3- 110V)	1
405050240	Fuse – 5A Type FF 20mm (F3- 240V)	1

Table 7.1 - Spare Parts for the CC7650

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 Customer Service 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	PARA
Unit appears dead	<ul style="list-style-type: none"> - Cable connections not made - Fuse blown (if new fuse blows immediately contact the customer care dept at Quorum Technologies) - Interlock not activating 	<ul style="list-style-type: none"> - Check all cable connections - Replace fuse (F2) on back panel 2A 1¹/₄ " Anti-surge. - 240V supply <i>or</i> 3A 1¹/₄ " Anti-surge. - 120V supply - Check interlock is operating 	5.2.1 4.6.2 -
Rotary Pump not Working When START PUMP button is operated, the integral indicator is illuminated When START PUMP button is operated, the integral indicator is not illuminated	<ul style="list-style-type: none"> - Unit not switched on - Cable connections not made - Fuse blown 	<ul style="list-style-type: none"> Check switch on Rotary Pump - Check all cable connections - Replace fuse (F1) on back panel 10A 1¹/₄ " Anti-surge. - 240V supply <i>or</i> 15A 1¹/₄ " Anti-surge. - 120V supply 	- 5.2.1 4.6.2
Controller not working When OUTGAS button is operated, if the integral indicator is not illuminated and PROCESS CURRENT meter fails to indicate.	<ul style="list-style-type: none"> - Fuse blown 	<ul style="list-style-type: none"> - Replace fuse (F3) on back panel 5A 20mm Anti-surge. - 120V Supply <i>or</i> 10A 20mm Anti-surge - 240V supply 	4.6.2
No Output When OUTGAS button is operated, if the integral indicator is illuminated but the PROCESS CURRENT meter fails to indicate when the VOLTAGE control is operated.	<ul style="list-style-type: none"> - Check the Carbon Source - Springs not retaining the Carbon Fibre 	<ul style="list-style-type: none"> - Replace the Carbon Fibre - Replace the Carbon Rod - Spring require replacement 	7.3.1 7.3.2 7.4

Table 8.1 - 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	X	

Table 8.2 - 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.1-7ºandar 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. Dudzinska Ul.Sotta K. "Sokola" 7/2A PI-02-796 Warszawa POLAND Tel: 48 004822 649 8690 Fax: 48 (22) 649 11 85 Email: S.Dudzinski@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: zenyang@gjga.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
Elexience 9 Rue Des Petits-Ruisseaux 91371 VERRIERS-le-BUISSON FRANCE Tel: 33 1695 38000 Fax: 33 1601 19809 www.elexience.fr	Jeol (Italia) S.p.A. Centro Direzionale Ripamonti Via Dei Tulipani 1 PIEVE EMANUELE (MI) 20090 ITALY Tel: 39 02904 1431 Fax: 39 02904 14303 Email: quill@jeol.it	Ellipsiz Singapore 29 Woodlands Industrial Park E1 #04-01/06 Northtech Lobby 1 SINGAPORE 757716 Tel: 65 6311 8500 Fax: 65 6269 2628 www.ellipsiz.com	Becthai Bangkok Equip. Co Ltd. 300 Phaholyothin Road Phayathai BANGKOK 10400 THAILAND Tel: 66 2615 2929 Fax: 66 2615 2350/2351 www.becthai.th.com
GaLa Instrumente GmbH An der Schalmuch 42 BAD SCHWALBACH D-65307 GERMANY Tel: 49 6124 77952 Fax: 49 6124 60274 www.gala-instrumente.de	Nanovision s.r.l Via Santa Margherita, 115 20047 BRUGHERIO ITALY Tel: 039 287 8358 Fax: 039 287 2197 Email : nanovision@mclink.it www.nanovision.it	Set-Point Instruments PO Box 11400, VORNA VALLEY Gauteng SOUTH AFRICA 1686 Tel: 27 11540 6000 Fax: 27 11466 1315 www.setpoint.co.za	Tekser Koll Sti Acibadem Ca. Erdem Sok Bayer Apr. No 6/1 Uskudar ISTANBUL 81010 TURKEY Tel: 90 216 327 4041 Fax: 90 216 327 4046
Asteriadis S.A 56 - 58 Spirou Trikoupi PO Box 26140 GR-100 22 ATHENS GREECE Tel: 30 1 823 5383 Fax: 30 1 823 9567 www.asteriadis.com	Topcon Electron Beam Services Corp 75 - 1 Hasunuma - Cho Itabashi - KU TOKYO 174 JAPAN Tel: 813 3558 2588 Fax: 813 5392 4992 www.topcon-eps.co.jp	DAE IL Commerce 2F Jinsung B/D 326-34 Magoek-dong Kangseo-gu SEOUL SOUTH KOREA Tel: 82 2366 58056 Fax: 82 2366 58059 www.daeilcm.co.kr	Energy Beam Sciences PO Box 468 11 Bowles Road AGAWAM MA01001 UNITED STATES OF AMERICA Tel: 1 413 786 9322 Fax: 1 413 789 2786 www.ebsciences.com
UNITED KINGDOM Quorum Technologies Ltd, Unit 15a Euro Business Park New Road, NEWHAVEN, East Sussex. England, BN9 0DQ Tel: (0) 1273 510535. Fax: (0)1273 510536 Email: Support@quorumtech.com			

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