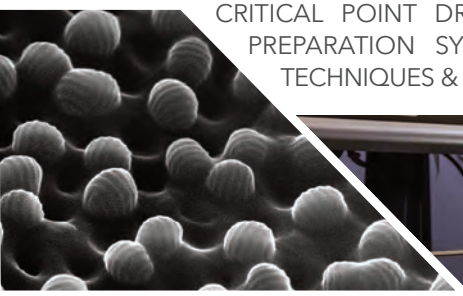
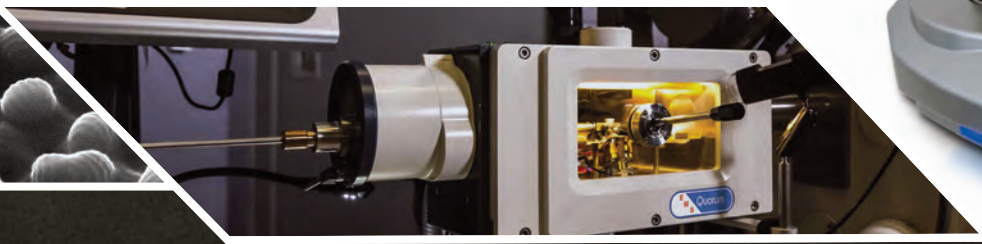
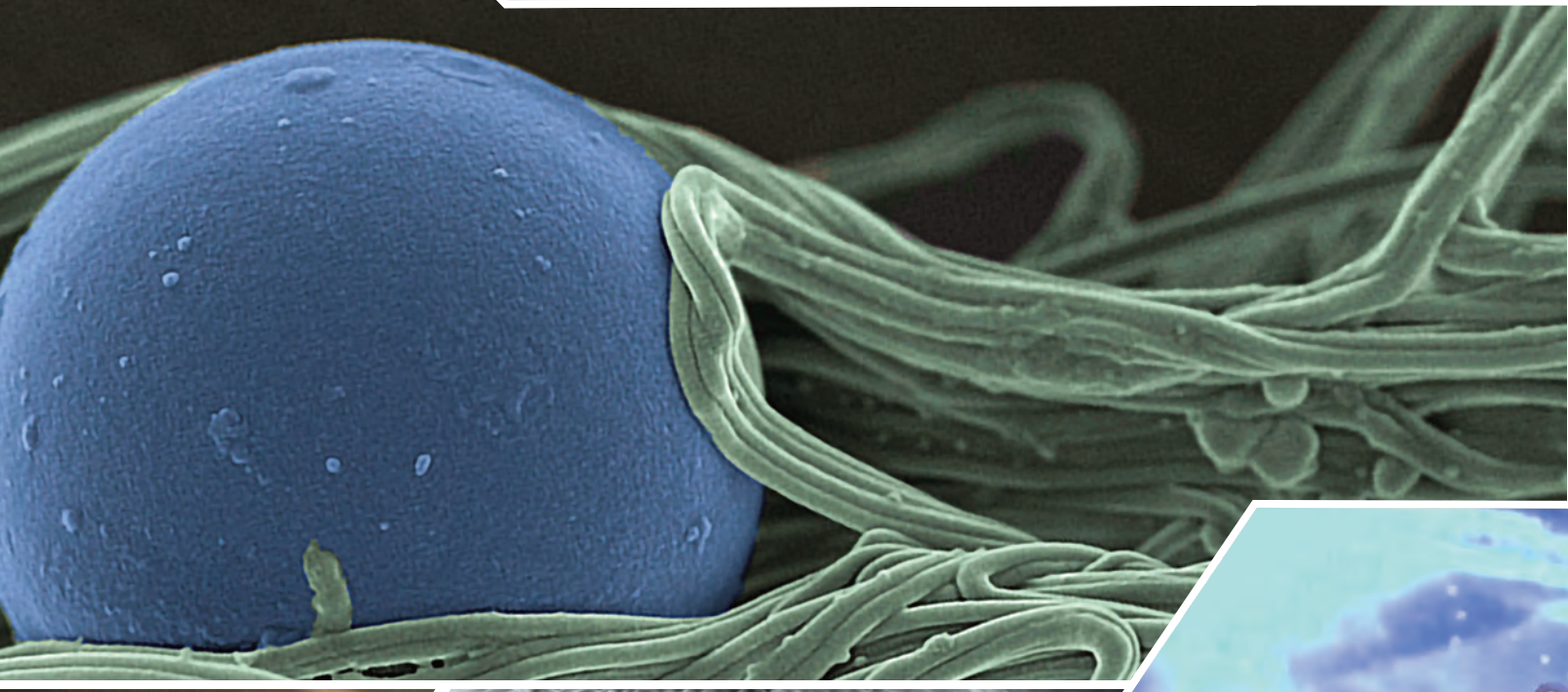
EDITION IV

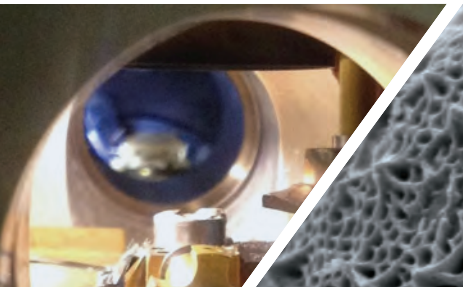
EQUIPMENT & ACCESSORIES CATALOG

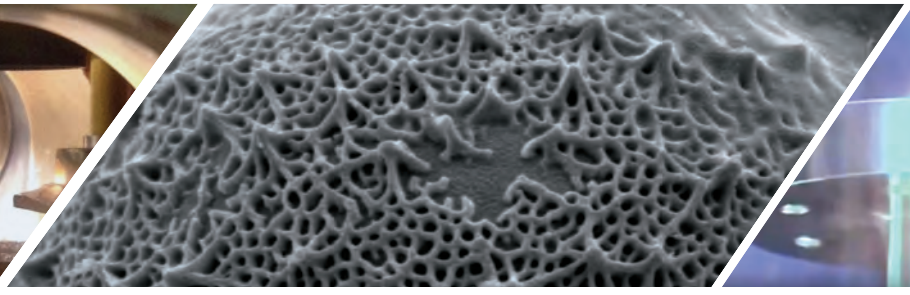
COOLING STAGES, **RECIRCULATING HEATERS AND CHILLERS,** GLOW DISCHARGE SYSTEMS, **SPUTTER COATERS,** SEM/TEM CARBON COATERS, **LARGE CHAMBER SPUTTER COATERS,** CRITICAL POINT DRYERS, **SPECIMEN STAGES,** CRYO-SEM PREPARATION SYSTEMS, **SPECIMEN TRANSFER SYSTEMS,** TECHNIQUES & APPLICATIONS, **AND MORE...**

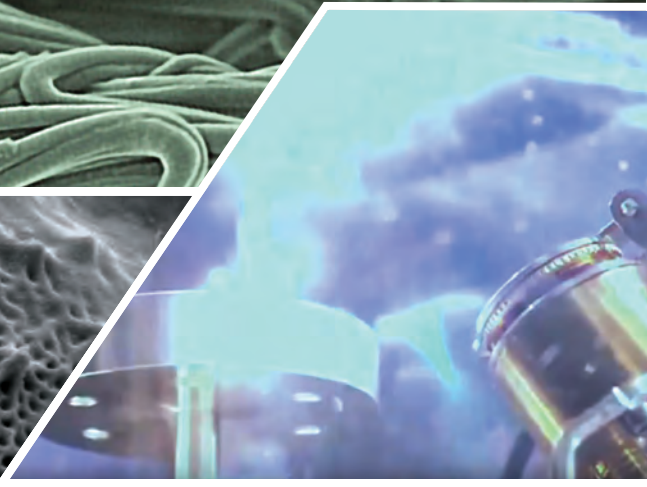










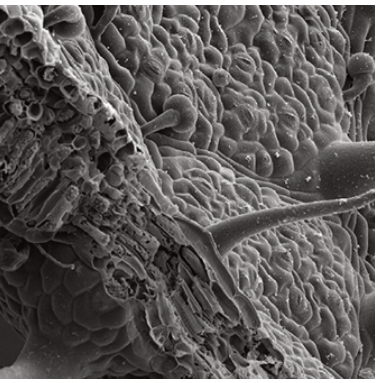


Electron Microscopy Sciences

www.emsdiasum.com

EMS HAS IT!

the latest equipment for critical point drying and surface modification...



NEW!

Qdry

Automated Critical Point Dryer

With automated control, the Qdry ensures repeatable outcomes with minimal user intervention. Built-in adiabatic cooling allows for fast cool-down rates and more throughput.

Features

- Easy-to-use and flexible software allowing for quick set-up of profiles.
- Status display to indicate time remaining.
- Recipe driven, with individual user profiles for quick set-up time.
- Supplied with pre-set profiles covering different sample types allowing easy start for new samples.
- Screw top chamber for easy sample loading.
- Large viewing window ensuring observation of process flow.
- Small footprint ideal for use in fume hoods.

Specifications

Instrument Dimensions	450mm W x 235mm H x 505mm D
Weight	35kg
Specimen Holders	AL800019-1 Specimen Holder as standard
Safety	Built-in safety devices in both hardware and software, including freielf valves, level sensors, pressure switches, and programming restraints
Chamber Diameter	60mm
Internal Chamber Height	59mm usable chamber height = 34.5 mm usable chamber volume = 97.5ml

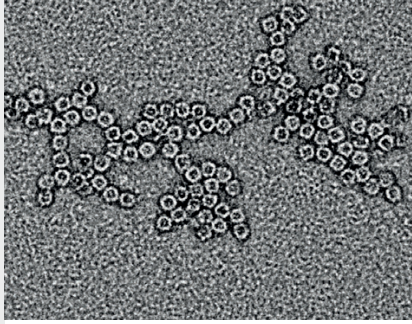
Ordering Information

Cat. No.	Description	Qty.
QDRY	Qdry Automated Critical Point Dryer	each

NEW!

MiniQ GD

For Surface Modification of TEM Grids



Above: Glow discharged grid allowing correct staining using a low concentration of ferritin solution.

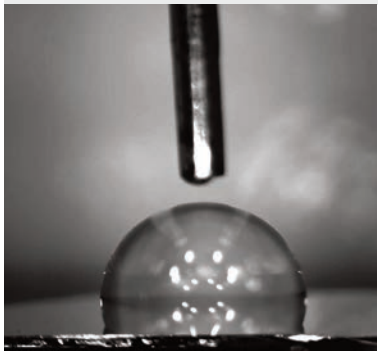
Designed with simplicity in mind, the easy-to-use MiniQ GD allows for surface modification of TEM grids, resulting in the clear imaging of macromolecules.

Features

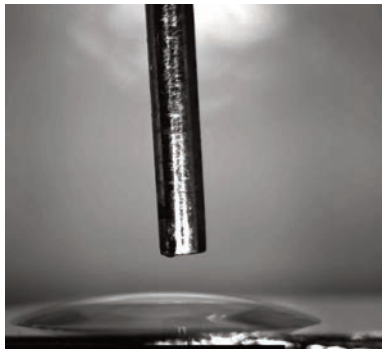
- Simple operation.
- Robust touch panel.
- Small footprint.
- Automatic operation with minimal user intervention required.
- Detachable chamber with implosion guard allowing for easy cleaning.
- Preset profiles with single touch operation.

Recommended Applications

- Changing wettability of surfaces, primarily used for TEM grids to improve the spread of particles/molecules on them.
- Could also be used for SEM and AFM imaging when samples are applied onto substrate surfaces from liquid.
- Soft cleaning of surfaces.



DDT modified Au surface before Glow Discharge.



DDT modified Au surface after Glow Discharge.

Specifications

Please note, the MiniQ GD specifications are based on use with a Pfeiffer Duo 6 pump. For more information regarding pump options please contact info@emsdiasum.com

Instrument Dimensions	225mm W x 325mm H x 420mm D (Total Height with coating head open 480mm H)
Weight	8.7kg
Compliance	The MiniQ GD complies to LVD, EMC, RoHS directives, and conforms to UKCA and European CE industry marks
Safety	Vacuum interlocks remove power from deposition sources to prevent users being exposed to high voltage

Ordering Information

Cat. No.	Description	Qty.
MiniQGD	MiniQ GD Glow Discharge System	each

EQUIPMENT & ACCESSORIES CATALOG

EDITION IV

TABLE OF CONTENTS

NEW PRODUCT...

NEW!
MiniQS
Entry-Level Sputter Coater

The MiniQS is ideal for the budget-conscious user who also demands reproducible results in an easy-to-use instrument. The MiniQS uses a Magnetron sputtering head with an easily replaceable disc target.

See page 19 for more information.

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COOLING STAGES

Why cool?

Low vacuum (LV) or variable pressure (VP) modes are now standard on most scanning electron microscopes (SEMs). For this reason it has become important to control water evaporation from wet specimens. Cooling such specimens reduces the loss of water by evaporation, or - depending on chamber pressure - can prevent it altogether.

Saturated vapour pressure of water decreases considerably with temperature. At room temperature, water will very quickly evaporate - causing considerable damage to specimen composition and ultra-structure. This is due to high forces of surface tension at the drying front as it passing though the specimen. In most biological systems this will result in distortion and collapse of membranes and other structures.

At 300Pa, the specimen temperature needs to be less than -9.5°C, and at 85Pa less than -25°C to stop water evaporation. Therefore, by cooling a specimen to -25°C, chamber pressures up to 85Pa can be used with little or no water loss by evaporation. In this way, changes in specimen structure can be minimised. In addition, being able to operate at higher vacuum gives a better signal-to-noise ratio and clearer images.

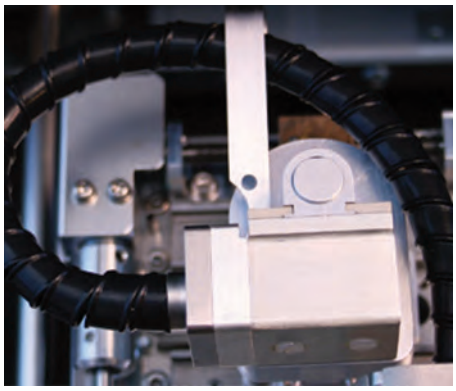
The EMS Coolstage for SEM, LV or VP

OVERVIEW

The Coolstage is a Peltier-driven SEM cooling stage for scanning electron microscopy (SEM), low vacuum (LV) or variable pressure (VP) applications. The stage can be cooled to sub-zero temperatures for specimens that may be sensitive at ambient temperature, subject to beam damage, or may otherwise 'sublime' (lose water) at ambient temperatures.

There are three versions of coolstage - Standard, Enhanced, and Ultra - to cover differing specimen requirements.

Standard Coolstage. Range: -30°C to +50°C at 300Pa



Ultra Coolstage. Range: -50ºC to +50ºC at 300Pa

FEATURES

Standard Coolstage

- Temperature range -30°C to +50°C at 300Pa
- Self contained cooling - no additional external cooling water needed
- Temperature accuracy +/- 1.5°C or 2% - whichever is greater
- Minimal image drift
- Cooling and heating rates of up to 30°C per minute
- Keypad control - with simultaneous display of actual and target temperature
- Supplied with SEM chamber port feed-though - specify when ordering
- One-year warranty

Enhanced Coolstage

- Temperature range -30°C to +160°C at 300Pa
- All other specifications as per Standard Coolstage

Ultra Coolstage

- Temperature range -50°C to +50°C at 300Pa
- All other specifications as per Standard Coolstage

PRODUCT DESCRIPTION

The Coolstage is a temperature-controlled specimen stage that can be fitted to any low vacuum (LV) or variable pressure (VP) scanning electron microscope (SEM).

The Standard Coolstage consists of a single stage Peltier device, onto which a thermally isolated specimen holder and dual temperature sensor is mounted. The Coolstage assembly is mounted onto the SEM stage using an adaptor plate specific to the microscope. Cooling pipes and electrical wires connect to the SEM feedthrough flange. External components are a recirculating water chiller and power supply case, and a compact keypad for digital temperature readout and control.

Compact, efficient cooling and temperature control

The temperature range of the Standard Coolstage is -30°C to +50°C at 300Pa. The specimen holder is water-cooled using a small, self-contained closed loop recirculating chiller that is normally positioned approx 2m from the SEM. A microprocessor controls and monitors the temperature of the cold stage. A small keypad is used to set the required temperature and display target and current temperatures.

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The EMS Coolstage *(continued)*

The specimen holder has been designed to minimise image drift due to temperature change, giving a stable image at high magnification. An integrated RS-232 interface allows temperature to be set and read from the SEM.

Rapid specimen exchange

To exchange a specimen it is necessary to increase the specimen stage temperature to ensure that condensation does not form on the specimen or specimen stage. The keypad controller has a convenient 'exchange' button that will automatically take the specimen holder temperature to a programmable temperature from between +5°C to +20°C. Typical cooling and heating rates are up to 30°C per minute.

When not in use, the major parts of the system can be left in situ and the cooling stage is very easily removed when reverting to 'normal' use. A convenient storage block is provided for Coolstage stage assembly and vacuum feedthrough for when the system is not in use.

SPECIFICATIONS

Specimen Size	10mm Ø (adaptor stub for 12" Hitachi stubs can be supplied on request)
Stage Temperature Range	Note: Higher vacuum will allow for cooler temperatures, compatible with high vacuum levels to $1x10^{-5}$Pa *Standard Coolstage:* -30°C to +50°C at 300Pa with no external cooling water from SEM (at ambient +20°C) *Enhanced Coolstage:* 30°C to +160°C at 300Pa with no external cooling water from SEM (at ambient +20°C) *Ultra Coolstage:* -50°C to +50°C at 300Pa with no external cooling water from SEM (at ambient +20°C)
Temperature Display Resolution	-0.1°C
Temperature Stability	+/- 0.2°C
Temperature Accuracy	+/- 1.5°C or 2% (whichever is greater)
Stage Movement	Normal x, y and z movements maintained. Tilt maintained for X-ray analysis (up to 45°). No rotation
Working Distance	As on SEM, Coolstage is set to the SEM Eucentric height
Operating Voltage	100V or 115V or 230V @ 100VA, voltage tolerance +/- 10%
Size and Weight	*Operation/display unit:* 90mm L x 112mm W x 350mm H, 300g *Power supply/cooling unit:* 305mm L x 245mm W x 330mm H, 15kg
Packed Size and Weight	550mm L x 580mm W x 400mm H, 28kg

Supplied With: Operating manual, one set of interconnecting cables and mains supply lead, storage block for specimen cooling unit when not in use, specimen holders: 15 x flat 10mm Ø stubs and 15 x dish 10mm Ø OD stubs

ORDERING INFORMATION

90100	EMS Standard Coolstage	each
90101	EMS Enhanced Coolstage	each
90102	EMS Ultra Coolstage	each
90103	Flat specimen stubs, 10mm diameter	10/pk
90104	Dish style specimen stubs, 10mm external diameter	10/pk

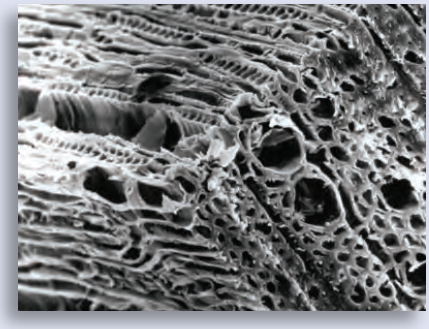
Coolstage and vacuum feed through connected to the storage block (stage protected by plastic shutter)

Coolstage and vacuum feed through connected to the storage block (with protection shutter open)

Dish-style specimen stub, showing flat bottom side (left) and dish side (right)

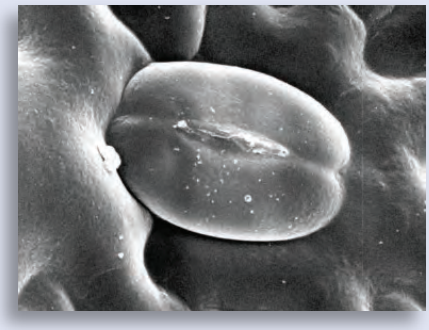
Using the EMS 3500 with Critical Point Dryers

The EMS 3500 will give controlled heating of EMS 3100 Critical Point Dryer. It is connected directly to the inlet and outlet of the EMS 3100 water jacket. The temperature of the circulating fluid is pre-set, typically set to 37°C (eg just above the critical temperature of carbon dioxide).



Mature Spruce Wood

Critical point dried block of mature spruce wood block, demonstrating transverse, tangential and radial views of tracheids and vessels.



Stomatal Pore on Xerophyte Leaf Surface

Critical point dried epidermis of a xerophyte (cactus), demonstrating raised stomatal pores.

Barley Leaf

Trichomes and stomatal pores on the epidermal surface of a barley (Hordeum vulgare) leaf. Some very fine wax crystallites are also just visible on the surface of the leaf.

EMS 3500 Thermocirculator

The EMS 3500 Thermocirculator is a low cost, portable water circulating system for supplying a constant temperature supply for closed and open loop applications at near ambient to +60°C.

Features

- Precise control of heating
- Compact
- Robust and reliable
- No running water to waste
- Ideal for use with the EMS 3100 Critical Point Dryer

The EMS 3500 is suitable for open and closed loop applications and has all controls and liquid connections on the front panel. The temperature controller shows not only the 'set' temperature (between ambient and +65°C), but also the actual liquid temperature. The fluid is circulated by a glandless magnetic pump, through an aluminum reservoir.

A cooling coil is mounted in the liquid reservoir. This coil can be directly connected to the main water supply and is primarily used when temperature control near to ambient is required. The electronic control system features a zero voltage switching unit which minimizes mains electrical interference, enabling the EMS 3500 to be used and sited with other sensitive electronic instruments.

SPECIFICATIONS

Working temperature range	Ambient to +65°C
Heating rating	500W
Reservoir capacity	2.2L / 3.5 Pints
Pump type	Glandless magnetic drive
Pump motor	Shaded pole
Pump flow	270L/h (zero head) / 60 Gal/hr (zero head)
Pump pressure	0.25kg/cm^2 / 3.5psi
Max pump head (unrestricted)	2.5m / 7.5ft
Size (unpacked)	330 x 280 x 150mm / 13 x 11 x 6"
Weight	8kg / 17.6lbs
Electrical	220-240V/50Hz, 115V/60Hz

ORDERING INFORMATION

91095	EMS 3500 Thermocirculator	each

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EMS 4800 Recirculating Heater/Chillers

Recommended for open and closed loop applications, offering simplicity, reliability and quiet operation. The range includes the EMS 4860, 4870, 4880 and 4890.

Features

- Precise temperature control
- Quiet, efficient operation
- Proven reliability
- Low maintenance
- Environmentally friendly- avoids running water to waste

Temperature control

Many instruments measuring physical properties depend on accurate control of temperature and in some processes optimum temperature is essential. With the EMS 4800 series, over-cooling (which affects efficiency) is prevented and the water temperature can be accurately controlled over the range -10 to +60°C.

A commonly misunderstood feature of refrigerated systems is in applications where the control temperature is other than at or near room temperature. When the instruments are to be operated at controlled temperatures below ambient, the extraction deteriorates significantly and, as a guide, the compounded change is 4% per degree Celsius. In practice, the refrigerant gas pressure has to be adjusted to optimize the performance at any particular temperature. However, the EMS 4800 series incorporate automatic adjustment valves in the systems.

The EMS 4800 series are of the 'closed loop' type and therefore efficiencies are dramatically improved compared with open bath models. They are simple to set up and to operate, and essentially maintenance free.

Choosing the correct heater/chiller

In order to optimize performance from a heater/chiller system, the correct specification must be selected for a particular application. To cool or heat any instrument or system it is important to obtain the following information from the manufacturer:

- Heat load to be dissipated to water, eg for an electron microscope: diffusion pump heater, lenses, etc
- Flow rate and size of tubing
- Minimum pressure

With this information, consult the Specifications below and select the appropriate heater/chiller. The basic heat load calculation formula is as follows:

SPECIFICATIONS

Heat Extraction Rates (in Watts)

	- 20°C	- 10°C	0°C	+10°C	+ 20°C
EMS 4860	75W	105W	180W	300W	420W
EMS 4870	125W	250W	500W	900W	1.2kW
EMS 4880	200W	425W	700W	1.6kW	2.2kW
EMS 4890	350W	600W	1.2kW	2kW	3kW
4.5kW Recirculator	700W	1kW	2kW	3kW	4.5kW
6kW Recirculator	800W	1.3kW	2.6kW	4.5kW	6kW

Model	**EMS 4860**	**EMS 4870**	**EMS 4880**	**EMS 4890**
Extraction rate at 20°C	400W	1.4kW	2.2kW	3kW
Temperature range	-20°C to +70°C	-20°C to +70°C	-20°C to +70°C	-20°C to +70°C
Refrigeration (HP)	1/5	1/2	3/4	1
Heater rating	1kW	1.5/2.0kW	2.5kW	2.5kW
Max pump flow	450L/h	450L/h	900L/h	900L/h
200Gal/hr	200Gal/hr	275Gal/hr	275Gal/hr	
Tank capacity	1.2L	1.7L	2.3L	3.0L
Max pump pressure psi/bar	12/60psi	12/60psi	60psi	60psi
0.7/3bar	0.7/3bar	1.5/3bar	1.5/3bar	
Height	37cm	45cm	50cm	50cm
Width	32cm	38cm	45cm	45cm
Depth	46cm	61cm	62cm	62cm
Weight	40kg	62kg	70kg	82kg
Water connections	16mm hose or 1/8 BSP	16mm hose or 1/8 BSP	16mm hose or 1/8 BSP	16mm hose or 1/8 BSP
Temperature sensor	R.T. Probe	R.T. Probe	R.T. Probe	R.T. Probe

Some typical applications

Vacuum coating equipment

Critical point dryers (EMS 3000 and EMS 3100)

Electron microscopes

Chromatography equipment

Electrophoresis baths

Environmental chambers

Crystal growth apparatus

Fermentation equipment

Interferometers

Photographic baths

X-ray equipment

Polarimeters, refractometers

...and many others

Optional Attachments

- High pressure pump for EMS 4860 and EMS 4870 (standard in EMS 4880 and EMS 4890)
- Water failure alarm
- Over and under temperature cut out

NOTE: Larger capacity heater/chillers (6kW and 12kW) are available on request - please contact us for further information.

- Custom-made heater/chiller units

ORDERING INFORMATION

91098	EMS 4860 1/5 HP Recirculating Heater/Chiller
91099	EMS 4870 1/2 HP Recirculating Heater/Chiller
91090	EMS 4880 3/4 HP Recirculating Heater/Chiller
91095	EMS 4890 1 HP Recirculating Heater/Chiller

GLOW DISCHARGE SYSTEMS

Rapid, reliable results...

GloQube® Plus

Dual Chamber Glow Discharge System for TEM and Surface Modification

OVERVIEW

The GloQube® Plus is a compact, easy-to-use glow discharge system primarily used for the hydrophilization (wetting) of TEM carbon support films and grids. Other applications include surface modifications, for example for enhancing polymer bonding.

The GloQube Plus has a convenient single drawer with two independent vacuum chambers: a clean chamber for glow discharge applications requiring hydrophobic/hydrophilic conversion and a vapour chamber designed for hydrophilic/hydrophobic (negative or positive) conversions.

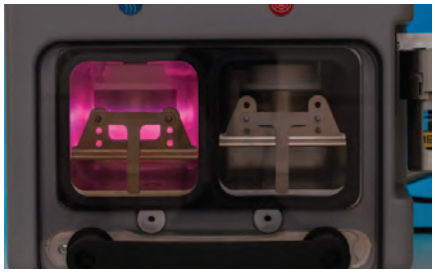
FEATURES

- **Dual independent chambers**
- **Hydrophilic/hydrophobic and negative/positive modes**
- **Fully automatic, short process times**
- **Intuitive touch screen control**
- **Safe vapor delivery using septum-sealed vials**
- **Automatic valving between chambers to prevent cross-contamination**
- **Quick and easy sample loading**
- **Controlled venting to prevent sample disturbance**
- **Consistent, reliable results**
- **Three-year warranty**

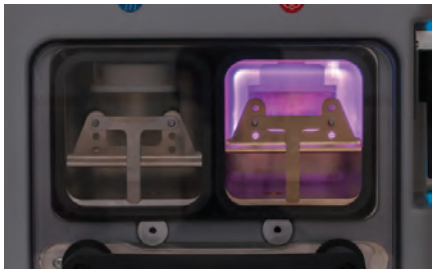
Unique Dual Chamber Processing, Safe Handling of Reagents

The GloQube Plus has two independent vacuum chambers: a clean chamber, designed for applications requiring hydrophobic/hydrophilic conversion, typically using air as the process gas; and a vapor chamber, designed for use with reagents such as methanol and alkylamine. With operator safety firmly in mind, reusable septum-sealed reagent vials are used. Loading and removing reagents is convenient and reliable – the vial, located in its holder, is inserted into a shielded needle using a simple bayonet fitting.

To prevent accidental damage, the high voltage lead is shielded. The plasma current is variable by adjustment of the vacuum level using an argon leak valve with the plasma voltage being preset. For maximum sputter coating efficiency, the gas injector system ensures that argon gas enters the chamber close to the plasma discharge. Venting is to argon.



Clean Chamber



Vapor Chamber

Vapor Delivery System

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GloQube® Plus (continued)

The primary application of the GloQube® Plus is the hydrophilization (wetting) of carbon-coated TEM support films and grids which otherwise have the tendency to be hydrophobic. Glow discharge treatment with air will make film surfaces negatively charged and hydrophilic and allow the easy spread of aqueous solutions. This and other processes are outlined below.

Glow Discharge Typical Processes

Surface State	Surface Charge	Atmosphere	Typical Applications
Hydrophilic	Negative	Air	Hydrophilisation and cleaning of carbon coated TEM grids
Hydrophilic	Positive	Air*	Nucleic acid adhesion to carbon films
Hydrophobic**	Positive	Alkylamine	Controlled orientation and improved adhesion of negatively charged proteins, antibodies and nucleic acids
Hydrophobic**	Negative	Methanol	Controlled orientation and improved adhesion of positively charged protein molecules (e.g. ferritin, cytochrome c)

* Air followed by post-treatment with magnesium acetate by the user.

** Hydrophobic, as noted above, may represent a less hydrophilic sample of less than 90 degrees contact angle.

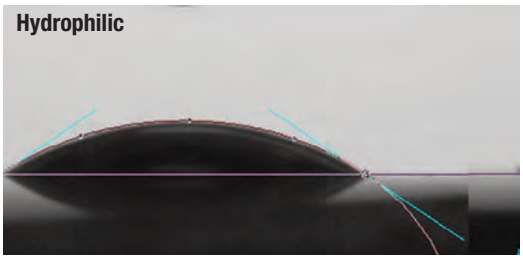
Recommeded applications for the GloQube® Plus:

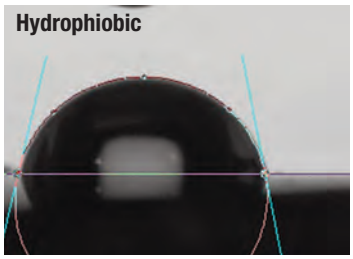
- **Hydrophilization and cleaning of TEM grids carbon support films* for better sample spreading**
- **Improved adhesion and orientation of proteins, nucleic acids and antibodies**
- **TEM grid preparation for nanoparticle studies**

These products are for Research Use Only.

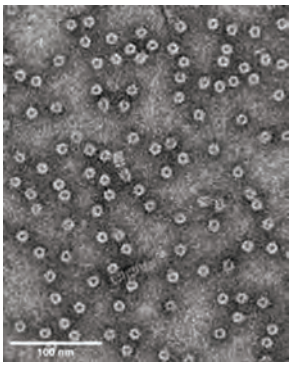
* Typically: Formvar®, Lacey Carbon, Holey Carbon, Continuous Carbon, Quantifoil®

Contact angle left: positive discharge using methanol shows carbon grid less hydrophobic
Contact angle right: negative discharge using amylamine shows carbon grid surface hydrophobic



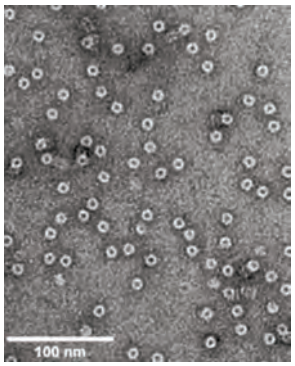


TEM images of the 20S human proteasome complexes, showing the effect of altering the surface charge of the carbon support film on the orientation of the protein. 2.5 nm of carbon film on Quantifoil® 1.2/1.3 400 mesh was used as a support for the sample.



Carbon surface without glow discharge treatment.

Visible some side views of the protein due to uneven charge of the surface.



Carbon surface with air glow discharge biased top view orientation of the protein caused by uniform negative charge of the surface.

Biased-top views 20s proteasome complex adsorption on in-air glow discharge modified carbon support TEM grids.

Carbon surface with amylamine glow discharge.

Biased side-view orientation of the protein caused by uniform positive charge on the surface.

What is... Glow Discharge?

Electric glow discharge is a type of plasma formed by passing a current at 100 V to several kV through a gas at low pressure (i.e. in a vacuum system). The main application of glow discharge in electron microscopy (EM) is to convert naturally hydrophobic ('water-hating') carbon-coated transmission electron microscopy (TEM) support grids into a hydrophilic ('water-loving') condition. Glow discharge treatment with air will make film surfaces negatively charged and hydrophilic and allow the easy spread of aqueous solutions.

Other treatments include:

Hydrophilic-positive treatment in air with magnesium acetate post-treatment to allow nucleic acid adhesion to carbon films.

Hydrophobic-positive treatment with alkylamine for proteins, antibodies and nucleic acids.

Hydrophobic-negative treatment in air for positively charged protein molecules, (e.g. ferritin and cytochrome c).

Glow discharge can also be used for modifying surface, for example, to increase bond strength of polymers.

Glow discharges are sometimes considered to be 'imperfect' plasmas and cannot be used to plasma etch or plasma ash specimens their use mainly being confined to altering surface energies, not the removal of bulk material.

GLOW DISCHARGE SYSTEMS

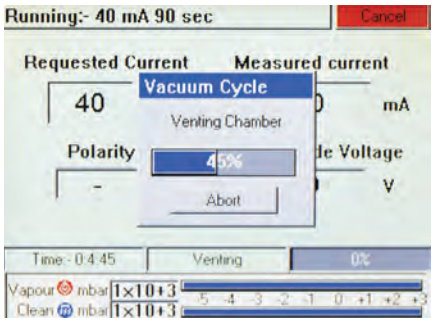
GloQube® Plus (continued)

Easy Sample Loading, Fast Turnaround Times

Each chamber can accommodate two 25 x 75 mm glass microscopes slides. Loading could not be easier using draw-style chamber doors and specimen stages. The stages are height adjustable and fitted with removable glass slide holders. For additional convenience – and to allow easy access for chamber cleaning – the stages can be completely removed.

Vacuum, Automatic Valving and Controlled Venting

The GloQube® Plus has automatic valving between chambers which maintains cleanliness by preventing cross-contamination. At the end of a process run, automatic soft venting to atmosphere through filtered inlets ensures TEM grids are not disturbed. The GloQube® Plus requires a single vacuum pump working in the 0.1 to 1 mbar range. A typical pump time to operational vacuum is 60 seconds.

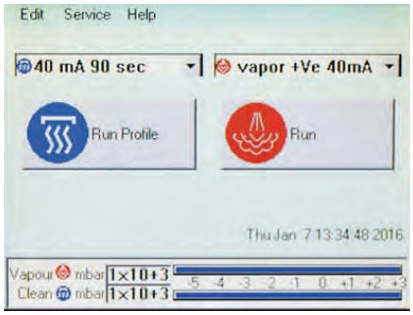


GloQube Plus and Optional Pfeiffer DUO 6 Rotary Pump

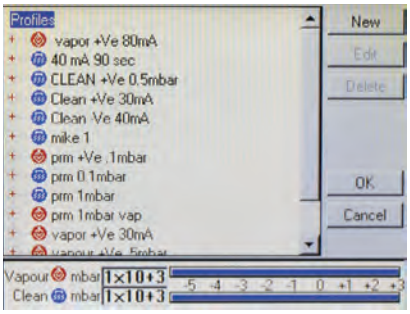
Touch Screen Control – Rapid Data Input, Simple Operation

The intuitive touch screen allows multiple users to rapidly input and store preferred process "recipes". Typical default glow discharge protocols are loaded as standard. Additionally, help files and useful maintenance data such as system on time and time since last clean are readily available to the operator. An Ethernet communications port is included for software updates.

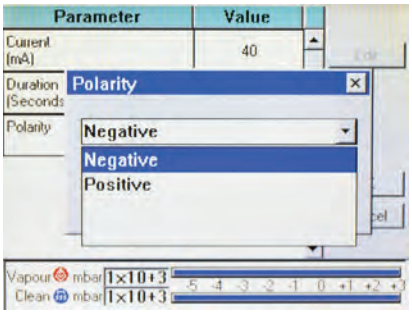
Start-up Screen



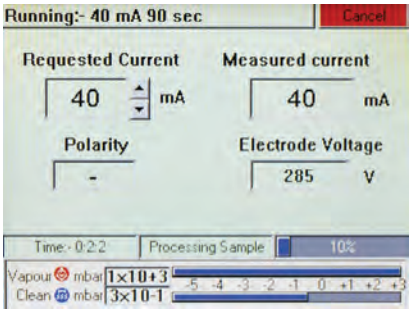
Stored Profiles



Selecting a New Profile



A Typical Process Run



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III GloQube® Plus (continued)

Specifications

Note: The pump data is for the Pfeiffer DUO 6

Glow Discharge Processes

Plasma current	1-50 mA
HV power supply	30 W
Maximum voltage	800 V
Electrode polarity – clean chamber	DC glow positive DC glow negative
Electrode polarity – vapor chamber	DC glow positive DC glow negative
Sample stage	125 x 100 mm (4.9" x 3.94") with location for two 25 x 75 mm (1" x 3") glass slides
Sample stage operational heights	Adjustable 12.5 mm (0.5"), 22.5 mm (0.9"), or 35 mm (1.38")
Pump hold time	0-72 hours
Process time	1-600 seconds

Safety

Chamber vent inlets	Filtered air inlets with slow vent options to minimize sample disturbance
On-board reagent storage	Reagents are contained in sealed glass vials to minimize exposure to hazards
High voltage safety interlocks	Hardware safety interlocked and software for process control

Vacuum

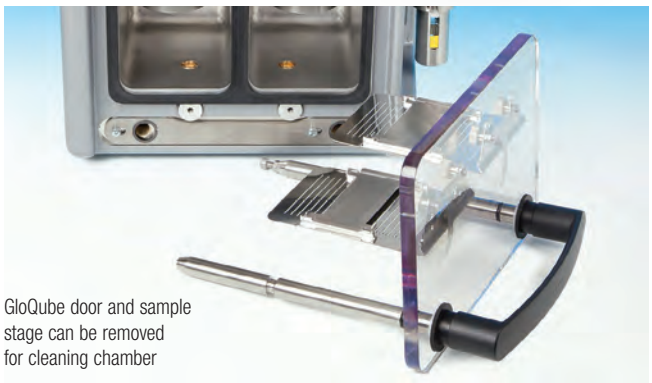
Vacuum control	Integrated pirani gauge
Working vacuum range	0.1 to 1 mbar
Pump min. requirements	5 m^3/hr, Inlet flange: KF 16.
Pumping time	Typical pump time to an operational vacuum of 0.1 mbar in 60 seconds
Vacuum isolation	Isolation valves to switch vacuum and prevent process chamber cross-contamination

Dimensions

Instrument size	336 mm H x 364 mm D x 336 mm H
Instrument weight	19.4 kg
Pump*	391 mm W x 127 mm D x 177 mm H
Pump weight	16 kg
Footprint with pump	366 mm W x 600 mm D x 336 mm H

Communications

Interface	USB
Power requirements	120 V 60 Hz, 15 A or 230 V 50 Hz, 10 A
Instrument power rating	100-240 V AC 60/50 Hz 700 VA including pump, IEC inlet
Pump power rating	115/230 V 60/50 Hz 450 W



GloQube door and sample stage can be removed for cleaning chamber

ORDERING INFORMATION

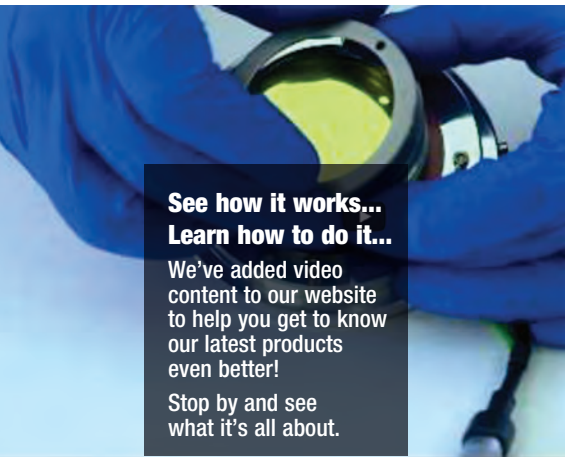
Cat No.	Description	Qty.
EMS-Glo-2	GloQube® Plus Dual Chamber Glow Discharge System. Accessory kit, including: mains power lead, rotary pump power lead, oil mist filter and clamp, 750 mm long flexible stainless steel vacuum tube with clamps, fuses, glass vials, vial caps and sealing washers, needle (spare). Vacuum pump to be ordered separately.	each
Vacuum Pumping		
91003	5 m^3/hr Pfeiffer DUO 6 two-stage rotary vacuum pump with oil mist filter	each
96000	Oil mist filter (spare)	each
Options, accessories and spares		
EMS-Glo-11	Microscope Slide Tray	each
EMS-Glo-12	Glass Vial	10/pk
EMS-Glo-13	Glass Vial Caps	3/pk
EMS-Glo-14	Needle	each
EMS-Glo-15	Door Seal	each

What is... Sputter Coating?

When a glow discharge is formed between a Cathode and Anode using a suitable gas (typically Argon), and Cathode target material (commonly Gold) the bombardment of the target with gas ions will erode this target material, this process being termed 'Sputtering'.

The resulting omni-directional deposition of sputtered atoms will form an even coating on the surface of the specimen. It will inhibit charging, reduce thermal damage, and improve secondary electron emission which are beneficial for Scanning Electron Microscopy.

The Cathode target material is commonly Gold. However, to achieve finer grain size, and thinner continuous coatings, it is advantageous to use cathode target materials such as Chromium. To achieve sputtering with this target material requires vacuums somewhat better than those achievable with a Rotary Vacuum Pump.



Techniques and Applications

Introduction

When a target is bombarded with fast heavy particles, erosion of the target material occurs. The process, when occurring in the conditions of a gaseous glow discharge between an anode and cathode is termed sputtering. Enhancement of this process for scanning electron microscopy (SEM) sample coating is obtained by the choice of a suitable ionization gas and target material. Sputtered metal coatings offer the following benefits for SEM samples:

- ***Reduced microscope beam damage.***
- ***Increased thermal conduction***
- ***Reduced sample charging (increased conduction).***
- ***Improved secondary electron emission***
- ***Reduced beam penetration with improved edge resolution***
- ***Protects beam sensitive specimens***

Increase in electrical conductivity of a sample is probably the single most common requirement for SEM, though all factors come into play with FEG SEM. Low voltage SEM operation can still benefit in many cases from a thin coating.

The development of Sputter Coater systems embodies significant empirical design, however, an understanding in classical terms of glow discharge characteristics enhance such designs and may assist in the comparison of differing systems.

Gaseous Condition

If an inert gas such as argon is included in a cathode gas tube, the free ions and electrons are attracted to opposite electrodes and a small current is produced. See **Figure 1**.

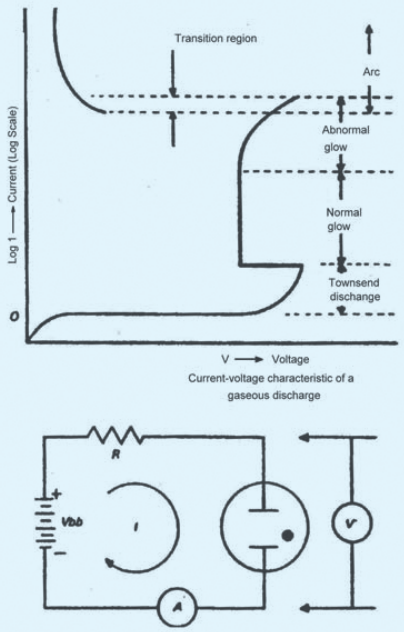
As voltage is increased some ionization is produced by collision of electrons with gas atoms, named the "Townsend" discharge. When the voltage across the tube exceeds the breakdown potential, a self sustaining glow discharge occurs - characterized by a luminous glow.

The current density and voltage drop remains relatively constant, the increase in total current being satisfied by the area of the glow increasing. Increasing the supply voltage increases current density and voltage drop, this is the abnormal glow region.

Further increase in supply voltage concentrates the glow into a cathode spot and arc discharge is apparent. The operating parameters of sputter coaters are within the glow discharge regions of the characteristic described.

Figure 1: Circuit to determine the current-voltage characteristics of a cold cathode gas tube

A = Ammeter V = Voltmeter



Glow Discharge

Once the condition for a sustained discharge is met, the tube exhibits the characteristic glow discharge, so called because of the associated luminous glow. It has been established that free ions and electrons are attracted to opposite electrodes producing a discharge - however for a discharge to be self-sustaining requires regeneration of the electrons by the positive ion bombardment of the cathode. This produces secondary electrons and enhances ionization. The resulting positive ion excess creates a positive space charge near the cathode. The voltage drop experienced is termed the cathode fall. If the discharge is established in a long narrow tube it exhibits the characteristics indicated.

The positive ion density in the "Crookes dark space" is very high; as a result a significant voltage drop is experienced between it and the cathode.

The resulting electric field accelerates the positive ions which produce secondary electron emission from the cathode.

These electrons accelerated in the direction of the anode cause ionixation, generating positive

Techniques and Applications

ions to sustain the discharge. Subsequently, excitation of the gas results in intense illumination in the negative glow region. From this stage the electrons have insufficient exciting or ionizing energy, resulting in the "Faraday dark space". Towards the anode a small accelerating field can produce ionization and excitation, the gas again becoming luminous. See **Figure 2**.

Sputter Coating

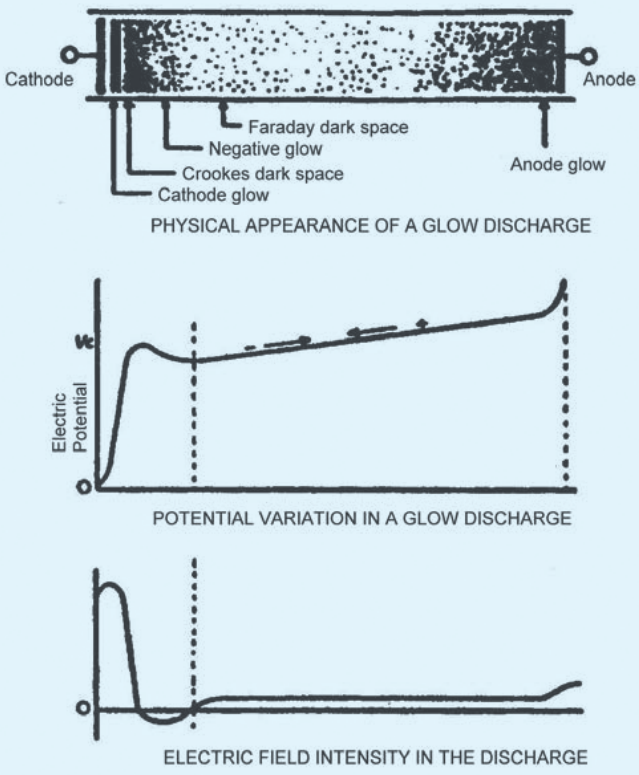
It has been indicated that under conditions of glow discharge, ion bombardment of the cathode will occur. This results in the erosion of the cathode material and is termed plasma sputtering, with the subsequent omni-directional deposition of the sputtered atoms forming coatings of the original cathode material on the surface of the sample and work chamber.

This process is enhanced in sputter coaters for use in Scanning Electron Microscopy where one objective is to provide an electrically conductive thin film representative of the specimen to be viewed. Such films inhibit "charging", reduce thermal damage, and enhance secondary electron emission.

The most common arrangement for a D.C. (Direct Current) sputter coater is to make the negative cathode the target material to be sputtered (typically gold, platinium or with high vacuum sputter coaters, metals such as chromium and iridium), and to locate the specimens to be coated on the anode (which is usually "earthed" to the system, so the specimens are effectively at "ground" potential).

The desired operating pressure is obtained by a pump (usually a two-stage rotary vacuum pump, or a turbomolecular pumped “backed” by a rotary pump), with an inert gas, such as argon admitted to the chamber by a fine control (leak) valve.

Figure 2



Operating Characteristics

The glow discharge in sputtering is significantly dependent on the work function of the target material and pressure of the environmental gas. A range of target materials are used including gold, gold-palladium, platinum and silver. Although gold is still a common sputtering metal, having the most effective electrical conduction characteristics, it does however, have the largest grain size and is not always suitable for high resolution coating. For this reason gold-palladium and platinum are now widely used as their grains sizes are smaller than gold. Films with even smaller grain sizes can be achieved using metals such as chromium and iridium, but both require the use of a high vacuum (turbomolecular pumped) sputtering system.

The sputter head and sputter power supply should be effective over a range of anticipated target materials.

The deposition rate is current dependant, and if we operate in the correct glow region of the characteristic plasma discharge, as previously described, several fold changes in current should be available for a relatively small change in sputtering voltage. The deposition rate should not be sensitive to small changes in pressure which may be experienced in the system.

If the sputtering head is well designed and operating at low voltage and as a result, low energy input, then radiant heating from the target and high energy electrons (potentially the most significant sources of damage to delicate specimens) should be considerably reduced. There is also evidence to suggest that such a sputter head system may also produce finer grain size for a given target material.

The presence of an inert gas which will not decompose in the glow discharge is obviously desirable. Argon, having a relatively high atomic weight, provides a suitable source of ions for effective bombardment of the target material. Sputtering in air is best avoided.

The effectiveness is also dependent on the "mean free path" (m.f.p.) which is inversely proportional to pressure. If the m.f.p. is too short, insufficient energy will be gained for effective bombardment and will inhibit movement of sputtered material from the target.

If the m.f.p. is too long, insufficient collisions occur and, in addition, the flow of sputtered material may change from diffusion in the gas to free molecular flow with a reduction in the effectiveness of omni-directional deposition.

If these characteristics for sputter heads are achieved, then it should not be necessary to cool the specimen stage for the majority of applications. If not, however, such cooling will only serve to reduce the baseline temperature, the thermal conductivity of most specimens we are considering being relatively poor.

For sensitive specimens pre-cooling (Peltier, water or cryo cooled) and subsequent reduction of the baseline may still be desirable and there is also evidence to suggest a reduction in grain size of the coating. It may be apparent that Scanning Electron Microscopy requires a versatile system without compromising performance. Specifically, fine grain size, uniform coating and low heat input. Consideration of these characteristics in design and development should enable a suitable coating system to be realised.

A major disadvantage of simple diode sputter coaters in SEM is the excessive amount of heat generated in the sample. To overcome this problem, permanent magnets are utilized to deflect the high energy electrons generated in the glow discharge away from the sample.

The magnetic lines of force cause enclosed loops at the target surface,

Techniques and Applications

increasing the interaction path length of the high energy electrons in the discharge. Deflection and retardation of electrons result in increased ion yield and sputtering efficiency.

It was indicated previously that while imperical design may be in evidence, it should now be apparent that effective production of positive ions for glow discharge is required. The sputter head and its associated power supply should be a primary objective of design and development.

All modern SEM sputter coaters use heads fitted with an arrangement of magnets and often an associated shroud assembly, with a disc target. Power supplies generally employ solid state switching for applied voltage control. See **Figure 3**.

The overall result is a low mean voltage head with low energy input. The possibility of thermal damage due to radiant heating and electron bombardment is considered negligible.

For a typical modern magnetron sputter coater

Vacuum	8 x 10^{-2}	to	2 x 10^{-2} mbar
Sputtering Voltage	100V	to	3Kv
Current	0	to	50mA
Deposition	0	to	25 nm/min
Grain size	Less than 5nm		
Temperature rise	Less than 10C		

It is, of course, possible to satisfy very precise parameters by the selection of target material, 'voltage' 'deposition'. 'current' and 'vacuum'. Under these conditions, it is possible to achieve thin films to l0nm with grain sizes better than 2nm and temperature rises of less than 1°C.

Choice of Sputtering Material

As stated many times, metal coating is an indispensable technique for SEM. The development of high resolution FEG SEMs has brought about more wide spread use of specialized techniques such as Ion Beam Sputtering, Penning Sputtering, E-Beam Evaporation and Planar magnetron ion-sputtering.

More lately Chromium coating has become the "fashionable" material to use. It offers a thin continuous film and emits less back scattered electrons than other sputter materials. However it is not free of its own problems. To operate it requires a high vacuum and ideally vacuum transfer (or vacuum storage) of the sample to avoid oxidation problem. Cr coated samples may often have a "see through" look as there is the possibility of images generated from electrons from sub surface structures. More recently iridium films have been shown to give excellent fine grain (sub nanometer) films that compare favorably with those generated with Cr. Both metals require high vacuum sputter coaters for effective deposition.

Application data collected has shown that a high quality well designed rotary pumped magnetron sputter coater, such as the EMS 550X, is capable of producing a continuous Pt (platinum) film with a grain size in the order of 2 nm. It also has the benefit of being a good secondary electron emitter, unlike chromium. Some images of chromium show bright high contrast images. Many workers, and our own studies have led us to consider the possibility of each grain of chromium being oxidised before sample is coated and hence the film is not truly continuous and indeed each metal grain is individually charging. This is another reason to consider iridium as an alternative.

Silver as a sputter material is often ignored but is a very satisfactory method for ensuring conductivity of the SEM sample but has a major advantage the whole process is reversible as the metal may be removed by the neutral aqueous reagent known as "Farmers reducer". This enables many samples to be viewed and then returned to their original condition. Beware. ...Silver may form crystalline deposits on the surface of the sample in the presence of active Halogens

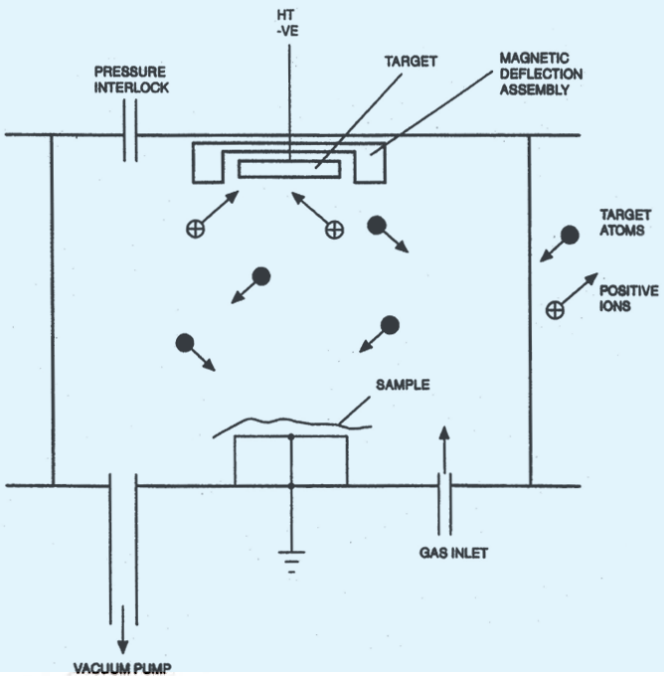
- ***Sputtered silver offers smaller grain size than evaporated silver.***
- ***Sputtered Gold and Silver have similar grain size but the silver has larger reticulation after storage.***
- ***Silver is the most conductive metal known.***
- ***Silver has a high secondary electron coefficient.***
- ***X-ray emission lines are well separated from the biologically important sulphur and phosphorous.***
- ***Cost effective.***

Gold/Palladium (80:20) targets are now a popular standard choice for the routine coating of a wide range of samples. The idea behind using this alloy is that the palladium will act as a physical barrier to the gold which will attempt to conglomerate into large islands and restrict ultimate resolution performance.

The minimal loss in secondary electron emission performance from the palladium is not seen as significant with current SEMs.

Other target choices are generally made based on the requirement for X-ray analysis of samples or back scattered electron detection.

Figure 3 – Diagram of a "cool" sputtering head



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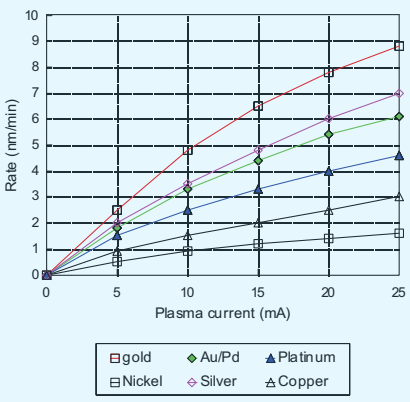
Techniques and Applications

Rates of Sputtering

A question regularly asked is what difference is there in sputtering rates for each of the target materials. The following list gives the variance of the materials in relation to gold, assuming gold to be: 1, it is impossible to give actual coating rates as this varies with sputtering conditions.

Au	Gold	1.0
Ag	Silver	1.2
Co	Cobolt	0.5
Cr	Chromium	0.5
Cu	Copper	0.7
Fe	Iron	0.5
Mo	Molybdenum	0.3
Ni	Nickel	0.5
Pd	Palladium	0.85
Pt	Platinum	0.6
Ta	Tantalum	0.2
W	Tungsten	0.2

Figure 4 - Sputtering Rates for the EMS 7620



Thickness of Coating

Experiments using interferometric techniques have shown that the thickness of Au/Pd coating sputtered in argon gas can be calculated at 2.5KV according to:
Th = 7.5 I t (angstroms) (V = 2.5KV, target to specimen distance = 50mm)
t = time in minutes
I = current in mA
Th = thickness in angstroms
Average coating times will be of the order of 2 -3 minutes using V = 2.5KV and I = 20 mA
Platinum targets when fitted will give approximately half the deposition rate.

General Points for Improving Performance

1. Cleanliness, the work chamber must be kept clean! We advise that a separate carbon coater be used in applications where the maximum performance of the sputter coater is required

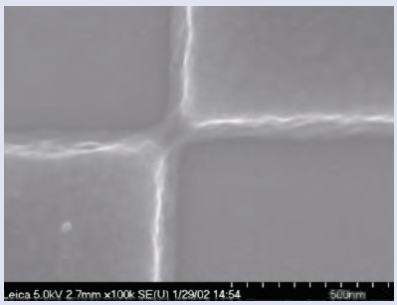
- Clean the glass chamber with hot soapy water and dry thoroughly, solvents can be used but we have found this unnecessary and having greater danger to health and safety. If the deposit is stubborn, use a kitchen scouring pad such as the green Scotch Bright variety.
- Use Isopropyl alcohol on metal surfaces, not acetone which has greater danger to health and safety.It will also take longer to out gas and reduce the vacuum performance.

2. Vacuum, Never leave the chamber under vacuum without isolating the roughing pump from the coater, this is usually done with a manual valve (Quorum high vacuum sputter coaters have useful “pump hold” facility that allows the vacuum chamber to be held under vacuum when the instrument is not in use). Failure to do so will increase the risk of suck back of hydrocarbons (pump oil) in to the sputter chamber and increase contamination.

- Always ensure the system is dry and pumping to its correct vacuum level before working with samples, failure to do so will result in poor sputter rate and contamination.
- Ballast rotary pumps on a regular basis and ensure they are serviced at regular intervals.

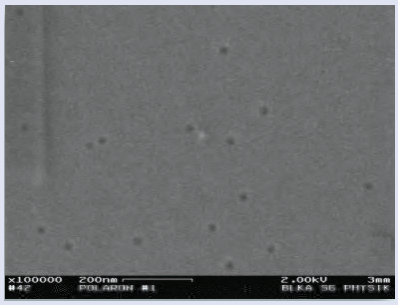
3. Sputter gas, Always use high purity argon gas of the grade known as “White spot” this will ensure fast sputter rate and good pump down time.

4. Rotary planetary specimen stages are essential for ensuring even coatings on specimens with irregular surfaces.



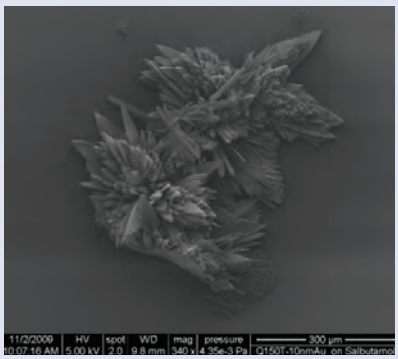
Gold/palladium coating of 6" wafer

This wafer was wafer-coated with 3nm of gold/palladium (Au/Pd) using the EMS 7640 Sputter Coater. Settings: 800V 12mA using argon gas and vacuum of 0.004 bar. Further tests revealed that coating was of an even thickness right to the edge of the 6" wafer. Work was done by Dr Jost Gabler of Gala Instrumente GmbH.



Platinum coating using SC7640

Borosilicate glass with surface imperfections (dark spots). Coated with 3nm of platinum (Pt) using the EMS 7640 Sputter Coater. Settings: 800V 12mA using argon gas and vacuum of 0.004 bar. Image provided by Gala Instrumente GmbH.



TEM image of 2nm sputtered platinum film

Carbon-coated Formvar film. Coated with 2nm of platinum (Pt) using the EMS 7640 Sputter Coater. Settings: 800V 10mA using argon gas and vacuum of 0.004 bar. Image courtesy of Topcon Electron Beam Services Corporation.

Techniques and Applications

Silver as a removable coating for scanning electron microscopy

Acknowledgement: The following abstract and method results (introduction only) is reproduced by kind permission of A.A. Mills, Scanning Microscopy, Vol. 2, No.3, 1988 (Pages 1265-1271)

Abstract

A thin film of silver, applied by sputtering or vacuum evaporation, provides an excellent conformal conductive coating for scanning electron microscopy of insulating specimens. When no longer required it is easily removed with Farmer's Reducer - a dilute aqueous solution of potassium ferricyanide and sodium thiosulphate.

No damage was apparent to fine structure in the calcite matrix of ostracode shells, or to other biological tissues. No problems have been encountered with grain in the silver film at magnifications up to x15,000, or in the storage of coated specimens in a desiccator for periods exceeding six months.

Introduction

Many specimens for which scanning electron microscopy (SEM) is invaluable are electrical insulators, for example microfossils and dried biological preparations. To promote the emission of secondary electrons, and to prevent charging of the surface (with consequent repulsion of bath incoming and secondary electrons) it is usual to coat such specimens with a very thin layer of metal.

Nowadays gold (sometimes over a thin undercoat of carbon) is commonly employed for the majority of work, although refractory metals have been recommended for the very highest magnifications. These coatings are normally applied by sputtering in a glow discharge, for this technique is omni-directional and tends to give a fine-grained deposit, while the apparatus required is comparatively simple and inexpensive since a high vacuum is not required.

An alternative, older technique (which also allows aluminum to be deposited) is evaporation of a molten bead of the chosen metal in a high vacuum. The inherent directionality of this method means that specimens must generally be moved continuously by a rotating/nodding table.

Problems arise when it is desired to return a specimen to its original uncoated condition, for example to allow successive treatments or because too thick a coating has been accidentally applied. Even specimens which have been correctly coated may be rendered unsuitable for subsequent optical and analytical examination, due to the highly reflective nature of the gold film and its interference with x-ray emission. For these reasons there is frequently a reluctance to allow SEM examination of certain material, eg type specimens and archaeological artifacts.

Removal of Gold and Aluminum Coatings

Attempts have therefore been made to remove the metal film by suitable reagents, which must obviously not attack the substrate. It is well-known that gold is recovered from siliceous ores by complexing with aqueous cyanide under oxidizing (aerobic) conditions, and two groups have independently utilized this reaction.

A major obstacle is the highly toxic nature of cyanides, necessitating efficient fume hoods and a high degree of supervision and control unwanted in most laboratories. A less objectionable reagent is ferric chloride in alcohol, but it requires some six hours on a gold/palladium film from a smooth PTFE surface, and appears likely to attach many specimens. Mercury amalgamates gold, but does not remove it completely and adds its own background.

Aluminum dissolves in weak acids and alkalies with the evolution of hydrogen. Sylvester and Bradley therefore hoped that soaking in a dilute solution of sodium hydroxide would enable this metal to be removed from calcite microfossils without damage to the matrix. Unfortunately, they were later obliged to acknowledge that insufficiently careful exposure to alkali could result in dissolution of fine structure.

Advantages of a silver film

Silver would appear to have much to commend it as an alternative to gold. It is the most conductive metal known, possesses a high secondary electron coefficient, and is readily applied by sputtering or evaporation to follow irregular contours better than any other material.

Unlike gold, its x-ray emission lines are well-separated from those of the biologically important sulphur and phosphorus. Its cost is only a fraction of gold and the platinum metals. The unique applicability of silver to photography has resulted in extensive research upon its complex ions and their solubility.

Quite early in the history of photography it was found that a dark, over-exposed negative could be rendered less opaque ('reduced') by aqueous oxidizing agents in the presence of sodium thiosulphate. The metallic silver forms the Ag ion, which is promptly complexed by the thiosulphate so that still more silver dissolves. No gas is evolved. The negative would be removed from the reagent and thoroughly washed when a sufficient amount of silver had been abstracted from the image.

Materials and methods

One of the mildest of these 'reducers' is that formulated by Farmer in 1884, employing very dilute potassium ferricyanide as the oxidizing agent. As paper, albumen and gelatine were apparently unaffected, it was thought that this reagent might well prove suitable for dissolving silver from a variety of coated specimens without damage to the matrix. Ferricyanides do not possess the extreme toxicity of the simple cyanides, and may be purchased and used in the same way as ordinary laboratory and photographic chemicals.

Farmer's Reducer - the formulation used is based on that given by Jacobson:

Solution A

25g sodium thiosulphate (crystals)

250ml water

2 drops of Kodak 'Photoflo'

Solution B

10g potassium ferricyanide

100ml water

These solutions appear to be stable indefinitely at room temperature if kept in securely stoppered amber glass bottles. Immediately before use, the following mixture is to be prepared:

50ml water

50ml Solution A

3ml Solution B

Techniques and Applications

It was found that the resulting pale yellow solution had a pH of about 5, the same as the CO_2-equilibrated tap water used for its preparation. It was unstable, losing activity and color after about two hours at room temperature.

A neutral mixture may be prepared by substituting pH 7 phosphate buffer (conveniently prepared from a BDH tablet) for water in the above dilution. However, all the tests to be described in the paper were conducted with the ordinary solution prepared with tap water.

It should be noted that calcium carbonate has a significant solubility in water. In nature, calcite microfossils are protected against percolating groundwater by the sacrificial dissolution of fossils above and around them. Once removed from this environment to the laboratory, such fossils should presumably be washed only with distilled water that has been allowed to stand in contact with CaCO (eg marble chips) and filtered. Otherwise needles and similar fine structures will be particularly at risk.

This equilibrated 'hard' water could be used to prepare and dilute the Farmer's Reducer. A very brief final rinse in distilled water is probably permissible; the common practice of 'soaking overnight' is not.

Results — silver mirror on glass

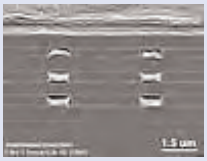
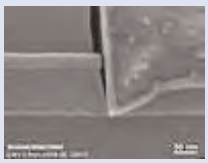
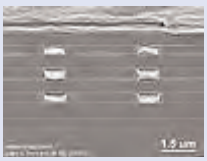
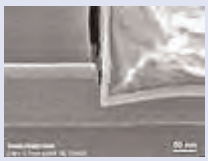
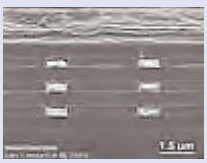
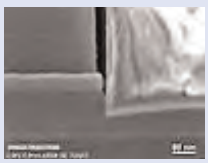
A silver mirror was made by evaporating the metal on to a microscope slide cleaned with chromic acid. Sufficient was deposited to give a semi-transparent film: silvery when placed on a dark background and viewed by reflected light, but behaving as a blue filter when examined by transmitted light.

The coated glass slide was immersed in freshly-prepared Farmer's Reducer. The silver was gently dissolved in a controlled manner, as shown by the gradual and uniform loss of color in transmitted light, until none remained after three minutes. No gas was evolved. It was decided that a 10 minute immersion should allow an ample margin to deal with specimens with convoluted surfaces. The reagent had no effect upon gold films. Alloys of silver and gold have not been investigated.

Comparative Sputter Data

Iridium and other materials

Samples were coated using an EMS 575X Sputter Coater and were examined using a Hitachi S-5200 Field Emission SEM.

Gold			
Magnification:	15,000 X	100,000 X	300,000 X
Coating Time:	10 seconds	10 seconds	10 seconds
Current Used:	20 mA	20 mA	20 mA
Gold/Palladium			
Magnification:	15,000 X	100,000 X	300,000 X
Coating Time:	10 seconds	10 seconds	10 seconds
Current Used:	20 mA	20 mA	20 mA
Chromium			
Magnification:	15,000 X	100,000 X	300,000 X
Coating Time:	30 seconds	30 seconds	30 seconds
Current Used:	100 mA	100 mA	100 mA
Iridium			
Magnification:	15,000 X	100,000 X	300,000 X
Coating Time:	10 seconds	10 seconds	10 seconds
Current Used:	20 mA	20 mA	20 mA
No Coating			
Magnification:	15,000 X	100,000 X	300,000 X
Coating Time:	N/A	N/A	N/A
Current Used:	N/A	N/A	N/A
Platinum			
Magnification:	15,000 X	100,000 X	300,000 X
Coating Time:	N/A	N/A	N/A
Current Used:	N/A	N/A	N/A

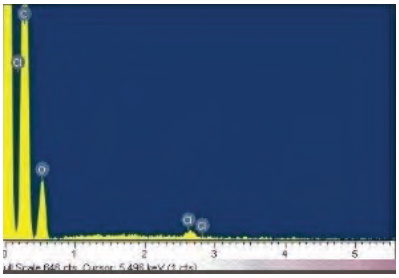
What is...
Carbon Coating?

The use of carbon films in Electron Microscopy with their low background signal and relatively good electrical conductivity is well known. Thin films, nominally 5nm or 50 Angstroms, are used in TEM, while a range of somewhat thicker films, ranging from 50nm or 500 Angstroms, may be used in SEM for such applications as X-ray microanalysis.

Commonly, a high vacuum evaporator with carbon rods is used to achieve these coatings, and still has preferential applications. The use of carbon fiber however, has allowed a flash evaporation technique to be developed which can be suitable for a number of general EM requirements.

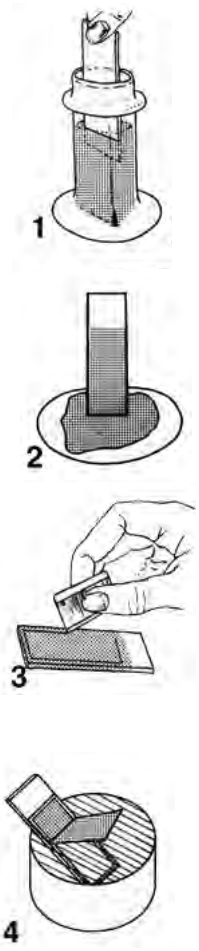
Pinus sylvestris (Scots pine)

Transverse section of Pinus sylvestris (Scots pine) in the first image shows the latewood portion of the growth ring. This surface shows latewood tracheids (transportation and structural cells) and also part of a ray (cells for storage of food substances). EDX spot analysis of the wood specimen using Oxford Instruments' INCA Energy shows a small chlorine peak, which results from treatment of the wood with a preservative - shown in the graph. The specimen charges excessively unless carbon coated. Other types of coating cannot be used due to the very low levels of chlorine used in the preservative, with which the wood is treated. With thanks to Oxford Instruments.



Techniques and Applications

Procedures for the preparation of TEM carbon support films



Figures from M. A. Hayat and S. E. Miller (1990). *Negative Staining.* McGraw Hill Publishing Co. , N.Y. 253pp.

Section A. Preparation of normal carbon support films

NOTE: Process uses a diffusion-pumped vacuum evaporator, for turbomolecular-pumped systems please modify the process as appropriate. For optimum results, vacuum levels in the range of $5x10^{-5}$mbar or better are recommended.

Step 1. Copper grids should be pre-cleaned by sonicating for 10 seconds in acetone, followed by 10 seconds of sonication in ethyl alcohol. Allow grids to dry on filter paper in a dust-free environment before use.

Step 2. Add 0.12g of formvar powder to 50ml of ethylene dichloride and mix well on a magnetic stirrer until dissolved. Pour the solution into a clean coplin jar.

Step 3. Clean a glass slide with water and detergent. Rinse well to make sure that all of the detergent is removed and finally rinse in de-ionized water before drying with a paper towel. Blow off any lint on the slide with compressed air. Place the slide in a dry, dust-free environment such as on filter paper under an upturned beaker. If there are problems in getting the plastic film to be released from the slide (Step 5), using a slide that has not been as thoroughly cleaned might help.

Step 4. Dip the cleaned slide into the formvar solution (step 1 in picture) and touch edge to filter paper to drain off the excess fluid (step 2 in picture). Dry upright in a dust-free environment (this requires 5-10 minutes).

Step 5. Score the edges of the formvar film with an acetone-cleaned razor blade (step 3 in picture). Breathe on the slide to loosen the film, and slowly slide off onto a clean water surface by immersing the slide into the water at a -15° angle (step 4 in picture). Place grids, dull/rough surface down, onto good (uniform, grey color, un-wrinkled) areas of the film. Place a small piece of clean, white office paper onto the surface of the grids and film and allow the paper to soak up water. Pick up the paper, grids and film and place in a covered petri dish to dry.

Step 6. Carbon coat film according to directions (see Section C) to desired thickness - a light-brown color indicates a thickness of 100Å.

Step 7. Place the paper and coated grids onto a piece of filter paper that is soaked with ethylene dichloride in a covered petri dish. 30 minutes should be sufficient time to dissolve the Formvar film and not damage the carbon support. Remove the grids and paper and allow them to dry in a dust-free area.

Section B. Preparation of perforated carbon support films

Step 1. Copper grids should be pre-cleaned by sonicating for 10 seconds in acetone, followed by 10 seconds of sonication in ethyl alcohol. Allow grids to dry on filter paper in a dust-free environment before use.

Step 2. Add 0.17g of formvar powder to 50ml of chloroform and mix well on a magnetic stirrer until dissolved. Pour the solution into a clean coplin jar.

Step 3. Clean a glass slide with water and detergent. Rinse well to make sure that all of the detergent is removed and finally rinse in de-ionized water before drying with a paper towel. Blow off any lint on the slide with compressed air. Place the slide in a dry, dust-free environment such as on filter paper under an upturned beaker. If there are problems in getting the plastic film to be released from the slide (Step 6), using a slide that has not been as thoroughly cleaned might help.

Step 4. Add about 50 drops of a 50% glycerol/water solution to the surface of the formvar solution. Place the tip of a probe sonicator onto the surface of the solution and sonicate until mixed. Sonication intensity should be great enough to 'violently' cause the solution to bubble. This often requires not much more than about five seconds. This should produce numerous holes that are 1-2µm in diameter and suitable for use with frozen-hydrated specimens. Sonicating for longer periods of time produces smaller holes in the film.

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Techniques and Applications

Step 5. Immediately after sonicating, dip the cleaned slide into the formvar solution (step 1 in first diagram) and touch edge to filter paper to drain off the excess fluid (step 2 in first diagram). Dry upright in a dust-free environment for about 5-10 minutes.

Step 6. Score the edges of the formvar film with an acetone-cleaned razor blade (step 3 in first diagram). Breathe on the slide to loosen the film, and slowly slide off onto a clean water surface by immersing the slide into the water at a -15° angle (step 4 in first diagram). Place grids, dull/rough surface down, onto good (uniform, grey color, unwrinkled) areas of the film. Place a small piece of clean, white office paper onto the surface of the grids and film and allow the paper to soak up water. Pick up the paper, grids and film and place in a covered petri dish to dry.

Step 7. Place the paper with the film and grids onto a methanol-soaked piece of filter paper in a covered petri dish for about 30 minutes. This should perforate any pseudo-holes that may be in the films (these occur when a small drop of glycerol was present but it was not enough to perforate the film).

After allowing the paper and film to dry, the grids may be examined in a light microscope under phase contrast to determine the quality of the films.

Step 8. Carbon coat film according to directions (see Section C) to desired thickness - a light-brown color indicates a thickness of 100Å.

Step 9. Place the paper and coated grids onto a piece of filter paper that is soaked with ethylene dichloride in a covered petri dish. 30 minutes should be sufficient time to dissolve the formvar film and not damage the carbon support. Remove the grids and paper and allow them to dry in a dust-free area.

Section C. Use of a shadow evaporator for carbon coating plastic films

Step 1. Turn shadow evaporator on: Turn both the main and mechanical pump switches on. Move the black-knobbed, manifold valve handle downwards to 'backing' position. Open the air inlet valve and CAREFULLY remove the implosion shield and bell jar. Set the bell jar upside down on the rest on the adjacent cabinet.

Step 2. Set up carbon coating apparatus: Plug one lead to ground ('E') and the other to '1' (see second diagram). Remove the cylindrical glass shield. Release the tension spring that holds the right carbon rod in place and remove the rod. File the edge of the left carbon rod flat with a piece of emery cloth. Replace the right rod with a fresh one or sharpen it by the procedure described below.

Step 3. Carbon rod sharpening procedure: Place the carbon rod in the chuck of the sharpener. Pull the rod out until its edge is aligned with the edge of the aligning arm and then tighten the chuck. Turn on the sharpener and run the first sharpener tool against the rod until a conical point is formed. Then run the other sharpener tool against the rod until a narrow point is formed. Turn off the sharpener and clean off all carbon dust. Put the newly sharpened rod in the chuck of the carbon coater and tighten. Replace the tension spring and then the glass shield.

Step 4. Set up grids: Place the grids and paper support on a piece of filter paper on top of the base of the carbon coating apparatus (see second diagram). Place a thumbtack alongside the slide. This provides a 'shadow' on the filter paper and helps you determine the relative thickness of the carbon coating.

Step 5. Diffusion pump warm up: Replace the bell jar and the implosion shield. Close the air inlet, and move the manifold valve handle slowly upwards to the roughing position. Allow the vacuum to reach 0.04 Torr on the bell jar gauge and then move the handle downwards to backing. IMPORTANT: Turn on the water supply. The water supply-line valve is located on the wall behind the shadow evaporator. Turn on the diffusion pump switch and allow the pump to warm up for 15 minutes before continuing.

Step 6. Obtaining a high vacuum: Move the manifold valve handle slowly upwards to the roughing position and allow the vacuum to reach 0.04 Torr on the bell jar gauge. While waiting for the vacuum to recover, fill the baffle with liquid nitrogen. When the bell jar vacuum has reached 0.04 Torr, move manifold valve handle down to the backing position. Depress the metal guard beneath the red mains valve knob and move the knob handle upwards to the open position Allow the vacuum to reach a minimum of $2x10^{-5}$ Torr or better.

Step 7. Carbon coating: Turn the electrode selector to #1. Turn the electrode switch on. Slowly turn the electrode current control knob until there is a slight glow at the point where the two carbon rods meet. Slowly increase the current until the rods become white hot. The proper current setting should be just before the point where the carbon starts to sputter. Frequently monitor the thickness of the carbon by turning down the current, checking the darkening of the filter paper and then turning the current back up again.

Step 8. Diffusion pump cool down: Turn down the electrode current control knob and turn off the electrode switch. Make sure the manifold valve is set to the backing position and close the mains valve. Open the air inlet, remove the implosion shield and bell jar and remove the grids. Then replace the bell jar and implosion shield, close the air inlet and move the manifold valve handle to the roughing position. Allow the vacuum to reach 0.04 Torr on the bell jar gauge, move the manifold valve handle to the backing position, turn off the diffusion pump, and allow the pump to cool for 20 minutes.

Step 9. Turn shadow evaporator off: Close the manifold and turn off the mechanical pump and main power switches. Turn off the cooling water.

Section D. Glow discharging carbon films

Step 1. NOTE: Place the very edge of your carbon coated grids along the edge of a piece of double-sided tape on a glass slide. This will help to prevent your grids from flying around inside the shadow evaporator when the air release switch is opened.

Step 2. Turn shadow evaporator on: Turn the main power switch on, turn on the mechanical pump and move the manifold valve handle (black knob) downwards to the backing position. Open the air inlet. CAREFULLY remove the implosion shield and bell jar.

Step 3. Set up glow discharge unit: Plug the lead into the proper receptacle (BNC connector). Place the glass slide with your grids on the unit and replace the bell jar and implosion shield. Close the air inlet, turn the butterfly switch by the current gauges to glow discharge and move the manifold valve handle slowly upwards to the roughing position. Allow the vacuum to reach 0.2-0.15 Torr on the bell jar gauge. The manifold valve may be turned to the closed position if the vacuum rises above 0.10 Torr.

Step 4. Glow discharging: Turn the electrode selector to position #1 and turn the electrode switch on. Slowly turn up the electrode current until there is a bright purple glow surrounding the glow discharge unit. Maintain this setting for approximately 10 seconds while monitoring vacuum. Turn off the electrode current control knob and the electrode switch. Move the manifold valve handle to the backing position. Turn the butterfly switch back to the evaporator setting.

Step 5. Turn shadow evaporator off: Slowly open the air inlet to prevent your grids from being blown around the bell jar. Remove the grids, replace the shields and then close the air inlet. Move the manifold valve to the roughing position. Allow the vacuum to reach 0.04 Torr on the bell jar gauge before moving the manifold valve handle to the horizontal (closed) position. Turn off the mechanical pump and the main switch.

Quorum

SPUTTER COATERS, SEM/TEM CARBON COATERS

Selection Guide: Q Series Sputter Coaters, SEM/TEM Carbon Coaters

If you are not sure which coating system suits your application's requirements please don't hesitate to contact us for advice.

Q150 R Plus

Q150 T Plus

Q150V Plus

Q150 GB

Model	High (Turbo) or Low (Rotary) Pumped Vacuum		Capable of Achieving Vacuum			Sputtering Metal Types		Coating Types			Carbon - SEM, TEM Films		Glow Discharge	Chamber Diameter	Max. Specimen Diameter	Typical Application	Summary
	Rotary	Turbo	2 x 10^{-3}	5 x 10^{-5}	1 x 10^{-6}	Non-Oxidising	Oxidising	Sputtering	Carbon	Metal Evaporation	SEM	TEM					
Q150R S Plus	√		√			√		√					option	150mm	100mm	W-SEM	Rotary pumped coaters for W-SEM specimens up to 100 mm dia.
Q150R E Plus	√		√						√		√			150mm	100mm	W-SEM	
Q150R ES Plus	√		√			√		√	√		√		option	150mm	100mm	W-SEM	
Q150T S Plus		√	√	√		√	√	√					option	150mm	100mm	W-SEM FE-SEM	Turbo pumped coaters for W-SEM, and FE-SEM specimens up to 100 mm dia.
Q150T E Plus		√	√	√					√	option	√			150mm	100mm	W-SEM FE-SEM	
Q150T ES Plus		√	√	√		√	√	√	√	option	√		option	150mm	100mm	W-SEM FE-SEM	
Q150V S Plus		√	√	√	√	√	√	√					option	150mm	100mm	FE-SEM	Turbo pumped high-vacuum coaters, for FE-SEM and TEM grids, specimens up to 100 mm dia.
Q150V E Plus		√	√	√	√				√	option	√	√		150mm	100mm	FE-SEM, Carbon TEM Grids	
Q150V ES Plus		√	√	√	√	√	√	√	√	option	√	√	option	150mm	100mm		
Q150 GB		√	√	√		√	√	√	√	option	√		option	150mm	100mm	W-SEM FE-SEM	Glove box coater. based on the Q150T ES Plus
Q300TT Plus		√	√	√		√	√	√						300mm	200mm	W-SEM FE-SEM	As the Q150T S Plus, but with capability to take larger specimens
Q300TD Plus		√	√	√		√	√	√						300mm	100mm option to 150mm	W-SEM FE-SEM Thin Film	Dual head coater, for multi-layer coating applications of two metals

Q300TT Plus

Q300T ES

Q300TD Plus

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MiniQS Entry-Level Sputter Coater

QUICK OVERVIEW

The MiniQS is ideal for the budget-conscious user who also demands reproducible results in an easy-to-use instrument. The MiniQS uses a Magnetron sputtering head with an easily replaceable disc target.

KEY FEATURES

- Sputter head is hinged for easy operation
- Fitted with safety interlocks
- Detachable chamber with implosion guard and top-plate, allowing for easy cleaning
- Pre-set profiles with single touch operation
- Automatic operation with minimal user intervention required
- Compact size; ideal for use with benchtop SEMs
- Range of noble target options to suit majority of applications including forensics
- Possibility of coating samples up to 50 mm diameter

Safety

The MiniQS meets UK and European (CE) industry standards, including LVD, EMC and RoHS. Vacuum interlocks remove power from deposition sources to prevent users being exposed to high-voltage.

SPECIFICATIONS

Instrument Dimensions	225 mm W x 420 mm D x 480 mm H x 470 mm (total height with coating head open)
Weight	8.7kg
Sputter Target	Disk-style 57 mm dia. 0.1mm thick gold (Au) target is included in the accessory pack. Gold/palladium (Au/Pd) and silver (Ag) target options available.
Specimen Stage	50 mm dia. stage
Vacuum (two options available)	*Long Pipe Option:* Suitable for placing rotary pump on the floor (1.5m KF16 stainless steel, average pump down 31.57 sec.)
	Short Pipe Option: Suitable for pump to be housed on bench or below bench (0.7m Armorvin hose, average pump down 53.60 sec.)

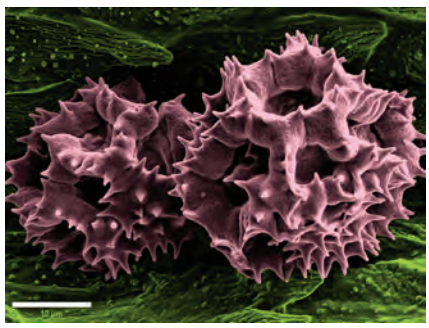
Recommended applications for MiniQS Entry-Level Sputter Coater:

- Table-top SEM coating
- Low and medium magnifications

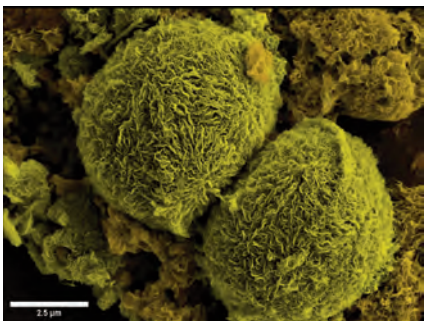
These products are for Research Use Only.

ORDERING INFORMATION

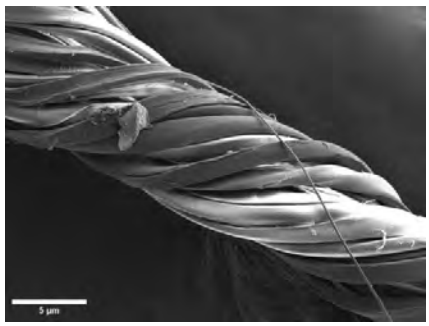
Cat No.	Description	Qty.
MiniQS	MiniQS Entry-Level Sputter Coater	each

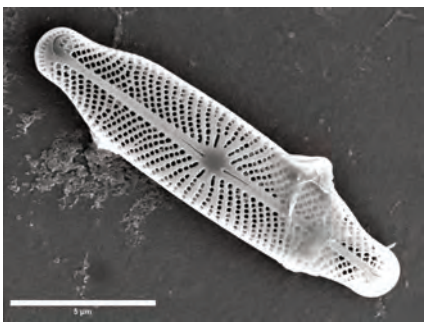


Dandelion spores, colorized



Algae, colorized





Quorum

SPUTTER COATERS, SEM/TEM CARBON COATERS

Q150R Plus Rotary Pumped Coater

QUICK OVERVIEW

The Q150R Plus is suitable for use with Tungsten/LaB_6 SEM and Benchtop SEM.

Typical uses

Sputter coating of noble metals using the Q150R S Plus & Q150R ES Plus

Recommended for magnifications:
- Up to x 50k using Au, Au/Pd
- Up to x 100k using Pt (optional)

Carbon cord coating for elemental analysis using the Q150R S Plus & Q150R ES Plus.

KEY FEATURES

- **Capable of achieving vacuum of 2 x 10^{-3} mbar**
- **New touch and swipe capacitive screen**
- **USB port for upgrades and download of log files**
- **Multiple-user profiles can be set up on one machine**
- **New software sorts recipes per user, according to recent use**
- **16GB of memory can store more than 1000 recipes**
- **New multi-color LED visual status indicator**
- **Interchangeable stage options and plug-in heads**

PRODUCT DESCRIPTION

The Q150R Plus is available in three configurations:

- Q150R S Plus – An automatic sputter coater for non-oxidizing metals. Available sputtering targets including gold, gold/palladium and platinum.
- Q150R E Plus – An automatic carbon cord coater for SEM applications such as EDS and WDS.
- Q150R ES Plus – A combined system system capable of both sputtering and carbon coating. The deposition heads can be swapped in seconds.

Improved Interface

- Capacitive touch screen is more sensitive for ease of use
- User interface software has been extensively revised, using a modern smartphone-style interface
- Comprehensive context-sensitive help screen
- USB interface allows easy software updates and backing up/copying of recipe files to USB stick
- Process log files can be exported via USB port in .csv format for analysis in Excel or similar. Log files include date, time and process parameters.
- 16GB of flash memory can store more than 1000 recipes
- Dual-core ARM processor for a fast, responsive display

Allows multiple users to input and store coating recipes, with a new feature to sort recipes per user according to recent use.

Intelligent system logic automatically detects which insert is in place and displays the appropriate operating settings and controls for that process.

System prompts user to confirm target material and it then automatically selects appropriate parameters for that material.

Intuitive software allows the most inexperienced or occasional operator to rapidly enter and store their own process data. For convenience a number of typical sputtering and carbon coating profiles are already stored but also allows the user to create their own.

Software detects failure to achieve vacuum in a set period of time and shuts down the process in case of vacuum leak, which ensures pump protection from overheating.

Recommended applications for Q150 R Plus:

- **Low and medium magnifications**
- **SE signal boost (1nm or less)**
- **Table-top SEM coating**
- **Elemental analysis**
- **Copper metallization layers**

These products are for Research Use Only.

Automatic, controlled pulsed carbon cord evaporation

The carbon evaporation process can be terminated using the optional film thickness monitor, which incorporates a quartz crystal monitor, fitted as standard on E and ES models. This recipe ensures that carbon is evaporated in short controlled pulses, which has two effects: protecting the sample from heating and ensuring the accuracy of the film thickness monitor. Pulsing also significantly reduces the amount of debris (including large carbon fragments) associated with traditional carbon "flash" evaporation. Pulsed and ramped carbon rod recipes are supplied as standard.

Cool Magnetron Sputtering

Sputter coating is a technique widely used in various applications; it is possible to create a plasma and sputter metals with high voltage, poor vacuum and no automation. However, this is not suitable for electron microscopy applications because it will heat the sample and can result in

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Q150R Plus *(continued)*

damage when the plasma interacts with the sample. The Q150R Plus series uses low temperature enhanced-plasma magnetrons optimized for the rotary pump pressures, combined with low current and deposition control, which ensures your sample is protected and uniformly coated.

The Q150R S Plus and Q150R ES Plus use easy-change, 57 mm diameter, disc-style targets which are designed to sputter non-oxidizing (noble) metals – ideal for W-SEM applications. The Q150R S Plus and Q150R ES Plus are fitted as standard with a gold (Au) sputter target.

Other targets options include Au/Pd, Pt/Pd, Pd, and Cu. Platinum (Pt) can also be sputtered with the optional Pt coating vacuum hose assembly.

Interchangeable Plug-in Heads

This allows the user to configure the system as a sputter coater, evaporator or glow discharge system – all in one space saving format. A carbon cord evaporation insert is available as an option. Automatic detection of the head type when changed.

Detachable chamber with built-in implosion guard

Removable glass chamber and easily accessible base and top plate allows for an easy cleaning process.

Users can rapidly change the chamber, if necessary, to avoid cross contamination of sensitive samples.

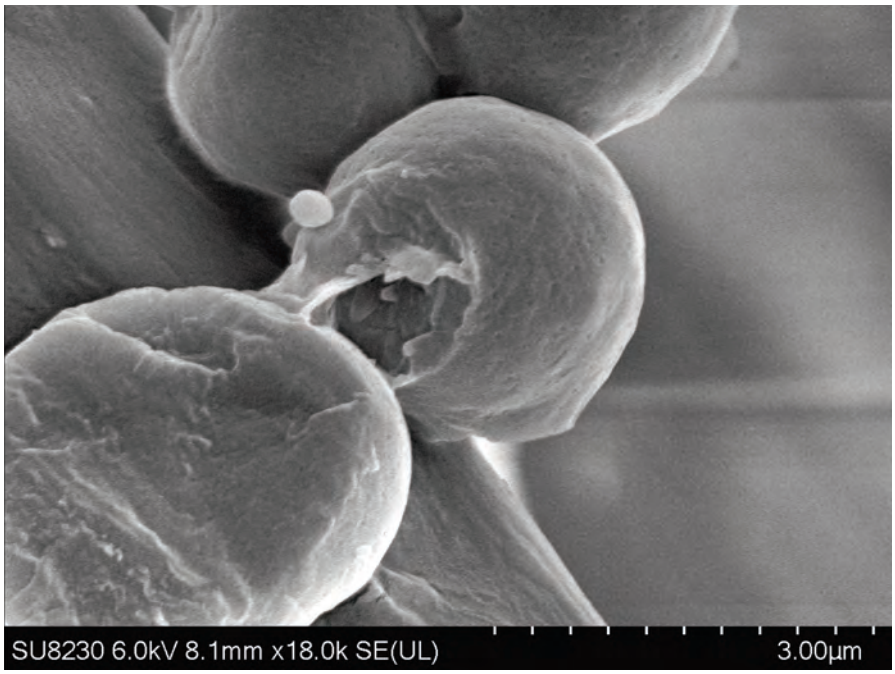
Tall chamber option is available for carbon evaporation to avoid sample heating, to improve uniformity for sputtering and to hold taller samples.

Multiple stage options

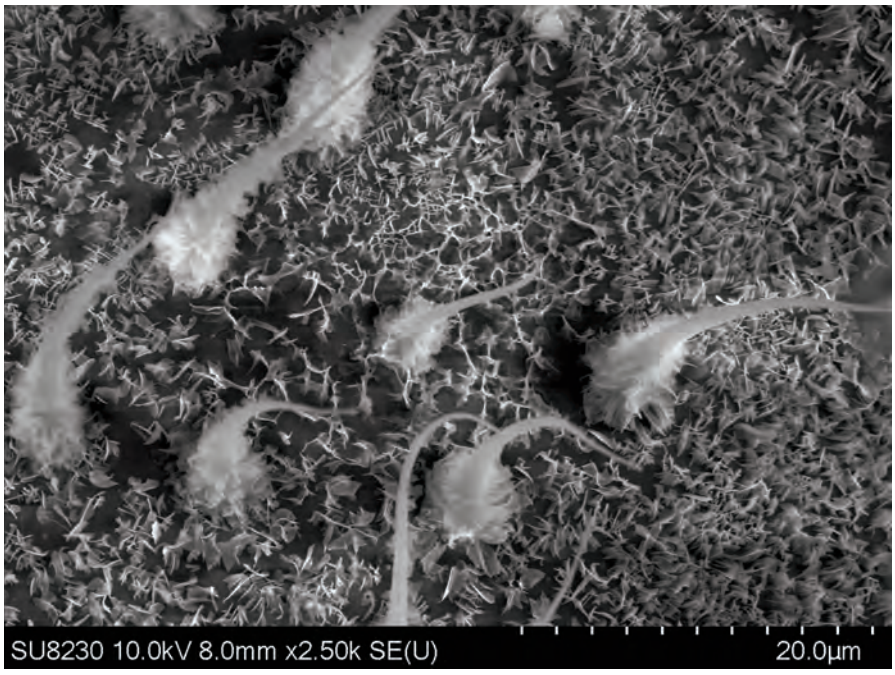
The Q150R Plus has specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except for the rotary planetary stage). Some examples:

- Rotation stage (supplied as standard): 50 mm Ø can accommodate six standard stubs. Height can be pre-set.
- Rotate-tilt stage for improved uniform coating: 50 mm Ø. Tilt and height can be pre-set.
- Variable angle, rotary planetary stage for heavily contoured samples
- Large flat rotation stage with offset gear box for 4"/100 mm wafers
- Rotation stage for glass microscope slides

Other options are available on request.



Pure silk coated 10nm Au x 18k magnification



Ladybird larvae hair coated 10nm Au x 2.5k magnification

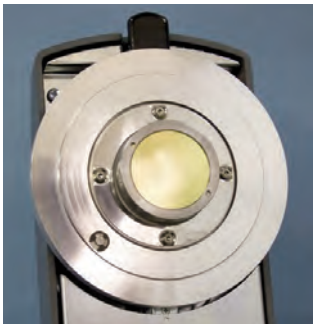
continued ››››

Q150R Plus *(continued)*

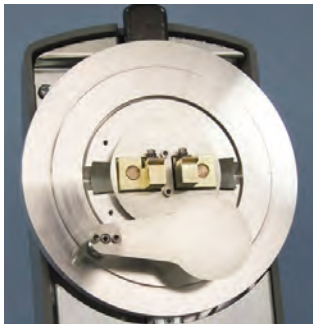
Safety

The Q150R Plus meets key industry CE standards:

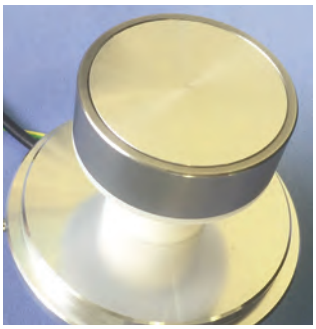
- All electronic components are protected by covers
- Implosion guard prevents user injury in event of chamber failure
- Vacuum interlocks remove power from deposition sources to prevent user exposure to high voltage in event of chamber being opened
- Electrical interlocks remove power when source head cover opened
- Overheating protection shuts down power supply



Sputtering insert. Gold (Au) fitted as standard, but other metals available

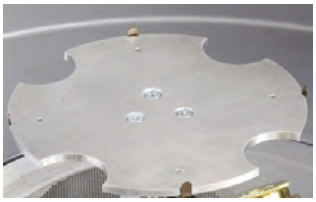


Carbon fiber evaporation insert and automatic source shutter

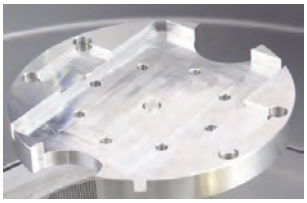


10262 optional glow discharge attachment (for R S and R ES versions)

Base plate. Standard specimen stage and optional film thickness monitor (FTM)



Optional flat rotation stage for 100 mm/4 wafers



Optional rotation stage for glass microscope slides

SPECIFICATIONS

Instrument Case	585mm W x 470mm D x 410mm H Total height with coating head open is 650 mm
Weight	28.4 kg (Packed 42 kg)
Packed Dimensions	725 mm W x 660 mm D x 680 mm H
Work Chamber	Borosilicate glass 150 mm ID x 127 mm H
Display	115.5 mm W x 86.4 mm H (active area), 640 RGB x 480 (display format), capacitive touch color display
User Interface	Full graphical interface with touch screen buttons, includes features such as a log of the last 1000 coatings and reminders for when maintenance is due
Sputter Target	Disc-style 57 mm Ø 0.1 mm thick gold (Au) target is fitted as standard. R S and R ES versions only

Specimen Stage

50 mm Ø rotation stage with rotation speed of 8-20 rpm.

Other stages available on request.

Vacuum

Rotary Pump	Optional 5 m^3/hr two-stage rotary pump with oil mist filter (order separately)
Vacuum Measurement	Pirani gauge
Ultimate Vacuum	2 x 10^{-2} mbar
Typical ultimate vacuum of the pumping system in a clean instrument after pre-pumping with dry nitrogen gas	
Sputter Vacuum Range	Between 7 x 10^{-3} and 1 x 10^{-1} mbar for gold

Processes

Sputter Deposition Current	Single target: 1 - 140mA All targets: 60 - 420mA
Visual Status Indicator	A large status multi-color indicator light provides a visual indication of the state of the equipment, allowing users to easily identify the status of a process at distance.

The indicator LED shows the following states:

- Initialization
- Process running
- Idle
- Coating in progress
- Process completed
- Process ended in fault condition

Audio indication also sounds on completion of the process.

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Q150R Plus *(continued)*

ORDERING INFORMATION

Q150R S Plus

4500	Q150R S Plus Fully automatic, capacitive touch-screen controlled rotary-pumped sputter coater with status LED indicator. **Including:** quick-release sputter insert, one 57 mm diameter x 0.1 mm gold target, and 50 mm diameter rotating specimen stage.

Q150R E Plus

4503	Q150R E Plus Fully automatic, capacitive touch-screen controlled rotary pumped carbon fiber evaporation coater with status LED indicator. **Including:** quick-release carbon fiber insert for evaporation of carbon cord, carbon fiber cord, and 50 mm diameter rotating specimen stage.

Q150R ES Plus

4507	Q150R ES Plus Fully automatic, capacitive touch-screen controlled rotary pumped sputter coater and carbon evaporator with status LED indicator. **Including:** quick release sputter insert, one 57 mm diameter x 0.1 mm gold target, and carbon fiber evaporation coater, including quick-release carbon fiber insert for evaporation of carbon cord*, and 50 mm diameter rotating specimen stage. *Coating inserts are interchangeable and can be swapped in seconds. The intelligent system logic automatically recognises which insert is in place and displays the appropriate operating settings.

Options and Accessories

Rotary pump requirements – order separately

91003	5m³ hr two-stage Pfeiffer Duo 6 rotary pump with oil mist filter	each

Head inserts and glow discharge

4511	Additional sputter insert for quick metal change (R E and R ES only). Note: this is an entire sputtering assembly – individual noble metal targets can also be purchased	each
4512	Carbon rod evaporation insert for 3.05 mm Ø rods (R E and R ES only). Includes manual rod shaper and 3.05 mm Ø carbon rod	each
4513	Glow discharge insert to modify surface properties (e.g. hydrophobic to hydrophilic conversion) or to clean surface residues (R S and R ES only). Can be retrofitted	each
4514	Additional standard glass chamber assembly	
4515	Extended height vacuum chamber (214 mm high – the standard chamber is 127 mm high). For increased source to sample distance and for coating large specimens	each
4516	Rotating vacuum spigot allows more convenient connectionof the vacuum hose to the rear of the Q150R when bench depth is limited	each
4517	Film thickness monitor (FTM) attachment. Consists of a built in chamber mounted quartz crystal oscillator (includes crystal). As sputtered or evaporated material is deposited onto the crystal, so its frequency of oscillation is modified. This "modification" is used to measure and control the thickness of material deposited	each
4518	Spare quartz crystal	each
13530	Standard coating shield assembly	each
11880	Extended height coating shield assembly	each
1371	Platinum coating vacuum hose assembly	each

Specimen stages

All rotating stages have variable rotation of between 8 and 20 rpm.

4519	50 mm Ø rotate-tilt specimen stage with adjustable tilt (up to 90 degrees) and height (37 mm-60 mm). Has six stub positions for 15 mm or 6.5 mm or 1/8" pin stubs. Stage rotation speed variable between 8 and 20rpm	each
4520	90 mm Ø rotating specimen stage for glass microscope slides (up to two x 75 mm x 25 mm slides). Stage rotation speed variable between 8 and 20rpm	each
4521	Variable angle "Rotacota" rotary planetary stage with 50 mm Ø specimen platform. Has six stub positions for 15 mm or 6.5 mm or 1/8" pin stubs. Stage rotation speed variable between 8 and 20rpm	each
4522	Flat rotation specimen stage for 100 mm/4" wafers, includes gearbox for increased coverage. Stage rotation speed variable between 8 and 20rpm	each
23850	Tilt stage sub-assembly 4"	each

For our complete selection of specimen stages, please see the **Specimen Stage Selection Guide** on page 49 >>>>

Carbon Supplies

4538	Carbon fiber cord – high purity – 1m	each
4539	Carbon fiber cord – high purity – 5m	each
4540	Carbon fiber cord – standard grade – 1m	each
4541	Carbon fiber cord – standard grade – 10m	each
4542	Carbon fiber cord – standard grade – 100m	each
4543	Carbon rods – 3.05 mm Ø x 50 mm length (shaped) pack of 10	10/pk
4544	Carbon rods 3.05 mm Ø x 300 mm length (unshaped) pack of 10)	10/pk
4546	Manual rod shaper for 3.05 mm Ø carbon rods	each
12097	Wedge Tool	each

Sputtering Targets

4523	57 mm Ø x 0.1 mm Gold	each
4524	57 mm Ø x 0.2 mm Gold	each
4525	57 mm Ø x 0.3 mm Gold	each
4526	57 mm Ø x 0.1 mm Gold/Palladium (80/20)	each
4527	57 mm Ø x 0.2 mm Gold/Palladium (80/20)	each
4528	57 mm Ø x 0.3 mm Gold/Palladium (80/20)	each
4529	57 mm Ø x 0.1 mm Platinum	each
4530	57 mm Ø x 0.2 mm Platinum	each
4531	57 mm Ø x 0.3 mm Platinum	each
4532	57 mm Ø x 0.1 mm Nickel	each
4533	57 mm Ø x 0.1 mm Silver	each
4534	57 mm Ø x 0.1 mm Palladium	each
4535	57 mm Ø x 0.1 mm Copper	each
4536	57 mm Ø x 0.1 mm Platinum/Palladium (80/20)	each
4537	57 mm Ø x 0.3 mm Platinum/Palladium (80/20)	each

Spare Kits

4547	Two-year spares kit for Q150R S Includes: 57 mm Ø x 0.1 mm gold target, standard glass chamber assembly quartz crystals, O-rings
4548	Two-year spares kit for Q150R E Includes: carbon fiber / cord, standard glass chamber assembly, quartz crystals, O-rings, springs
4549	Two-year spares kit for Q150R ES Includes: 57 mm Ø x 0.1 mm gold target, carbon fiber / cord, standard glass chamber assembly, quartz crystals, O-rings, springs

Q150T Plus Turbomolecular Pumped Coater

QUICK OVERVIEW

The Q150T Plus is optimized for use with a turbomolecular pump, which gives a lower vacuum down to 5 x 10-5 mbar. This enables the sputtering of oxidizing metals, which have a lower grain size suitable for high-resolution imaging. Similarly, lower scattering allows for high purity, amorphous carbon films of high density.

Typical uses

Sputter coating of noble and oxidizing metals using the Q150T S Plus & Q150T ES Plus:

Recommended for magnifications::
- Up to x 50k using Au, Au/Pd
- Up to x 100k using Pt
- above x 100k using Cr, Ir(optional)

Ideal for thin film applications such as coating with ITO, W, Al, Zn.

KEY FEATURES

- **New touch and swipe capacitive screen**
- **USB port for upgrades and download of process log files**
- **Multiple-user profiles can be set up on one machine**
- **New software sorts recipes per user according to recent use**
- **16GB of memory can store more than 1000 recipes**
- **New multi-color LED visual status indicator**
- **Capable of achieving vacuum of 5 x 10-5 mbar**

PRODUCT DESCRIPTION

The Q150T Plus is available in three configurations:

- Q150T S Plus – An automatic sputter coater for non-oxidizing metals. Sputtering targets include; Cr, Ir, W, ITO, Al. Other targets available.
- Q150T E Plus – An automatic carbon cord coater for SEM applications such as EDS and WDS. Metal evaporation/aperture cleaning option available.
- Q150T ES Plus – A combined system system capable of both sputtering and carbon coating. The deposition heads can be swapped in seconds. Metal evaporation/aperture cleaning option available.

Improved Interface

- Capacitive touch screen is more sensitive for ease of use
- User interface software has been extensively revised, using a modern smartphone-style interface
- Comprehensive context-sensitive help screen
- USB interface allows easy software updates and backing up/copying of recipe files to USB stick
- Process log files can be exported via USB port in .csv format for analysis in Excel or similar. Log files include date, time and process parameters.
- 16GB of flash memory can store more than 1000 recipes
- Dual-core ARM processor for a fast, responsive display

Allows multiple users to input and store coating recipes, with a new feature to sort recipes per user according to recent use.

Intelligent system logic automatically detects which insert is in place and displays the appropriate operating settings and controls for that process.

System prompts user to confirm target material and it then automatically selects appropriate parameters for that material.

Intuitive software allows the most inexperienced or occasional operator to rapidly enter and store their own process data. For convenience a number of typical sputtering and carbon coating profiles are already stored but also allows the user to create their own.

Software detects failure to achieve vacuum in a set period of time and shuts down the process in case of vacuum leak, which ensures pump protection from overheating.

Recommended applications for Q150 T Plus:

- **High-resolution magnification SEM**
- **Protective platinum layers for FIB**
- **R&D of corrosion-, friction-, and wear protective layers**
- **Protective layers on medical devices**
- **BSE imaging**
- **EDX, WDS, EBSD analysis**
- **Carbon coating of replicas**

These products are for Research Use Only.

Controlled ramped carbon rod evaporation

Careful evaporation allows precise control of carbon thickness (with or without the optional film thickness monitor). The quality of the resulting carbon films is also enhanced by the eradication of "sparking" that is a common feature of less advanced coaters.

For reproducible high-quality carbon films, we would recommend the use of shaped carbon rods. Rods are higher purity, less susceptible to debris and easier to control. Pulsed and ramped carbon rod recipes are supplied as standard.

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Q150T Plus *(continued)*

Cool Magnetron Sputtering

Sputter coating is a technique widely used in various applications; it is possible to create a plasma and sputter metals with high voltage, poor vacuum and no automation. However, this is not suitable for electron microscopy applications because it will heat the sample and can result in damage when the plasma interacts with the sample. The Q150T Plus series uses low temperature enhanced-plasma magnetrons optimized for the rotary pump pressures, combined with low current and deposition control, which ensures your sample is protected and uniformly coated.

The Q150T S Plus and Q150T ES Plus use easy-change, 57 mm diameter, disc-style targets which are designed to sputter oxidizing and noble metals. The Q150T S Plus and Q150T ES Plus are fitted as standard with a chromium (Cr) sputter target. Other targets options include Au, Au/Pd, Pt/Pd, Pd, Pt, Cu, Ir, W, ITO and Al. Others are available on request.

Pulsed cleaning for Aluminum sputtering

Aluminum (Al) rapidly forms an oxide layer which can be difficult to remove, but the Q150T ES Plus & Q150T S Plus have special recipes for Al that reduce the oxide removal time and prevent excessive pre-sputtering of the target.

Interchangeable plug-in heads

This allows the user to configure the system as a sputter coater, evaporator or glow discharge system – all in one space saving format. A carbon cord evaporation insert is available as an option. Automatic detection of the head type when changed.

Detachable chamber with built-in implosion guard

Removable glass chamber and easily accessible base and top plate allows for an easy cleaning process. Users can rapidly change the chamber, if necessary, to avoid cross contamination of sensitive samples. Tall chamber option is available for carbon evaporation to avoid sample heating, improved uniformity for sputtering and to hold taller samples.

Multiple stage options

The Q150T Plus has specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except for the rotary planetary stage).

Some examples:

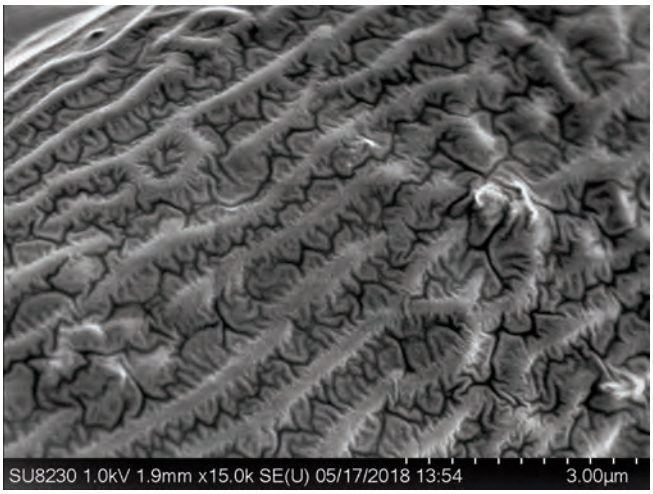
- Rotation stage (supplied as standard): 50 mm Ø can accommodate six standard stubs. Height can be pre-set.
- Rotate-tilt stage for improved uniform coating: 50 mm Ø. Tilt and height can be pre-set.
- Variable angle, rotary planetary stage for heavily contoured samples.
- Large flat rotation stage with offset gear box for 4"/100 mm wafers.
- Rotation stage for glass microscope slides.

Other options are available on request.

Safety

The Q150T Plus meets key industry CE standards

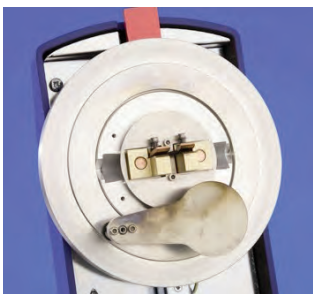
- All electronic components are protected by covers
- Implosion guard prevents user injury in event of chamber failure
- Vacuum interlocks remove power from deposition sources to prevent user exposure to high voltage in event of chamber being opened
- Electrical interlocks remove power when source head cover opened
- Overheating protection shuts down power supply



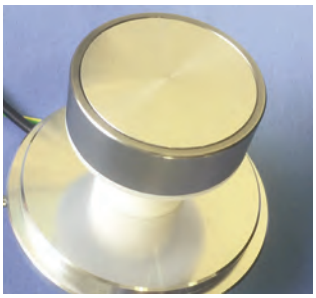
Pollen coated in 3nm Au x15k magnification on Q150T Plus

Sputter coater insert (standard with T S and T ES)

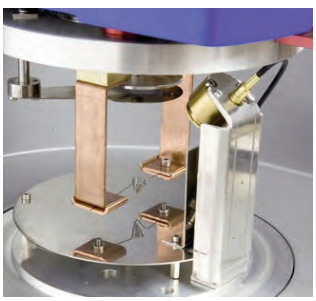
Metal evaporation insert (set up for downwards evaporation)



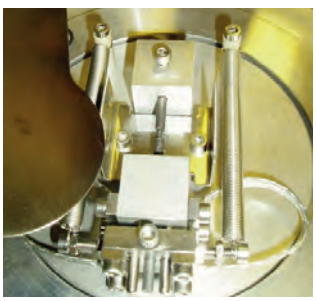
Carbon cord evaporation insert option



Optional glow discharge attachment (for T S and T ES versions)



Metal evaporation insert (set up for upwards evaporation)



Carbon rod evaporation insert

Q150T Plus *(continued)*

SPECIFICATIONS

Instrument Case	585mm W x 470mm D x 410mm H Total height with coating head open is 650 mm
Weight	28.4 kg (Packed 42 kg)
Packed Dimensions	725 mm W x 660 mm D x 680 mm H
Work Chamber	Borosilicate glass 150 mm ID x 127 mm H
Display	115.5 mm W x 86.4 mm H (active area), 640 RGB x 480 (display format), capacitive touch color display
User Interface	Full graphical interface with touch screen buttons, includes features such as a log of the last 1000 coatings and reminders for when maintenance is due
Sputter Target	Disc-style 57 mm Ø 0.1 mm thick gold (Au) target is fitted as standard. R S and R ES versions only

Specimen Stage

50 mm Ø rotation stage with rotation speed of 8-20 rpm.

Other stages available on request.

Vacuum

Rotary Pump	Optional 5 m^3/hr two-stage rotary pump with oil mist filter (order separately)
Vacuum Measurement	Pirani gauge
Ultimate Vacuum	2 x 10^{-2} mbar

Typical ultimate vacuum of the pumping system in a clean instrument after pre-pumping with dry nitrogen gas

Sputter Vacuum Range	Between 7 x 10^{-3} and 1 x 10^{-1} mbar for gold

Processes

Sputter Deposition Current	Single target: 1 - 140mA All targets: 60 - 420mA
Visual Status Indicator	A large status multi-color indicator light provides a visual indication of the state of the equipment, allowing users to easily identify the status of a process at distance.

The indicator LED shows the following states:

- Initialization
- Process running
- Idle
- Coating in progress
- Process completed
- Process ended in fault condition

Audio indication also sounds on completion of the process.

ORDERING INFORMATION

Q150T S Plus

3380 Q150T S Plus Sputter Coater. High resolution turbomolecular pumped capacitive touch-screen controlled sputter coater with status LED indicator. Includes quick release sputter insert and one 57 mm diameter x 0.3 mm chromium target. Rotating specimen stage, 50 mm diameter, supplied as standard.

Q150T E Plus

3390 Q150T E Plus Carbon Evaporator. Turbomolecular pumped capacitive touch-screen controlled carbon evaporator with status LED indicator suitable for TEM and SEM applications. Fitted with a carbon rod evaporation head for 3.05 mm diameter carbon rods. Supplied with carbon rods (3.05 mm x 300 mm) and a carbon rod shaper (manual operation). Rotating specimen stage, 50 mm diameter, supplied as standard.

Q150T ES Plus

3400 Q150T ES Plus Combined Sputtering and Carbon Coating System. The deposition heads can be swapped in seconds and the intelligent system logic automatically recognizes which head is in place and displays the appropriate operating settings. Consists of high resolution turbomolecular pumped capacitive touch-screen controlled sputter coater and carbon evaporator with status LED indicator, including quick release sputter insert and one 57 mm diameter x 0.3 mm chromium target, and high vacuum carbon rod evaporation coater, including quick-release carbon rod insert for 3.05 mm diameter carbon rods. Coating inserts are interchangeable. Rotating specimen stage, 50 mm diameter, supplied as standard.

Options and Accessories

Including details of coating head inserts and specimen stages fitted as standard.

Coating head options

A range of interchangeable, plug-in style coating head inserts are available:

3200	Sputtering head insert suitable for oxidizing and non-oxidizing metals. Supplied with a 54 mm x 0.3 mm thick chromium (Cr) target as standard. For additional targets see Sputtering Targets section	each
3210	Additional sputter insert for quick metal change. Note: this is an entire sputtering assembly.	each
3230	Carbon rod evaporation head insert (for 3.05 mm Ø rods)	each
3240	Carbon rod evaporation head insert (for 6.15 mm Ø rods). Note that EMS recommends 3.05 mm Ø rods as they offer greater process control and are more economical (less wastage).	each
3250	Carbon fiber evaporation head insert	each
3260	Metal evaporation and aperture cleaning head insert, including the ability to evaporate upwards or downwards (T E and T ES versions only). Supplied with a pack of ten tungsten filaments and a molybdenum boat.	each
3270	Extended height vacuum chamber (214 mm high – the standard chamber is 127 mm high). For increased source to sample distance and for coating large specimens	each
3280	Rotating vacuum spigot allows more convenient connection of the vacuum hose to the rear of the Q150T Plus when bench depth is limited	each
3290	Film thickness monitor (FTM) attachment. Consists of a built in chamber mounted quartz crystal oscillator (includes crystal). As sputtered or evaporated material is deposited onto the crystal, so its frequency of oscillation is modified. This 'modification' is used to measure and control the thickness of material deposited	each
3300	Spare quartz crystal for FTM.	each
13530	Standard coating shield assembly	each
27691	Extended glass cylinder assembly, 220 mm H	each
3320	Full range vacuum gauge for low and high vacuum measurement (a low vacuum Pirani gauge is fitted as standard)	each

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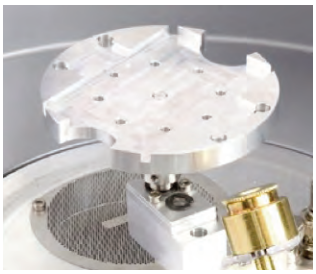
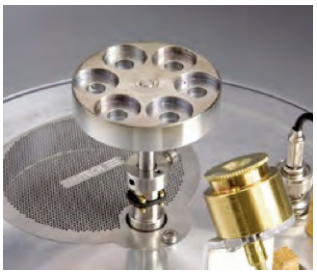
Q150T Plus *(continued)*

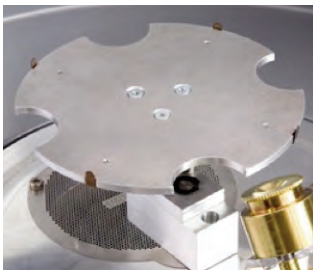
ORDERING INFORMATION (continued)



Microscope slide stage



Rotation stage



Wafer stage

Rotacota planetary stage

4513	Glow discharge insert to modify surface properties (e.g. hydrophobic to hydrophilic conversion) or to clean surface residues (TS and T ES only). Can be retrofitted	each
Specimen stages		
The Q150T Plus has specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except rotary planetary stage):		
3330	Rotation stage, 50 mm Ø (supplied as standard). This stage only rotates – no tilt or height adjustment	each
3340	Rotate-tilt specimen stage with adjustable tilt (up to 90 degrees) and height (37 mm-60 mm). Tilt angle can be preset. 50 mm Ø specimen platform with six stub positions for 15 mm or 6.5 mm or ⅛" pin stubs. Stage rotation speed variable between 8 and 20rpm	each
3350	Variable angle "Rotacota" rotary planetary stage with 50 mm Ø specimen platform. Has six stub positions for 15 mm or 6.5 mm or ⅛" pin stubs. Stage rotation speed variable between 8 and 20rpm	each
3360	Flat rotation specimen stage for 100 mm / 4" wafers, includes gearbox for increased coverage. Stage rotation speed variable between 8 and 20rpm	each
3370	Rotating specimen stage for glass microscope slides (up to two x 75 mm x 25 mm slides). Stage rotation speed variable between 8 and 20rpm. Includes gear box to allow optional FTM to be used	each
23850	Tilt stage sub-assembly 4"	each

For our complete selection of specimen stages, please see the **Specimen Stage Selection Guide** on page 49 ››››

Evaporation Supplies		
73830-SP	Tungsten wire baskets – pack of 10	10/pk
73810-SP	Molybdenum boats – pack of 10	10/pk
Carbon supplies		
3500	Carbon rods – 6.15 mm Ø x 100 mm length (unshaped) pack of 10	10/pk
3510	Carbon rods – 6.15 mm Ø x 50 mm length (shaped) pack of 10	10/pk
3520	Carbon rods – 3.05 mm Ø x 50 mm length (shaped) pack of 10	10/pk
3525	Carbon rods – 3.05 mm Ø x 100 mm length (unshaped) pack of 10	10/pk
3530	Carbon rods 3.05 mm Ø x 300 mm length (unshaped) pack of 10	10/pk
3540	Carbon fiber cord – high purity – 1m	each
3550	Carbon fiber cord – high purity – 5m	each
3560	Carbon fiber cord – standard grade – 1m	each
3570	Carbon fiber cord – standard grade – 10m	each
3580	Carbon fiber cord – standard grade – 100m	each
3590	Manual rod shaper for 6.15 mm Ø carbon rods	each
3595	Manual rod shaper for 3.05 mm Ø carbon rods	each
12097	Wedge Tool	each
Sputtering Targets		
3410	57 mm Ø x 0.1 mm Gold	each
3410-2	57 mm Ø x 0.2 mm Gold	each
3411	57 mm Ø x 0.1 mm Gold/Palladium (80/20)	each
3411-2	57 mm Ø x 0.2 mm Gold/Palladium (80/20)	each
3412	57 mm Ø x 0.1 mm Platinum	each
3413	57 mm Ø x 0.1 mm Nickel	each
3414	57 mm Ø x 0.1 mm Silver	each
3415	57 mm Ø x 0.1 mm Palladium	each
3416	57 mm Ø x 0.1 mm Copper	each
3417	57 mm Ø x 0.3 mm Chromium	each
3418	57 mm Ø x 0.5 mm Tungsten	each
3419	57 mm Ø x 1.5 mm Chromium	each
3420	57 mm Ø x 0.2 mm Tungsten	each
3421	54 mm Ø x 1.5 mm Carbon	each
3422	57 mm Ø x 0.1 mm Aluminum	each
3423	57 mm Ø x 0.1 mm Platinum/Palladium (80/20)	each
3424	57 mm Ø x 1.5 mm Titanium	each
3425	57 mm Ø x 0.3 mm Platinum/Palladium (80/20)	each
3426	57 mm Ø x 0.3 mm Gold	each
3427	57 mm Ø x 0.3 mm Gold/Palladium (80/20)	each
3428	57 mm Ø x 0.3 mm Platinum	each
3429	57 mm Ø x 0.5 mm Titanium	each
3430	57 mm Ø x 0.1 mm Iron	each
3431	57 mm Ø x 0.3 mm Iridium	each
3432	57 mm Ø x 0.1 mm Cobalt	each
3433	57 mm Ø x 0.1 mm Tin	each
3434	57 mm Ø x 0.1 mm Molybdenum	each
3435	57 mm Ø x 0.3 mm Magnesium	each
3436	57 mm Ø x 0.1 mm Tantalum	each
3437	57 mm Ø x 3 mm Indium Tin Oxide (90/10)	each
Other consumables and spare kits		
3600	Metal evaporation basket – pack of 10 (for use with metal evaporation head)	10/pk
07803	Basic Oil Mist Filter (spare)	each
13233	Rotary Pump Oil (spare), 1L	each
13235	Rotary Pump Oil (spare), 5L	each
27607	Non-seal L Gasket	each
G6260	Glass cylinder 6"	each
10068	AdditionalÂ glass cylinder assembly	each
10429	ExtendedÂ glass cylinder assembly	each
3610	Two-year spares kit for Q150T S Plus Includes: chromium (Cr) target, glass cylinder, carbon fiber cord, quartz crystals, O-rings	kit
3620	Two-year spares kit for Q150T E Plus Includes: chromium (Cr) target, glass cylinder, carbon fiber cord, carbon fiber – fine, carbon rods 3.05 mm, quartz crystals, O-rings	kit
3630	Two-year spares kit for Q150T ES Plus Includes: chromium (Cr) target, glass cylinder, carbon fiber cord, carbon fiber – fine, carbon rods 3.05 mm, quartz crystals, O-rings	kit

Q150V Plus Automatic Coater

For ultra-fine coatings

QUICK OVERVIEW

The Q150V Plus is optimized for high-vacuum applications, with an ultimate vacuum of 1 x 10-6 mbar. Together with the use of a wide-range Penning/Pirani gauge, this enables the sputtering of oxidizing metals with ultra-fine grain sizes, which are suitable for high resolution imaging. The lower background pressure removes oxygen nitrogen and water vapour from the chamber, avoiding chemical reactions during the sputter process, which could otherwise lead to impurities or defects in the coatings. Similarly, lower scattering allows for high purity, amorphous carbon films of high density.

The Q150V Plus offers all the benefits of the Q150T Plus, but with a finer grain size and thinner coating, for ultra-high-resolution applications (above x 200,000 magnification).

KEY FEATURES

- **Ultimate vacuum of 1x10^{-6}mbar**
- **New multi-color LED visual status indicator**
- **16Gb of flash memory can store more than 1000 recipes**
- **New software sorts recipes per user according to recent use**
- **Multiple-user profiles can be set up on one machine**
- **New touch and swipe capacitive screen**

PRODUCT DESCRIPTION

The Q150V Plus is available in three configurations:

Q150V S Plus — an automatic sputter coater for oxidizing metals with ultra-fine grain size. Available sputtering targets include chromium, iridium and all noble metals

Q150V E Plus — an automatic carbon coater (rod/cord) for TEM applications. For carbon coating TEM grids.

Q150V ES Plus — a combined system capable of both sputtering and carbon coating. The deposition head inserts can be swapped in seconds. Metal evaporation/aperture cleaning option available.

New user interface has been thoroughly updated:

- Capacitive touch screen is more sensitive for ease of use
- User interface software has been extensively revised, using a modern smartphone-style interface
- Comprehensive context-sensitive help screen
- USB interface allows easy software updates and backing up/copying of recipe files to USB stick
- Process log files can be exported via USB port in .csv format for analysis in Excel or similar. Log files include date, time and process parameters.
- 16GB of flash memory can store more than 1000 recipes
- Dual-core ARM processor for a fast, responsive display

Allows multiple users to input and store coating recipes, with a new feature to sort recipes per user according to recent use.

Intelligent system logic automatically detects which insert is in place and displays the appropriate operating settings and controls for that process.

System prompts user to confirm target material and it then automatically selects appropriate parameters for that material.

Recommended applications for Q150 V Plus:

- **Ultra-high-resolution magnification SEM**
- **Carbon coating of TEM grids**
- **Protective platinum layers for FIB**
- **R&D of corrosion-, friction-, and wear- protective layers**
- **Protective layers on medical devices**
- **BSE imaging**
- **EDX, WDS, EBSD analysis**
- **Carbon coating of replicas**
- **Nano-technology e.g. Zeolites, polymer nanobrushes**

These products are for Research Use Only.

Intuitive software allows the most inexperienced or occasional operator to rapidly enter and store their own process data. For convenience a number of typical sputtering and carbon coating recipes are already stored but also allows the user to create their own. Software detects failure to achieve vacuum in a set period of time and shuts down the process in case of vacuum leak, which ensures pump protection from overheating.

Automatic, controlled carbon rod evaporation for TEM applications

Careful evaporation allows precise control of carbon thickness (with or without the optional film thickness monitor). The quality of the resulting carbon films is also enhanced by the eradication of “sparking” that is a common feature of less advanced coaters.

For reproducible high-quality carbon films, we would recommend the use of shaped carbon rods. Rods are higher purity, less susceptible to debris and easier to control. Pulsed and ramped carbon rod recipes are supplied as standard.

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Q150V Plus Automatic Coater (*continued*)

Cool magnetron sputtering

Sputter coating is a technique widely used in various applications; it is possible to create a plasma and sputter metals with high voltage, poor vacuum and no automation. However, this is not suitable for electron microscopy applications because it will heat the sample and can result in damage when the plasma interacts with the sample. The Q150V Plus series uses low temperature enhanced-plasma magnetrons optimized for the turbomolecular pump pressures, combined with low current and deposition control, which ensures your sample is protected and uniformly coated.

The Q150V S Plus and Q150V ES Plus use easy-change, 57 mm diameter, disc-style targets which are designed to sputter oxidizing and noble metals. The Q150V S Plus and Q150V ES Plus are fitted as standard with a chromium (Cr) sputter target. Other targets options include: Au, Au/Pd, Pt/Pd, Pd, Pt, Cu, Ir, W, ITO and Al. Others are available on request.

Pulsed cleaning for Al sputtering

Aluminum (Al) rapidly forms an oxide layer, which can be difficult to remove, but the ES & S Plus have special recipes for aluminum that reduce the oxide removal time and prevent excessive pre-sputtering of the target.

Interchangeable plug-in heads

This allows the user to configure the system as a sputter coater, evaporator or glow discharge system - all in one space saving format. A carbon cord evaporation insert is available as an option. Automatic detection of the head type when changed.

Detachable chamber with built-in implosion guard

Removable glass chamber and easily accessible base and top plate allows for an easy cleaning process.

Users can rapidly change the chamber, if necessary, to avoid cross contamination of sensitive samples.

Tall chamber option is available for carbon evaporation to avoid sample heating, to improve uniformity for sputtering and to hold taller samples.

Multiple stage options

The Q150V Plus has specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except for the rotary planetary stage).

Some examples:

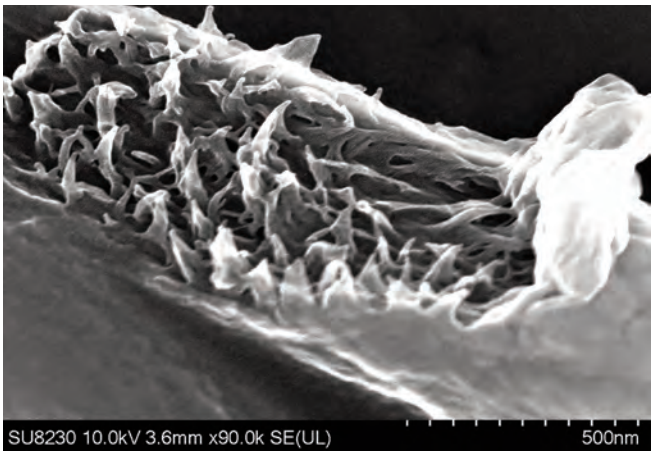
- Rotation stage (supplied as standard): 50 mm Ø can accommodate six standard stubs. Height can be pre-set.
- Rotate-tilt stage for improved uniform coating: 50 mm Ø. Tilt and height can be pre-set.
- Variable angle, rotary planetary stage for heavily contoured samples.
- Large flat rotation stage with offset gear box for 4"/100 mm wafers.
- Rotation stage for glass microscope slides.

Other options are available on request.

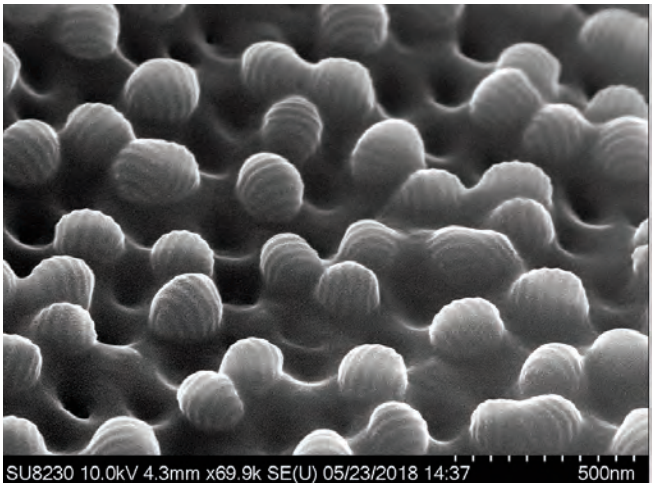
Safety

The Q150V Plus meets key industry CE standards

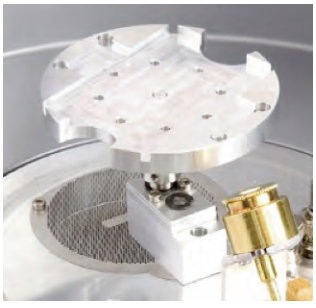
- All electronic components are protected by covers
- Implosion guard prevents user injury in event of chamber failure
- Vacuum interlocks remove power from deposition sources to prevent user exposure to high voltage in event of chamber being opened
- Electrical interlocks remove power when source head cover opened
- Overheating protection shuts down power supply



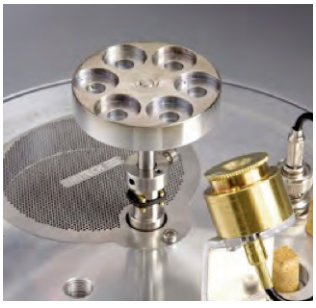
Single electrospinning fiber tear coated with 1nm Au x 90k magnification



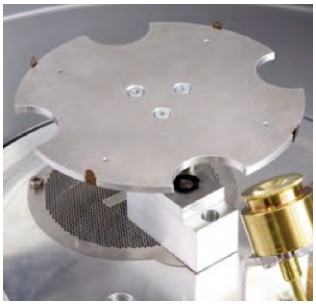
Microsporangium, spore size 150nm, coated with 3nm of Au x 70k magnification



Microscope slide stage



Rotation stage



Wafer stage

Rotacota planetary stage

Q150V Plus Automatic Coater (*continued*)

SPECIFICATIONS

Instrument Case	585 mm W x 470 mm D x 410 mm H (total height with coating head open: 650 mm)
Weight	33.4 kg (packed: 42 kg)
Packed Dimensions	725 mm W x 660 mm D x 680 mm H
Work Chamber	Borosilicate glass 150 mm ID x 133 mm H
Display	115.5mm W x 86.4mm H (active area), 640 RGB x 480 (display format), capacitive touch color display
User interface	Full graphical interface with touch screen buttons, includes features such as a log of the last 1000 coatings and reminders for when maintenance is due.
Sputter Target	Disc-style 57 mm Ø. A 0.3 mm thick chromium (Cr) is fitted as standard. V S and V ES versions only
Specimen stage	50 mm Ø rotation stage with rotation speed of 8-20 rpm. Other stages available on request.

Vacuum

Rotary Pump	5 m^3/hr two-stage rotary pump with oil mist filter. Hydraulically-formed bellows stainless-steel backing line.
Turbo Pump	Internally mounted 70 L/s air-cooled
Vacuum Measurement	Wide range gauge (10428)
Ultimate Vacuum	1 x 10^{-6} mbar

Typical ultimate vacuum of the pumping system in a clean instrument after pre-pumping and venting with dry nitrogen gas

Pump Down Time	5x10^{-6} mbar in 30 mins*
Sputter Vacuum Range	Between 5 x 10^{-3} and 1 x 10^{-1}mbar for gold targets

Processes

Sputtering	Sputter current 0-150 mA to a predetermined thickness (with optional FTM) or by the built-in timer. The maximum sputtering time is 60 minutes (without breaking vacuum and with automatically built-in cooling periods)
Evaporation	Carbon evaporation using rods/cord. Thermal evaporation of metals from filaments or boats. For cleaning TEM apertures a standard molybdenum boat (supplied) can be fitted

Visual Status Indicator

A large multi-color status indicator light provides a visual indication of the state of the equipment, allowing users to easily identify the status of a progress at a distance.

The indicator LED shows the following states:

- Initialization
- Process Running
- Idle
- Coating in Progress
- Process Completed
- Process Ended in Fault Condition

Audio indication also sounds on completion of the process.

ORDERING INFORMATION

Q150V S Plus each

5700 Q150V S Plus Sputter Coater optimized for high-vacuum applications. High resolution turbomolecular pumped capacitive touch-screen controled sputter coater with status LED indicator, including quick release sputter insert and one 57 mm diameter x 0.3 mm chromium target. A rotating specimen stage, 50 mm diameter, supplied as standard.

Q150V E Plus each

5710 Q150V E Plus Carbon Evaporator optimized for high-vacuum applications. Turbomolecular pumped capacitive touch-screen controled carborn evaporator with status LED indicator suitable for TEM and SEM applications. Fitted with a carbon rod evaporation head for 3.05 mm diameter carbon rods. Supplied with carbon rods (C5422 3.05 mm x 300 mm) and a carbon rod shaper (manual operation). A rotating specimen stage, 50 mm diameter, supplied as standard.

Q150V ES Plus each

5720 Q150V ES Plus Combined Sputtering and Carbon Coating System optimized for high-vacuum applications. The deposition heads can be swapped in seconds and the intelligent system logic automatically recognizes which head is in place and displays the appropriate operating settings. Consists of high resolution turbomolecular pumped capacitive touch-screen controled sputter coater and carborn evaporator with status LED indicator, including quick release sputter insert and one 57 mm diameter x 0.3 mm chromium target, and high vacuum carbon rod evaporation coater, including quick-release carbon rod insert for 3.05 mm diameter carbon rods. Coating inserts are interchangeable. A rotating specimen stage, 50 mm diameter, supplied as standard.

Rotary pump requirements (needs to be ordered separately)

91003 Edwards RV3 50L/s two-stage rotary pump, with vacuum hose, coupling kit and oil mist filter each

6550-A Diaphragm pump. A "dry" alternative to the standard 91003 oil-based rotary pump complete with vacuum hose, coupling kit and oil mist filter each

Options and Accessories

Including details of coating head inserts and specimen stages that are fitted as standard.

Coating head options

A range of interchangeable, plug-in style coating head inserts are available:

3200 Sputtering head insert suitable for oxidizing and non-oxidizing metals. Supplied with a 54 mm x 0.3 mm thick chromium (Cr) target as standard. For additional targets see Sputtering Targets section each

3210 Additional sputter insert for quick metal change (V E and V ES versions only). Note: this is an entire sputtering assembly. each

3230 Carbon rod evaporation head insert (for 3.05 mm Ø rods) each

3240 Carbon rod evaporation head insert (for 6.15 mm Ø rods). Note that EMS recommends 3.05 mm Ø rods as they offer greater process control and are more economical (less wastage). each

3250 Carbon fiber evaporation head insert each

3260 Metal evaporation and aperture cleaning head insert, including the ability to evaporate upwards or downwards (V E and V ES versions only). Supplied with a pack of ten tungsten filaments and a molybdenum boat. each

3270 Extended height vacuum chamber (214 mm high – the standard chamber is 127 mm high). For increased source to sample distance and for coating large specimens each

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Q150V Plus Automatic Coater (*continued*)

ORDERING INFORMATION (continued)

3280	Rotating vacuum spigot allows more convenient connection of the vacuum hose to the rear of the Q150V Plus when bench depth is limited	each
3290	Film thickness monitor (FTM) attachment. Consists of a built in chamber mounted quartz crystal oscillator (includes crystal). As sputtered or evaporated material is deposited onto the crystal, so its frequency of oscillation is modified. This 'modification' is used to measure and control the thickness of material deposited	each
3300	Spare quartz crystal for FTM.	each
3320	Full range vacuum gauge for low and high vacuum measurement (a low vacuum Pirani gauge is fitted as standard)	each
4513	Glow discharge insert to modify surface properties (e.g. hydrophobic to hydrophilic conversion) or to clean surface residues (VS and V ES only). Can be retrofitted	each
13530	Standard coating shield assembly	each
27691	Extended glass cylinder assembly, 220 mm H	each
11880	Extended height coating shield assembly	each

Specimen stages

The Q150V Plus has specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except rotary planetary stage):

3330	Rotation stage, 50 mm Ø (supplied as standard). This stage only rotates – no tilt or height adjustment	each
3340	Rotate-tilt specimen stage with adjustable tilt (up to 90 degrees) and height (37 mm-60 mm). Tilt angle can be preset. 50 mm Ø specimen platform with six stub positions for 15 mm or 6.5 mm or ⅛" pin stubs. Stage rotation speed variable between 8 and 20rpm	each
3350	Variable angle "Rotacota" rotary planetary stage with 50 mm Ø specimen platform. Has six stub positions for 15 mm or 6.5 mm or ⅛" pin stubs. Stage rotation speed variable between 8 and 20rpm	each
3360	Flat rotation specimen stage for 100 mm / 4" wafers, includes gearbox for increased coverage. Stage rotation speed variable between 8 and 20rpm	each
3370	Rotating specimen stage for glass microscope slides (up to two x 75 mm x 25 mm slides). Stage rotation speed variable between 8 and 20rpm. Includes gear box to allow optional FTM to be used	each
23850	Tilt stage sub-assembly 4"	each

For our complete selection of specimen stages, please see the **Specimen Stage Selection Guide** on page 49 ››››

Carbon supplies

3500	Carbon rods – 6.15 mm Ø x 100 mm length (unshaped) pack of 10	10/pk
3510	Carbon rods – 6.15 mm Ø x 50 mm length (shaped) pack of 10	10/pk
3520	Carbon rods – 3.05 mm Ø x 50 mm length (shaped) pack of 10	10/pk
3530	Carbon rods 3.05 mm Ø x 300 mm length (unshaped) pack of 10	10/pk
3540	Carbon fiber cord – high purity – 1m	each
3550	Carbon fiber cord – high purity – 5m	each
3560	Carbon fiber cord – standard grade – 1m	each
3570	Carbon fiber cord – standard grade – 10m	each
3580	Carbon fiber cord – standard grade – 100m	each
3590	Manual rod shaper for 6.15 mm Ø carbon rods	each
3595	Manual rod shaper for 3.05 mm Ø carbon rods	each
12097	Wedge Tool	each

Evaporation Supplies

The Q150V S Plus and Q150V ES Plus are fitted as standard with a 0.3 mm thick chromium (Cr) sputter target. Other optional targets:

73830-SP	Tungsten wire baskets – pack of 10	each
73810-SP	Molybdenum boats – pack of 10	each

Sputtering Targets

The Q150V S Plus and Q150V ES Plus are fitted as standard with a 0.3 mm thick chromium (Cr) sputter target. Other optional targets:

3410	57 mm Ø x 0.1 mm Gold	each
3410-2	57 mm Ø x 0.2 mm Gold	each
3411	57 mm Ø x 0.1 mm Gold/Palladium (80/20)	each
3411-2	57 mm Ø x 0.2 mm Gold/Palladium (80/20)	each
3412	57 mm Ø x 0.1 mm Platinum	each
3413	57 mm Ø x 0.1 mm Nickel	each
3414	57 mm Ø x 0.1 mm Silver	each
3415	57 mm Ø x 0.1 mm Palladium	each
3416	57 mm Ø x 0.1 mm Copper	each
3417	57 mm Ø x 0.3 mm Chromium	each
3418	57 mm Ø x 0.5 mm Tungsten	each
3419	57 mm Ø x 1.5 mm Chromium	each
3420	57 mm Ø x 0.2 mm Tungsten	each
3421	54 mm Ø x 1.5 mm Carbon	each
3422	57 mm Ø x 0.1 mm Aluminum	each
3423	57 mm Ø x 0.1 mm Platinum/Palladium (80/20)	each
3424	57 mm Ø x 1.5 mm Titanium	each
3425	57 mm Ø x 0.3 mm Platinum/Palladium (80/20)	each
3426	57 mm Ø x 0.3 mm Gold	each
3427	57 mm Ø x 0.3 mm Gold/Palladium (80/20)	each
3428	57 mm Ø x 0.3 mm Platinum	each
3429	57 mm Ø x 0.5 mm Titanium	each
3430	57 mm Ø x 0.1 mm Iron	each
3431	57 mm Ø x 0.3 mm Iridium	each
3432	57 mm Ø x 0.1 mm Cobalt	each
3433	57 mm Ø x 0.1 mm Tin	each
3434	57 mm Ø x 0.1 mm Molybdenum	each
3435	57 mm Ø x 0.3 mm Magnesium	each
3436	57 mm Ø x 0.1 mm Tantalum	each
3437	57 mm Ø x 3 mm Indium Tin Oxide (90/10)	each

Other consumables and spare kits

3600	Metal evaporation basket – pack of 10 (for use with metal evaporation head)	each
3610	Two-year spares kit for Q150V S Plus Includes: chromium (Cr) target, glass cylinder, carbon fiber cord, quartz crystals, O-rings	each
3620	Two-year spares kit for Q150V E Plus Includes: chromium (Cr) target, glass cylinder, carbon fiber cord, carbon fiber – fine, carbon rods 3.05 mm, quartz crystals, O-rings	each
3630	Two-year spares kit for Q150V ES Plus Includes: chromium (Cr) target, glass cylinder, carbon fiber cord, carbon fiber – fine, carbon rods 3.05 mm, quartz crystals, O-rings	each
07803	Basic Oil Mist Filter (spare)	each
13233	Rotary Pump Oil (spare), 1L	each
13235	Rotary Pump Oil (spare), 5L	each
27508	O-ring (each) 2 required per coater	each
27607	Non-seal L Gasket	each
6413	Additional Standard Glass Cylinder Assembly	each

Q150 GB Turbo-Pumped Sputter Coater/ Carbon Coater — For Glove Box

QUICK OVERVIEW

The Q150 GB is a modular glove box version of the highly successful Q150T ES bench top turbomolecular-pumped coating system - suitable for SEM, TEM and many thin-film applications. The Q150 GB comes as standard with sputtering and carbon rod evaporation inserts and a rotating specimen stage. Options include a metal evaporation insert, glow discharge, a film thickness monitor (FTM), aperture cleaning insert and special stages to suit a range of specimen types.

FEATURES

- **Modular construction for mounting in glove boxes**
- **Integral glove box pressure monitoring**
- **Remote operation from a touch screen control panel**
- **Metal sputtering and carbon evaporation in one system**
- **Fine grain sputtering for advanced high resolution FE-SEM applications**
- **High vacuum turbo pumping - allows sputtering of a wide range oxidising and non-oxidising metals**
- **High vacuum carbon rod coating - ideal for SEM and TEM carbon coating applications (carbon fiber available as an option)**
- **Advanced "anti-stick" carbon rod evaporation gun – simple operation, reproducible results**
- **Control of evaporation current profile - ensures consistently reproducible carbon films**
- **Precise thickness control using the film thickness monitor option**
- **Fully automatic touch screen control – rapid data input, simple operation**
- **Multiple, customer defined coating schedules can be stored - ideal for multi-user laboratories**
- **Automatic vacuum control which can be pre-programmed to suit the process and material – no manual needle valve to adjust**
- **"Intelligent" recognition of system - automatically detects the type of coating insert fitted**
- **Easy-to-change, drop-in style specimen stages (flat rotation stage as standard)**
- **Vacuum shut down feature - leaves the process chamber under vacuum when not in use - improved vacuum performance**
- **Thick film capabilities - up to 60 minutes sputtering time without breaking vacuum**
- **Power Factor Correction - complies with the current legislation (CE certification) - efficient use of power means reduced running costs**
- **Three-year warranty**

PRODUCT DESCRIPTION

The Q150 GB is single platform for sputtering and carbon rod evaporation. Metal evaporation using filament or boat sources is possible using an optional insert.

Depending upon user preference, the Q150 GB can be a top-of-the-range sputter coater for high resolution scanning electron microscopy (SEM), or a high vacuum carbon coater suitable for SEM and transmission electron microscopy (TEM). The flexibility of the system can be further expanded using a range of optional accessories.

The Q150 GB can rapidly sputter a wide selection of oxidising and non-oxidising metals making it ideal for many thin film applications.

The Q150 GB has an integral turbomolecular pump and additionally requires a suitable rotary pump or dry pump to "back" the turbomolecular pump (see Option and Accessories).

Flexible modular design

A modular design enables the vacuum chamber to be mounted through the base of the glove box or - when modification to the glove box floor is not possible - inside the glove box (optional feedthroughs are required).

A separate power supply housed in a rugged case is designed to be floor mounted and can be positioned conveniently beneath the glove box or bench. The touch screen user interface is housed in a robust stainless steel case and can be positioned outside of the glove box environment, if preferred.

Q150 GB mounted in a glove box

Options for glove box mounting:

Vacuum module mounted in the floor of the glove box

A cut-out is made in the floor of the glove box and the vacuum chamber fitted and sealed with the gasket supplied. External connections from the floor mounted power supply, vacuum pump and argon gas can then be made directly to the chamber.

OR

Vacuum module placed inside the glove box

The chamber assembly is placed inside the glove box and the power supply, vacuum pump and argon gas connections are made through two KF40 feedthroughs in the rear of the glove box.

Note: each Q150 GB is supplied with an accessory/configuration kit to suit either internally or externally mounted vacuum chambers. Additional kits can be designed on a case-by-case basis to allow the system to be adapted to various manufacturers' glove boxes. *Please contact EMS for more details.*

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Q150 GB Turbo-Pumped Sputter Coater/Carbon Coater — For Glove Box (continued)

Touch screen user interface

Enclosed in a stainless steel case and mounted at a convenient position outside the glove box, the touch screen allows multiple users to input and store coating protocols.

Vacuum module - including "vacuum shutdown" and glove box pressure interlock

Touch screen control module

The vacuum module houses all the working components, including the efficient 70L/s air-cooled turbomolecular pump. An automatic bleed control ensures optimum vacuum conditions during sputtering and a full range active gauge is fitted as standard to monitor the vacuum.

The Q150 GB includes "vacuum shutdown", a convenient feature which enhances vacuum performance by allowing the chamber vacuum to be maintained when the coater is not in use.

A unique feature of the Q150 GB is the integral pressure interlock switch. This independently monitors the pressure inside the glove box and shuts off the vacuum pump if the glove box atmosphere is unacceptably reduced due to a vacuum leak.

The vacuum chamber is 214mm high to allow for increased source to substrate distances required for coating large specimens. It has an external diameter of 165mm and comes with an integral implosion guard. The chamber assembly is easily removed to allow specimen exchange and chamber cleaning.

A variable speed rotary specimen stage is fitted as standard, with full height adjustment from 0 to 190mm above the base plate; other stages are available as options.

Sputter coating and carbon coating as standard, plus an option for metal evaporation

Vacuum chamber assembly

"Intelligent" Quick-change deposition inserts

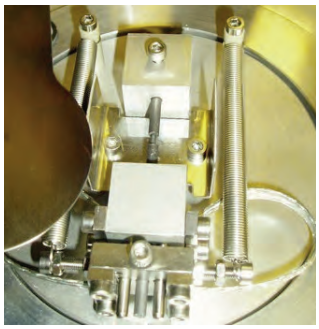
The deposition inserts can be swapped in seconds and the intelligent system logic automatically recognises which insert is in place and displays the appropriate operating settings.

High resolution sputter coating

The Q150 GB features a high-resolution sputter coater insert (3200) for oxidising and non-oxidising (noble) metals. A wide selection of sputtering targets is available, including iridium and chromium, which are highly recommended for FE-SEM applications. Please see Options and Accessories for details of available metal targets.

Carbon rod evaporation

The high vacuum carbon rod coating insert (3230) is ideal for the production of highly stable carbon films and surface replicas for transmission electron microscopy (TEM). The system uses economical 3.05mm diameter carbon rods and the advanced "anti-stick" carbon rod evaporation gun offers simple operation and reproducible results. A carbon fiber evaporation insert (3250) is available as an option (see Options and Accessories).



Carbon rod evaporation insert

Metal evaporation/ aperture cleaning option

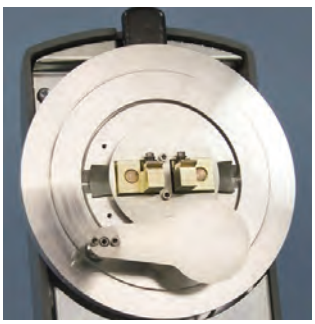
A quick change insert (3260) allows metal evaporation from tungsten baskets or molybedenum boats - ideal for thin film applications. For ease of set up in a glove box, the metal charge can be loaded into the evaporation source away from the vacuum chamber.

Each of the above configurations can be used with a range of optional accessories. See options and Accessories for details.

Metal evaporation insert option

Rapid data entry

At the operational heart of Q150 GB is a simple color touch screen, which allows even the most inexperienced or occasional operators to rapidly enter and store their own process data. To further aid ease of use a number of typical sputtering and evaporation profiles are provided.



Carbon fiber evaporation insert option

Additional Information

Options and Accessories (including details the standard specimen stage)

Coating inserts included with the Q150 GB

A range of interchangeable, plug-in style coating head inserts are available:

- Sputtering head insert (3200) is suitable for oxidising and non-oxidising metals. Supplied with a 54mm Ø x 0.3mm thick chromium target (3417) as standard. For additional targets see "Ordering Information" section.

Note: changing sputtering targets is easy, but additional sputter head inserts can be purchased for even quicker coating material change - see (3210)

- Carbon rod evaporation head insert and accessories for 3.05mm Ø rods (3230)

Optional coating inserts

Carbon rod evaporation head insert for 6.15mm Ø rods (3240). Note that EMS recommends 3.05mm Ø rods as they offer greater process control and are more economical (less wastage)

continued ››››

Q150 GB Turbo-Pumped Sputter Coater/Carbon Coater — For Glove Box (continued)

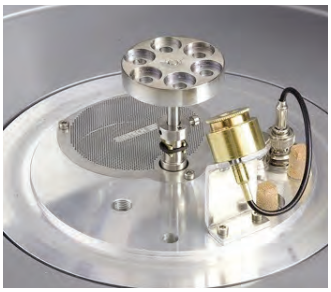
- Carbon fiber evaporation head insert (3250)
- Metal evaporation and aperture cleaning head insert (3260), using tungsten wire baskets and molybdenum boats. Includes electrode extensions to allow upwards evaporation, if required. Note: when the electrodes are fitted some stage options cannot be used

Specimen stages

The Q150 GB has specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except rotary planetary stage).

- 6800-S rotation stage, 50mm Ø (supplied as standard). This stage only rotates – no tilt or height adjustment.
- 6801 rotate-tilt stage, 50mm Ø with height adjustment (target to stage height variable between 37mm and 60mm). The tilt angle can be pre-set.
- 6803 variable angle 'Rota-Cota' rotary planetary specimen stage with 50mm Ø specimen platform with six stub positions for 15mm or 6.5mm or 1/8" pin stubs.
- 3360 flat rotation stage for 4"/100mm wafers. Includes gear box which needs to be fitted when the optional FTM is being used or for coating over the full area of the stage.
- 6804 rotation stage for glass microscope slides. Allows two 75 x 25mm slides to be coated.

Note: all rotation stages have rotation speeds that can be variable between 8 and 20 rpm.



4" wafer stage option

standard rotating specimen stage and optional film thickness monitor (FTM)

SPECIFICATIONS

Vacuum Module Size	267mm W x 490mm D x 494mm H (total height with coating head open: 767mm)
Power Supply Size	310mm W x 357mm D x 262mm H
User Interface Size	160mm W x 157mm D x 42mm .....
Weight	40kg
Packed Dimensions	725mm W x 660mm D x 787mm H (44kg)
Work Chamber	Borosilicate glass 152mm Ø (inside) x 214mm H
Safety Shield	Integral polyethylene terephthalate (PET) cylinder
Display	145mm 320 x 240 color graphic TFT (Thin Film Transistor) display
User Interface	Intuitive full graphical interface with touch screen buttons, includes features such as a log of the last 100 coatings carried out and reminders for when maintenance is due
Sputtering Target	Disc style 57mm Ø x 0.3mm thick chromium target is fitted as standard
Specimen Stage	60mm Ø rotation stage. Rotation speed 8 ~ 20 rpm
For alternative stages see Options and Acessories	
Specimen Shutter	An automatic shutter is fitted as standard to shield specimens during pre-sputtering of oxidising metals and protection during evaporation outgassing procedures

Vacuum

Turbomolecular Pump	Internally mounted, 70L/s air-cooled turbomolecular pump
Rotary Pump	$5m^3$/hr-1 two-stage rotary pump with oil mist filter (order separately: 91003)
Vacuum Measurement	An active full-range gauge is fitted
Typical Ultimate Vacuum	$5x10^{-5}$mbar
Sputter Vacuum Range	Between $5x10^{-3}$ and $5x10^{-1}$mbar

Interlocks

The Q150 GB is interlocked to prevent continuous pumping of the glove box in the event of a vacuum leak

Processes

Sputtering 0-150mA to a pre-determined thickness (with optional FTM) or by the built-in timer. The maximium sputtering time is 60 minutes (without "breaking" vacuum and with built-in rest periods)

Carbon evaporation A robust, ripple free, D.C. power supply featuring pulse evaporation ensures reproducible carbon evaporation from rod or fiber sources. Current pulse: 1-90A

Metal evaporation and aperture cleaning insert (option) For thermal evaporation of metals from filaments or molybdenum boat can be fitted. The metal evaporation head is set up for downwards evaporation, but upward evaporation can be achieved by fitting two terminal extensions (supplied). Evaporation times: up to four minutes

Services and other information

Gases	Quick-connect inlet for: argon sputtering process gas, 99.999% ("zero grade")
Nitrogen Venting Gas	(no quick-connect – uses the glove box atmosphere as the source
Electrical Supply	90-250V ~ 50/60 Hz 1400 VA including rotary pump power. 110/240V voltage selectable
Conformity	*CE conformity*: Power Factor Correction. Complies with the current legislation (CE Certification) and ensures efficient use of power which means reduced running costs

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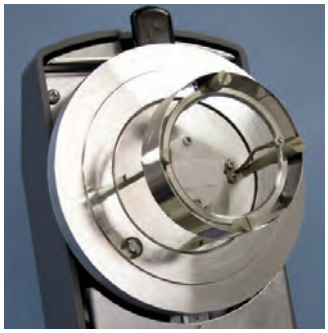
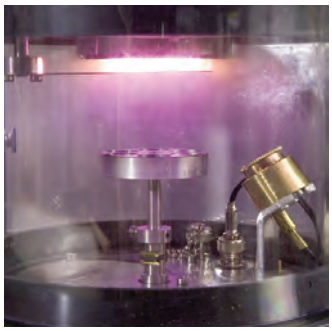
Q150 GB Turbo-Pumped Sputter Coater/Carbon Coater — For Glove Box (continued)

Other options, including FTM and glow discharge

- 3270 extended height chamber (87mm higher than the standard stage) For tall specimens.
- 3290 Film Thickness Monitor (FTM). Consists of a controller and quartz crystal oscillator built into the Q150 GB and a vacuum feed though, chamber mounted crystal holder and quartz crystal. As sputtered or evaporated material is deposited onto the crystal, so its frequency of oscillation is modified. This 'modification' is used to measure and control the thickness of material deposited.
- 4513 glow discharge insert. Used to modify surface properties (eg hydrophobic to hydrophilic conversion).



Glow discharge attachment option



During sputtering, optional film thickness monitor (FTM) shown

ORDERING INFORMATION

Q150GB	A modular, high resolution turbomolecular-pumped sputter coater/carbon rod evaporator for glove boxes. **Includes:** sputtering insert, 54mm Ø x 0.3mm chromium target, carbon rod evaporation insert, carbon rods (3.05mm Ø x 300mm) and carbon rod shaper (manual operation). Fitted with a rotation stage	each

Rotary pump requirements (needs to be ordered separately)

91003	Edwards RV3 50L/s two-stage rotary pump, with vacuum hose, coupling kit and oil mist filter	each
91003-E	Edwards RV3 50L/s two-stage rotary pump, with vacuum hose, coupling kit and oil mist filter, 220V	each
6550-A	Diaphragm pump. A "dry" alternative to the standard 91003 oil-based rotary pump complete with vacuum hose, coupling kit and oil mist filter	each

Options and accessories

3230	Carbon rod evaporation head insert (for 3.05mm Ø rods	each
3240	Carbon rod evaporation head insert (for 6.15mm Ø rods).	each

Note that EMS recommends 3.05mm Ø rods as they offer greater process control and are more economical

3250	Carbon fiber evaporation head insert	each
3260	Metal evaporation and aperture cleaning head insert, including the ability to evaporate upwards or downwards. Supplied with a pack of ten tungsten filaments and a molybdenum boat.	each
3270	Extended height vacuum chamber (214mm high – the standard chamber is 127mm high). For increased source to sample distance and for coating large specimens	each
3290	Film thickness monitor (FTM) attachment. Consists of a built in chamber mounted quartz crystal oscillator (includes crystal). As sputtered or evaporated material is deposited onto the crystal, so its frequency of oscillation is modified. This 'modification' is used to measure and control the thickness of material deposited	each
3300	Spare quartz crystal.	each
3320	Full range vacuum gauge for low and high vacuum measurement (a low vacuum Pirani gauge is fitted as standard)	each
4513	Glow discharge insert to modify surface properties (eg hydrophobic to hydrophilic conversion) or to clean surface residues	each
3600	Metal evaporation basket - pack of 10 (for use with metal evaporation head)	each
3630	Two-year spares kit for Q150 GB	each

Includes: chromium target, glass cylinder, carbon fiber cord, carbon fiber - fine, carbon rods 3.05mm, quartz crystals, O-rings each

Specimen stages

6790-S	Swinging arm stage drive, a stage drive and positioning mechanism which positions the stage under the correct target. Also provides rotation drive to the stage. Rotation Speed Max 38 rpm Min 14 rpm	each
6800-S	Rotating specimen stage for 6" (152 mm) wafers, with rotation variable between preset limits.	each
6801	Rotating 50 mm Ø specimen stage with adjustable tilt. The platform has six specimen stub positions for 15 mm, 10 mm, 6.5 mm or 1/8" pin stubs. The stage rotation speed is variable between preset limits. The target to stage height is variable between 0 mm and 42 mm for the standard stage. When used with the extended height cylinder the target to stage height would be an additional 87 mm.	each
6802	50 mm Ø variable height specimen stage with six stub positions for 15 mm, 10 mm, 6.5 mm disc stubs or 1/8" pin stubs. Stage rotation speed variable between preset limits.	each

Note: *Target to stage height is variable between 10 mm and 53 mm for the standard stage. The stage is supplied with two mounting pillars; one provides 10 mm to 32 mm target to stage distance and the other 31 mm to 53 mm. An adjustable stop is used to set the height. When used with the extended height cylinder (optional accessory) the target to stage height would be an additional 87 mm.*

6803	50 mm Ø rotary tilting stage. A rotary planetary style stage with a variable tilt angle from horizontal to 30 degrees. The platform has six positions for either 6.5 mm, 10 mm and 15 mm disc stubs or 1/8" pin stubs. Rotation speed is variable between preset limits.	each

Note: *depending upon specimen height, this stage may require the optional extended height cylinder.*

6804	A 90 mm Ø specimen stage for glass microscope slides (up to two 75 mm x 25 mm slides or a single 75 mm x 50 mm slide). The stage can alternatively accommodate up to six 1/8" SEM pin stubs. The stage rotation speed is variable between preset limits. A gear box is included to allow the optional FTM to be used.	each

For our complete selection of specimen stages, please see the **Specimen Stage Selection Guide** on page 49 ››››

Quorum

LARGE CHAMBER SPUTTER COATERS

Q300T T Plus Triple Target, Large Chamber, Turbo-Pumped Sputter Coater

QUICK OVERVIEW

The Q300T T Plus is a large chamber, turbo-pumped coating system, ideally suited for sputtering a single large diameter specimen up to 8"/200mm or multiple smaller specimens over a similar diameter. Ideal for thin-film applications and SEM/FE-SEM. It is fitted with three sputtering heads to ensure even deposition of individual large specimens or multiple specimens.

Please note it is not possible to sequentially sputter three different sputtering metals from each sputtering head. For sequential coating, see the Q300T D Plus.

KEY FEATURES

- **Ultimate vacuum of 1x10^{-6}mbar or less possible**
- **New touch and swipe capacitive screen**
- **USB port for upgrades and download of process log files**
- **Multiple-use profiles can be set up on one machine**
- **New software sorts recipes per user according to recent use**
- **16GB of memory can store more than 1000 recipes**
- **New multi-color LED visual status indicator**
- **Interchangeable stage options**
- **Three sputter heads for larger area deposition of different materials**

PRODUCT DESCRIPTION

Detachable chamber with built-in implosion guard

Removable glass chamber and easily accessible base and top plate allows for an easy cleaning process. Users can rapidly change the chamber, if necessary, to avoid cross contamination of sensitive samples. Tall chamber option is available for improved uniformity for sputtering and to hold larger substrates.

Triple Target Sputtering System

The Q300T T Plus is fitted with three individual sputtering heads to ensure even deposition of individual large specimens or multiple specimens. For economical coating of small specimens, 'single target' mode can be selected. They are ideal coaters for the preparation of large specimens for examination by SEM, FEG-SEM. To ensure even deposition, the Q300T T Plus coaters are fitted with a rotating specimen stage and three individual magnetron target assemblies, which enhance the efficiency of the process by using low voltages.

Triple sputtering head with automatic shutter open

Triple sputtering head with automatic shutter closed

Recommended applications for Q300T T Plus:

- **Wafer Inspection**
- **Multiple sample preparation for SEM**

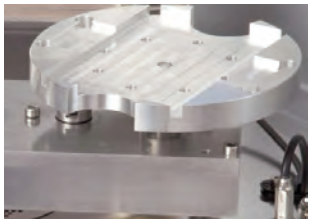
These products are for Research Use Only.

Multiple stage options

The Q300T T Plus has specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and the rotation speed is variable between pre-set limits. Flat rotation stage for 200 mm/8" and 150 mm/6" wafers (fitted as standard).

rotary planetary specimen stage (option)

Standard specimen stage



Specimen stage for glass microscope slides (option)

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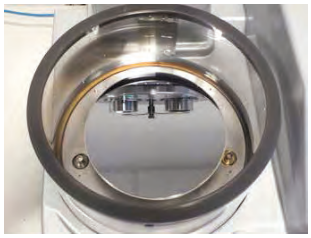
Q300T T Plus *(continued)*



Q300T T Plus has a 200 mm wafer capability

Safety

The Q300T T Plus meets key industry CE standards

- All electronic components are protected by covers
- Implosion guard prevents user injury in event of chamber failure
- Vacuum interlocks remove power from deposition sources to prevent user exposure to high voltage in event of chamber being opened
- Overheating protection shuts down power supply

Vacuum control

High vacuum turbo pumping allows sputtering of a wide range of oxidizing and non-oxidizing metals for thin film and electron microscopy applications. Automatic vacuum control which can be pre-programmed to suit the process and material, therefore removing the need for manual intervention or control.

Cool magnetron sputtering

Sputter coating is a technique widely used in various applications; it is possible to create a plasma and sputter metals with high voltage, poor vacuum and no automation. However, this is not suitable for electron microscopy applications because it can heat the sample and result in damage when the plasma interacts with the sample. The Q300T T Plus uses low temperature enhanced-plasma magnetrons optimized for the turbomolecular pump pressures, combined with low current and deposition control, which ensures your sample is protected and uniformly coated.

The Q300T T Plus uses easy-change, 57 mm diameter, disc-style targets which are designed to sputter oxidizing and noble metals. The Q300T T Plus is fitted as standard with a chromium (Cr) sputter target. Other targets options include; Au, Au/Pd, Pt/Pd, Pd, Pt, Cu, Ir, W, ITO and Al, etc.

Pulsed cleaning for aluminum sputtering

Aluminum (Al) rapidly forms an oxide layer which can be difficult to remove. The Q300T T Plus has a special recipe for Aluminum that reduces the oxide removal time and prevents excessive pre-sputtering of the target.

Film thickness monitor

The Q300T T Plus can be fitted with an optional film thickness monitor (FTM), which measures the coating thickness on a quartz crystal monitor within the chamber, in order to control the coating thickness of material deposited on to the sample.

Film thickness monitor option

New user interface has been thoroughly updated:

- **Dual-core ARM processor for a fast, responsive display**
- **Capacitive touch screen is more sensitive for ease of use**
- **User interface software has been extensively revised, using a modern smartphone-style interface**
- **Comprehensive context-sensitive help**
- **USB interface allows easy software updates and backing up/copying of recipe files to USB stick**
- **Process log files can be exported via USB port in .csv format for analysis in Excel or similar. Log files include date, time and process parameters.**
- **16GB of flash memory can store more than 1000 recipes**
- **Quick and easy creation of process sequences with a simple copy, drag and drop operation**

Allows multiple users to input and store coating recipes.

New feature to sort recipes per user according to recent use.

System prompts user to confirm target material and it then automatically selects appropriate parameters for that material

Intuitive software allows the most inexperienced or occasional operator to rapidly enter and store their own process data. For convenience a number of typical sputtering and carbon coating profiles are already stored but also allows the user to create their own.

Software detects failure to achieve vacuum in a set period of time and shuts down the process in case of vacuum leak, which ensures pump protection from overheating.

continued ››››

LARGE CHAMBER SPUTTER COATERS

Q300T T Plus *(continued)*

SPECIFICATIONS

Instrument Case	590mm W x 535mm D x 420mm H (maximum height during the opening of the coating head: 772mm)
Weight	36 kg (packed: 59kg)
Packed Dimensions	730 mm W x 630 mm D x 690 mm H
Work Chamber	Borosilicate glass with integral PET implosion guard Size 300 mm outside diameter x 127 mm High
Display	115.5mm W x 86.4mm H (active area), 640 RGB x 480 (display format), capacitive touch color display
User Interface	Full graphical interface with touch screen buttons, includes features such as a log of the last 1000 coatings and reminders for when maintenance is due

Specimen Stage

A flat rotation stage for 6"(150mm) and 8" (200mm) wafers is fitted as standard.

A rotating/tilt stage and the 'rota cota' rotary tilt stage are also options

Vacuum

Rotary Pump	4 m^3/hr, two stage rotary pump with oil mist filter for the 300T T Plus
Turbo Pump	Internally mounted 70L/sec air cooled
Vacuum Measurement	Pirani gauge as standard, full range gauge available as an option
Ultimate Vacuum	5 x 10^{-5}mbar*
Sputter Vacuum Range	5x10^{-2} to 5x10^{-3} mbar*

*Typical ultimate vacuum of the pumping system in a clean instrument after pre-pumping and venting with dry nitrogen gas

Processes

Sputter Deposition Current	Single target: 1 - 140mA All targets: 60 - 420mA
Visual Status Indicator	A large status multi-color indicator light provides a visual indication of the state of the equipment, allowing users to easily identify the status of a process at distance.

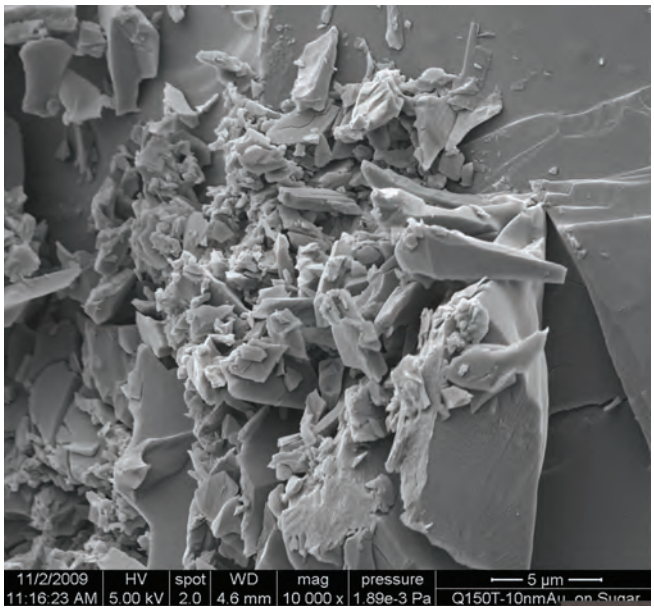
The indicator LED shows the following states:

- Initialization
- Process running
- Idle
- Coating in progress
- Process completed
- Process ended in fault condition

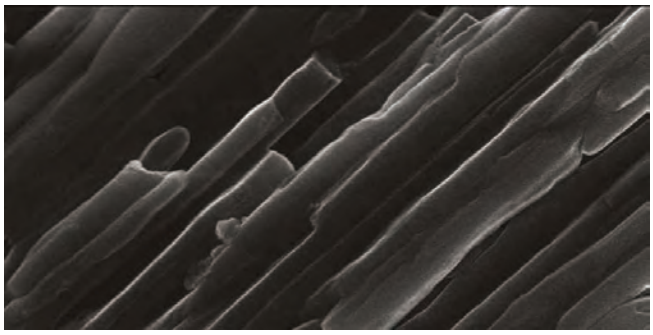
Audio indication also sounds on completion of the process.

Services

Gases	process gas argon, 99.999% Nominal 5 psi



10nm Au on Sugar



Sea mineral sample 3nm Cr, Mag x 25k

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Q300T T Plus *(continued)*

ORDERING INFORMATION

Q300T T Plus

	Triple Target, Large Chamber, Turbo-Pumped Sputter Coater, fitted with three sputtering heads to ensure even metal deposition. Includes three 57 mm Ø x 0.3 mm chromium (Cr) sputter targets. A flat rotation stage for 200 mm/8" and 150 mm/6" wafers is fitted as standard.	each

Rotary pump requirements (needs to be ordered separately)

91003	Edwards RV3 50L/s two-stage rotary pump, with vacuum hose, coupling kit and oil mist filter	each
6548	XDS 5 Scroll Pump	each
6550-A	Diaphragm pump. A "dry" alternative to the standard 91003 oil-based rotary pump complete with vacuum hose, coupling kit and oil mist filter	each

Specimen stages

6551	Rotating 50 mm Ø specimen stage with adjustable tilt. The platform has six specimen stub positions for 15 mm, 10 mm, 6.5 mm or 1/8" pin stubs. Stage rotation speed is variable between preset limits. No rotation when in single target mode. Target to stage height is variable between zero and 42 mm for the standard stage. When used with the extended height cylinder (optional accessory) the target to stage height would be an additional 87 mm	each
6552	50 mm Ø variable height specimen stage with six stub positions for 15 mm, 10 mm, 6.5 mm disc stubs or 1/8" pin stubs. Stage rotation speed variable between preset limits	each
6553	50 mm Ø rotary tilting stage. A rotary planetary style stage with variable tilt angle from horizontal to 30 degrees. The platform has six positions for either, 6.5 mm, 10 mm, 15 mm disc stubs, or 1/8" pin stubs. Rotation speed is variable between preset limits. Note: depending upon specimen height, this stage may require the optional extended height cylinder	each
6554	A 90 mm Ø specimen stage for glass microscope slides (up to two 75 mm x 25 mm slides or a single 75 mm x 50 mm slide). The stage can alternatively accommodate up to six " SEM pins stub. Stage rotation speed is variable between preset limits. Includes gear box to allow optional FTM to be used.	each
6547	6" Wafer Specimen Stage: A flat adjustable stage capable of accepting 6" or 101.6 mm wafers	each
6549	A 4" 102 mm flat drop-in-wafer stage which accepts 2", 3", and 4" wafers	each

For our complete selection of specimen stages, please see the **Specimen Stage Selection Guide** on page 49 ››››

Options and Accessories

6555	Film thickness monitor (FTM) attachment. Including oscillator, feed-through, quartz crystal holder and one quartz crystal	each
6556	Spare quartz crystal	each
6557	Extended height vacuum chamber (214 mm in height – the standard chamber is 127 mm high). For increased source to specimen distance and for coating large specimens	each
6558	A lockable emergency stop (e-stop) switch which can be mounted on top of the system in a position easily accessible for the operator. It is provided with a key to release the knob after activation. Note: the addition of the e-stop does not inhibit or replace the normal On/Off switch function. The e-stop can be retrofitted to existing systems	each
6559	Coating shields. Shields can be fitted to protect large surfaces from coating deposition – easily removable for ease of cleaning	each
6560-A	Vacuum spigot allows more convenient connection of the vacuum hose to the rear of the Q300T T Plus when bench depth is limited	each
6561	Full range, active vacuum gauge capable of measurement over the range of 1000 mbar to 5 x 10^{-9} mbar. Typical ultimate vacuum of system is 5 x 10-5 mbar. Note: gauge must be factory fitted	each
6562	Spares kit, including: spare standard glass cylinder, three 3417 chromium (Cr) sputtering targets, vacuum tubing with coupling insert, argon gas tubing, three sputter head magnets, rotary pump oil mist filter and fuses	each

Sputter targets

Note: The Q300T T Plus is fitted as standard with three 0.3 mm chromium (Cr) targets (3417). Other optional targets are available (three required):

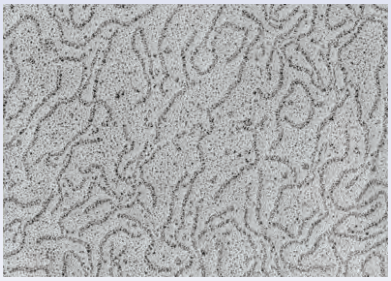
3410	57mm Ø x 0.1mm Gold	each
3411	57mm Ø x 0.1mm Gold/Palladium (80/20)	each
3412	57mm Ø x 0.1mm Platinum	each
3413	57mm Ø x 0.1mm Nickel	each
3414	57mm Ø x 0.1mm Silver	each
3415	57mm Ø x 0.1mm Palladium	each
3416	57mm Ø x 0.1mm Copper	each
3417	57mm Ø x 0.3mm Chromium	each
3418	57mm Ø x 0.5mm Tungsten	each
3419	57mm Ø x 1.5mm Chromium	each
3420	57mm Ø x 0.2mm Tungsten	each
3421	54mm Ø x 1.5mm Carbon	each
3422	57mm Ø x 0.1mm Aluminium	each
3423	57mm Ø x 0.1mm Platinum/Palladium (80/20)	each
3424	57mm Ø x 1.5mm Titanium	each
3425	57mm Ø x 0.3mm Platinum/Palladium (80/20)	each
3426	57mm Ø x 0.3mm Gold	each
3427	57mm Ø x 0.3mm Gold/Palladium (80/20)	each
3428	57mm Ø x 0.3mm Platinum	each
3429	57mm Ø x 0.5mm Titanium	each
3430	57mm Ø x 0.1mm Ironeach	each
3431	57mm Ø x 0.3mm Iridium	each
3432	57mm Ø x 0.1mm Cobalt	each
3433	57mm Ø x 0.1mm Tin	each
3434	57mm Ø x 0.1mm Molybdenum	each
3435	57mm Ø x 0.3mm Magnesium	each
3435-5	57mm Ø x 0.5mm Magnesium	each
3436	57mm Ø x 0.1mm Tantalum	each
3437	57mm Ø x 3mm Indium Tin Oxide (90/10)	each

What is...
Carbon Evaporation?

The use of Carbon Evaporation is well known in Electron Microscopy for support films and replicas in TEM, and X-Ray Microanalysis and conducting coatings in SEM.

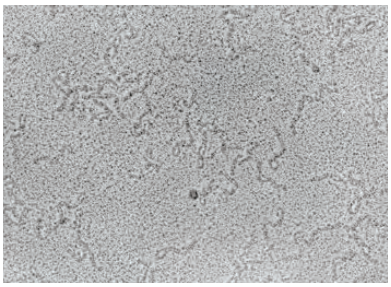
The films are continuous for thicknesses of 2nm (or 20 Angstroms) or more, and free of significant structure.

The most common form of deposition is from resistance heated carbon, or graphite rods, spectrographically pure. The rods are shaped to achieve a high current density at the point of contact of the rods with sufficient temperature being generated to cause the evaporation. At this point, the appearance being that of small, bright, glowing particles of carbon. To achieve the required vacuum condition of 1x 10^{-4} mbar, or better, requires the use of Diffusion or



DNA strands

Pseudomonas fluorescens



Spectrin molecules

Q300T ES Large Chamber Turbo-Pumped Evaporator/Sputter Coater

QUICK OVERVIEW

The Q300T ES is a large chamber, turbomolecular-pumped coating system ideally suited to metal evaporation onto large diameter specimens up to 6"/152 mm (for example a wafer) or smaller multiple specimens. The Q300T ES also comes with interchangeable sputtering and carbon evaporation inserts to allow a coating radius of up to 4"/102 mm.

KEY FEATURES

- **Metal evaporation, carbon evaporation and metal sputtering – in one space saving design**
- **Larger area metal evaporation – up to 6"/152 mm**
- **Larger area sputter/carbon coating – up to 4"/102 mm diameter**
- **High vacuum sputtering – oxidizing and non-oxidizing (noble) metals: suitable for SEM, high resolution FE-SEM and many thin film applications**
- **High vacuum carbon coater – ideal for SEM and TEM carbon coating**
- **Controlled, ramped carbon rod evaporation – precise control of carbon thickness. Non-sparking process gives superior quality films**
- **Up to 60 minutes sputtering time – thick films capabilities**
- **Three-Year Warranty**

PRODUCT DESCRIPTION

The Q300T ES is a large chamber, turbomolecular-pumped coating system ideally suited to metal evaporation onto large diameter specimens up to 6"/152 mm (for example a wafer) or smaller multiple specimens. The Q300T ES also comes with interchangeable sputtering and carbon evaporation inserts to allow a coating radius of up to 4"/102 mm.

The sputter coating insert will deposit both oxidizing metals, e.g. chromium and Aluminum and non-oxidizing (noble) metals such as gold and platinum. A chromium (Cr) target is fitted as standard.

The Q300T ES has a full range of optional accessories, including specimen stages and film thickness measurement which means the system can be tailored to the precise requirements of the user.

Thermal evaporation of metals

The Q300T ES allows controlled thermal evaporation of metals onto large substrates (up to 6"/152 mm). For many evaporative processes, tungsten filaments supplied with the system are used. However, some metals require the use of a molybdenum boat, which can also be used for heat-cleaning SEM and TEM apertures.

The evaporation head is normally positioned for downwards evaporation, but for small specimens upward evaporation is possible using two terminal extensions supplied with the system.

Thermal evaporation insert

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Q300T ES Large Chamber Turbo-Pumped Evaporator/Sputter Coater (continued)

Sputter coating for high resolution FE-SEM and thin film applications

The advance design of sputtering head, power supply and system control allows sputtering of both oxidizing and non-oxidizing (noble) metals for thin film applications and for scanning electron microscopy (SEM) coating. The full range of target materials available is extensive and detailed in the Ordering Information section.

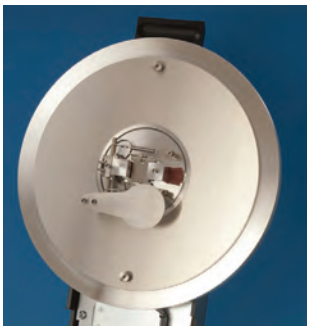
For sputtering applications where thick films are required, then the Q300T ES can operate for up to 60 minutes.

Sputtering insert

High vacuum carbon evaporation for SEM and TEM

The carbon rod evaporation insert allows high quality carbon films to be deposited over a radius of up to 4"/102 mm.

The Q300T ES uses controlled ramped carbon rod evaporation to ensure optimum control of the process and quality of results (with or without the optional film thickness measurement system). In addition the quality of the resulting carbon films is enhanced by the eradication of "sparking" which is a common problem with less advanced coating systems.

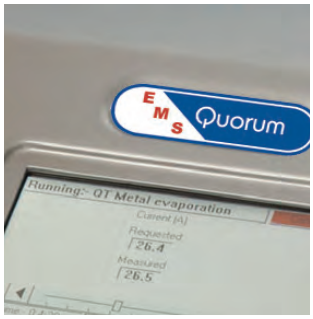


Carbon rod evaporation insert

High vacuum turbomolecular pumping and vacuum measurement

The Q300T ES is fitted with an internally mounted 70 L/s turbomolecular pump backed by a 5m3 hr two-stage rotary pump (order separately). A full range vacuum measurement gauge is included. Typically ultimate vacuums of around 5 x 10-5 mbar can be expected in a clean system after pre-pumping with dry nitrogen gas. For details of pumping options, see Ordering Information.

Touch-screen control and stored recipes



At the operational heart of the Q300T ES is a color touch screen which allows users to rapidly enter and store their own process data. A range of typical sputtering and evaporation profiles are pre-installed. The Q300T ES uses an 'Intelligent' recognition system that automatically detects the type of coating insert fitted and "becomes" either an evaporator, carbon coater or sputter coater.

Vacuum chamber and specimen stages

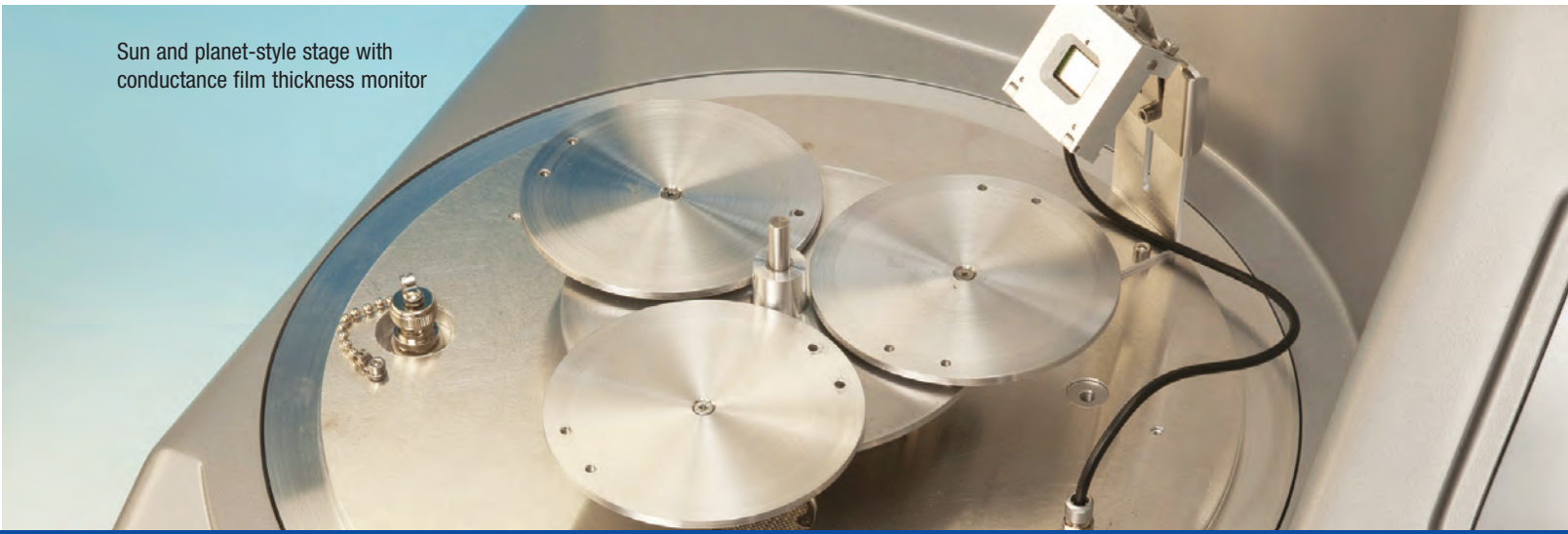
The Q300T ES is presented in a custom-molded, one-piece case allowing easy servicing access. The case houses all the working components and includes an automatic bleed control that ensures optimum vacuum conditions during sputtering.

The vacuum chamber has an internal diameter of 283 mm/11" and comes with an integral safety guard. The vacuum shutdown option enhances vacuum performance by allowing the chamber vacuum to be maintained when the coater is not in use.

A variable speed rotary specimen stage is fitted as standard and accommodates specimens up to 4"/100 mm in diameter. For details of other stages, see Ordering Information.

Pumping Requirement

A suitable rotary vacuum pump is required. The Pfeiffer DUO 6 5m3/hr two-stage rotary vacuum pump (91003) is ideal for this purpose. Dry pumping alternatives are also available. See Ordering Information for more details.



Sun and planet-style stage with conductance film thickness monitor

Terms and Techniques

Magnetron Sputtering

Magnetron sputtering using a crossed-field electromagnetic configuration keeps the ejected secondary electrons near the cathode (target) surface and in a closed path on the surface. This allows a dense plasma to be established near the sputter target surface. The ions that are accelerated from the plasma do not sustain energy loss by collision before they bombard the sputter target.

For electron microscopy (EM) specimen coating, the magnetron sputtering head design ensures that minimal heat energy (electrons) reach the specimen surface. This is important as it reduces heat damage to specimen and is a significant factor in ensuring the grain size within the sputtered film is optimally small essential for high resolution field emission scanning electron microscopy (FE-SEM).

Film Thickness Monitor (FTM)

A film thickness monitor can be used to monitor and control the thickness of sputtered and evaporated metal films. A gold-coated quartz crystal is mounted in the vacuum chamber of the coating system, ideally close to the specimen or substrate. The quartz crystal is made to oscillate at a defined frequency, using an externally-mounted oscillator. As metal is deposited on the quartz crystal, the frequency of oscillation alters and the change is converted to a digital (eg LED) display on the monitoring unit.

Film thickness monitors are available for use with most of our coating systems and cryo preparation systems.

Turbomolecular Pump

A turbomolecular (turbo) pump is a type of vacuum pump used to obtain and maintain high vacuum. The principle of operation is that gas molecules within a vacuum chamber can be given momentum in a desired direction by repeated collisions with a rapidly spinning turbine rotor. The rotor hits gas molecules from the inlet of the pump towards the exhaust in order to create or maintain a vacuum. A turbo pump normally works in tandem with a low-vacuum pump, such as a rotary vacuum pump, which is used to rough pump the vacuum system (eg sputter coater or vacuum evaporator) during initial pump-down period, and to back the turbo pump (ie remove gases from the back of the pump) during high-vacuum operation.

Iridium Sputter Coating

Sputtering with iridium (Ir) is increasingly popular for high resolution sputter coating of field emission scanning electron microscopy (FE-SEM) specimens, because iridium will produce films with very small grain structure and it is a non-oxidising metal. It is increasingly preferred to chromium (Cr) as a coating material for FE-SEM. Iridium-coated specimens can be stored at atmospheric pressure, compared to chromium - which readily oxidises on contact with air.

Q300T ES *(continued)*

Options and Accessories

Specimen stages and holders

The Q300T ES has additional specimen stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except for the rotary planetary stage). Rotation speeds are variable between preset limits.

- Rotation stage for 4" wafers (supplied with system)
- Rotation stage for 6" wafers
- Flat rotation stage for SEM specimen stubs
- Rotation stage with preset tilt for SEM specimen stubs
- Rotate-tilt (rotary-planetary style) stage
- Rotation stage for glass microscope slides
- Eight-place stage for 25 mm or 30 mm embedded polished specimens
- "Sun and planets" style rotary stage; Three platforms, each 92 mm Ø
- Microscope coverslip stage for nine 20 mm x 20 mm coverslips
- TEM grid holder

Other options

- Extended height chamber (supplied with the Q300T ES)
- Standard height chamber
- Film thickness monitor (FTM)
- Conductance film monitor (CFM)

SPECIFICATIONS

Dimensions	585 mm W x 470 mm D x 410 mm H, total height with coating head open is 710 mm
Weight	37 kg
Packed dimensions	725 mm W x 660 mm D x 680 mm H (45 kg)
Work chamber	Borosilicate glass 283 mm ID x 215 mm H
User interface	Intuitive full graphical interface with touch-screen menus and buttons
Sputter target	Disc-style 57 mm Ø with thickness depending upon the target fitted. One 0.3 mm thick chromium (Cr) target (3417) is fitted as standard
Pumping	Internally-mounted 70 L/s turbomolecular pump
Rotary pump	5m^3 hr two-stage rotary pump with oil mist filter. (Order separately: see 91003). Dry pumping option available.
Typical ultimate vacuum	5 x 10^{-5} mbar in a clean system after pre-pumping with dry nitrogen gas. Measurement using a full range Penning gauge
Specimen stage	Stage for 4" wafer supplied as standard. For alternative stages, see Ordering Information
Services and other Information	
Gases	Argon sputtering process gas, 99.999%. Nitrogen venting gas (optional)
Electrical supply	90-250 V 50/60 Hz 1,400 VA including rotary pump, 110/240 V voltage selectable

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Q300T ES *(continued)*

ORDERING INFORMATION

Q300T ES	Turbomolecular-pumped sputtering, metal evaporation and carbon coating system with 300 mm Ø x 215 H mm work chamber. Consists of high quick release sputter insert with a 3417 57 mm Ø x 0.3 mm chromium (Cr) target. High vacuum carbon rod evaporation coater and metal evaporation head. Coating inserts are interchangeable. A 4" wafer stage supplied as standard. Integrated full range gauge assembly for high vacuum measurement.	each

Rotary pump requirements – order separately

Pumps supplied with vacuum hose and coupling kit

91003	5m³ hr two-stage Pfeiffer Duo 6 rotary pump with oil mist filter	each
6550-A	Diaphragm pump. A "dry" alternative to the standard 91003 oil-based rotary pump	each
6548	Edwards nXDS6i scroll pump. Lubricant-free and hermetically sealed, giving totally clean and dry vacuum to prevent cross-contamination	each

Options and Accessories – specimen stages

Rotation stages rotation speed variable between preset limits

6551	Rotating 50 mm Ø specimen stage with adjustable tilt. The platform has six specimen stub positions for 15 mm, 10 mm, 6.5 mm or " pin stubs. Stage rotation speed is variable between preset limits. No rotation when in single target mode. Target to stage height is variable between zero and 42 mm for the standard stage. When used with the extended height cylinder (optional accessory 10596) the target to stage height would be an additional 87 mm	each
6552	50 mm Ø variable height specimen stage with six stub positions for 15 mm, 10 mm, 6.5 mm disc stubs or 1/8" pin stubs. Stage rotation speed variable between preset limits	each
6553	50 mm Ø rotary tilting stage. A rotary planetary style stage with variable tilt angle from horizontal to 30 degrees. The platform has six positions for either, 6.5 mm, 10 mm, 15 mm disc stubs, or " pin stubs. Rotation speed is variable between preset limits. Note: depending upon specimen height, this stage may require the optional extended height cylinder	each
6554	A 90 mm Ø specimen stage for glass microscope slides (up to two 75 mm x 25 mm slides or a single 75 mm x 50 mm slide). The stage can alternatively accommodate up to six 1/8" SEM pins stub. Stage rotation speed is variable between preset limits. Includes gear box to allow optional FTM to be used.	each
6547-SP	Rotation stage for 4" or 6" wafers	each
6513	Sun and planet-style rotation stage (each stage is 92 mm Ø)	each
6549	Eight-place stage for 25 or 30 mm embedded, polished specimens	each
6512	Nine-place TEM grid holder	each

For our complete selection of specimen stages, please see the **Specimen Stage Selection Guide** on page 49 ››››

Other Options and Accessories

6555	Film thickness monitor (FTM) attachment. Including oscillator, feed-through, quartz crystal holder and one quartz crystal	each
6556	Spare quartz crystal for FTM	each
6555-SP	Conductance film monitor (CFM) attachment including housing, feedthrough, glass slides and cable. A factory fitted only option for monitoring sheet resistance of evaporated films allowing termination at a known resistance	each
6557	Extended height glass cylinder, 300 mm Ø x 215 mm high (supplied as standard)	each
6557-10	Standard height glass cylinder, 300 mm Ø x 127 mm high	each
6558	A lockable emergency stop (e-stop) switch mounted on top of the system for easy access	each
6559	Coating shields. Can be fitted to protect large surfaces in the chamber from coating deposition – easily removable for ease of cleaning	each
6560-A	Vacuum spigot allows a more convenient connection of the vacuum hose to the rear of the Q300T ES when bench depth is limited	each

Evaporation Supplies

73830-SP	Tungsten wire baskets – pack of 10	each
73810-SP	Molybdenum boats – pack of 10	each

Sputter targets

The Q300T ES is fitted as standard with one 57 mm x 0.3 mm chromium (Cr) target. Other optional targets are available:

3410	57mm Ø x 0.1mm Gold	each
4524	57mm Ø x 0.2 mm Gold	each
3411	57mm Ø x 0.1mm Gold/Palladium (80/20)	each
4527	57mm Ø x 0.2mm Gold/palladium (80/20)	each
3412	57mm Ø x 0.1mm Platinum	each
4530	57mm Ø x 0.2mm Platinum	each
3413	57mm Ø x 0.1mm Nickel	each
3414	57mm Ø x 0.1mm Silver	each
3415	57mm Ø x 0.1mm Palladium	each
3416	57mm Ø x 0.1mm Copper	each
3538	57mm Ø x 1.0mm Aluminum	each
3421	57mm Ø x 1.5mm Carbon	each
3417	57mm Ø x 0.3mm Chromium	each
3418	57mm Ø x 0.5mm Tungsten	each
3419	57mm Ø x 1.5mm Chromium	each
3420	57mm Ø x 0.2mm Tungsten	each
3424	57mm Ø x 1.5mm Titanium	each
3425	57mm Ø x 0.3mm Platinum/Palladium (80/20)	each
3426	57mm Ø x 0.3mm Gold	each
3427	57mm Ø x 0.3mm Gold/Palladium (80/20)	each
3428	57mm Ø x 0.3mm Platinum	each
3429	57mm Ø x 0.5mm Titanium	each
3430	57mm Ø x 0.1mm Ironeach	each
3431	57mm Ø x 0.3mm Iridium	each
3432	57mm Ø x 0.1mm Cobalt	each
3433	57mm Ø x 0.1mm Tin	each
3434	57mm Ø x 0.1mm Molybdenum	each
3436	57mm Ø x 0.1mm Tantalum	each
3437	57mm Ø x 3mm Indium Tin Oxide (90/10)	each
3539	57mm Ø x 0.5mm Magnesium	each

Q300T D Plus Dual Target Sequential Sputtering System

QUICK OVERVIEW

Suitable for multi-layer sequential sputtering of two materials, the Q300T D Plus has two independent sputtering heads, which allows sequential sputtering of two metals without the need to break vacuum. The system is fully automated with user defined recipes controlling the pumping sequence, time, number of sputter cycles, and the current used during the process. Unlimited layers of varying thickness from two target materials can be sputtered sequentially by cycling between both targets. When not in use the targets are shuttered for protection from contamination.

KEY FEATURES

- **Capable of achieving vacuum of 5 x 10^{-5} mbar**
- **New touch and swipe capacitive screen**
- **USB port for upgrades and download of process log files**
- **Multiple-user profiles can be set up on one machine**
- **New software sorts recipes per user according to recent use**
- **16GB of memory can store more than 1000 recipes**
- **New multi-color LED visual status indicator**
- **Interchangeable stage options**
- **Three sputter heads for large area deposition of different materials**
- **Single head selection for small samples**

PRODUCT DESCRIPTION

Improved Interface

- Dual-core ARM processor for a fast, responsive display
- Capacitive touch screen is more sensitive for ease of use
- User interface software has been extensively revised, using a modern smartphone-style interface
- Comprehensive context-sensitive help
- USB interface allows easy software updates and backing up/copying of recipe files to USB stick
- Process log files can be exported via USB port in .csv format for analysis in Excel or similar. Log files include date, time and process parameters.
- 16GB of flash memory can store more than 1000 recipes
- Quick and easy creation of process sequences with a simple copy, drag and drop operation

Allows multiple users to input and store coating recipes. New feature to sort recipes per user according to recent use.

System prompts user to confirm target material and it then automatically selects appropriate parameters for that material.

Intuitive software allows the most inexperienced or occasional operator to rapidly enter and store their own process data. For convenience a number of typical sputtering and carbon coating profiles are already stored but also allows the user to create their own.

Software detects failure to achieve vacuum in a set period of time and shuts down the process in case of vacuum leak, which ensures pump protection from overheating.

Recommended applications for Q300T D Plus:

- **Ideal for multi-layer coating**
- **Adhesion studies**

These products are for Research Use Only.

Detachable chamber with built-in implosion guard

Removable glass chamber and easily accessible base and top plate allows for an easy cleaning process. Users can rapidly change the chamber, if necessary, to avoid cross contamination of sensitive samples. Tall chamber option is available for improved uniformity for sputtering and to hold larger substrates.

Dual head sputtering – for sequential sputtering

The Q300T D Plus has two independent sputtering heads to allow sequential sputtering of two different metals without the need to 'break' vacuum, for example, a thin 'seeding' layer of chromium (Cr) followed by deposition of gold (Au). An automatic shutter mechanism enables cleaning of oxidizing sputter targets and protects the second target and substrate during coatings. For single metal applications one target can be selected.

Multiple stage options

The Q300T D Plus has substrate stages to meet most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except the rotary planetary stage). A swinging arm stage drive is supplied as standard, which is a stage drive and positioning mechanism that positions the stage under the correct target. Rotation speed is variable between 14-38 rpm.

In addition a flat, adjustable stage capable of accepting 4" (101.6 mm) wafers is supplied as standard with the Q300T D Plus.

As an accessory, a 6" wafer stage is available, which is a flat adjustable stage capable of accepting 6" or 150 mm wafers. The stage includes two masks for improving uniformity of coating.

continued ››››

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Q300T D Plus *(continued)*

Rotation stage – 50 mm Ø. This stage only rotates and has no tilt or height adjustment.

Rotate-tilt stage – 50 mm Ø. With height adjustment (target to stage height variable between 30-80 mm). The tilt angle can be pre-set (horizontal to 30°).

Rotation stage for glass slides – 25 mm x 76 mm

Safety

The Q300T D Plus meets key industry CE standards

- All electronic components are protected by covers
- Implosion guard prevents user injury in event of chamber failure
- Vacuum interlocks remove power from deposition sources to prevent user exposure to high voltage in event of chamber being opened
- Overheating protection shuts down power supply

Vacuum control

High vacuum turbo pumping allows sputtering of a wide range of oxidizing and non-oxidizing metals for thin film and electron microscopy applications. Automatic vacuum control which can be pre-programmed to suit the process and material, therefore removing the need for manual intervention or control.

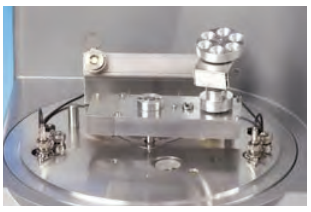
Cool magnetron sputtering

Sputter coating is a technique widely used in various applications; it is possible to create a plasma and sputter metals with high voltage, poor vacuum and no automation. However, this is not suitable for some applications because it can heat the substrate and result in damage when the plasma interacts with the substrate. The Q300T D Plus uses low temperature enhanced-plasma magnetrons optimized for the turbomolecular pump pressures, combined with low current and deposition control, which ensures your substrate is protected and uniformly coated.

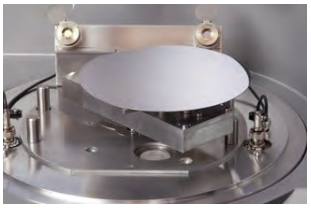
The Q300T D Plus uses easy-change, 57 mm diameter, disc-style targets which are designed to sputter oxidizing and noble metals. It is fitted with gold (Au) and chromium (Cr) sputter targets as standard.

continued ››››

Dual sputtering heads and automatic shutter



Rotary planetary stage and dual-channel film thickness monitor - both Q300T D Plus option



Standard rotating specimen stage with 4 wafer and optional dual-channel film thickness monitor

Optional specimen stage for glass microscope slides and dual-channel film thickness monitor

New user interface has been thoroughly updated:

- **Dual-core ARM processor for a fast, responsive display**
- **Capacitive touch screen is more sensitive for ease of use**
- **User interface software has been extensively revised, using a modern smartphone-style interface**
- **Comprehensive context-sensitive help**
- **USB interface allows easy software updates and backing up/copying of recipe files to USB stick**
- **Process log files can be exported via USB port in .csv format for analysis in Excel or similar. Log files include date, time and process parameters.**
- **16GB of flash memory can store more than 1000 recipes**
- **Quick and easy creation of process sequences with a simple copy, drag and drop operation**

Allows multiple users to input and store coating recipes.

New feature to sort recipes per user according to recent use.

System prompts user to confirm target material and it then automatically selects appropriate parameters for that material

Intuitive software allows the most inexperienced or occasional operator to rapidly enter and store their own process data. For convenience a number of typical sputtering and carbon coating profiles are already stored but also allows the user to create their own.

Software detects failure to achieve vacuum in a set period of time and shuts down the process in case of vacuum leak, which ensures pump protection from overheating.

Quorum

LARGE CHAMBER SPUTTER COATERS

Q300T D Plus *(continued)*

SPECIFICATIONS

Instrument Case	590mm W x 535mm D x 420mm H (maximum height during the opening of the coating head: 772mm)
Weight	36 kg (packed: 59kg)
Packed Dimensions	730 mm W x 630 mm D x 690 mm H
Work Chamber	Borosilicate glass with integral PET implosion guard Size 300 mm outside diameter x 127 mm High
Display	115.5mm W x 86.4mm H (active area), 640 RGB x 480 (display format), capacitive touch color display
User Interface	Full graphical interface with touch screen buttons, includes features such as a log of the last 1000 coatings and reminders for when maintenance is due

Specimen Stage

A flat adjustable stage capable of accepting either 4" or 6" wafers is mounted on a swinging arm stage, which rotates the stage under the targets to optimise coating. Rotation speed is variable from 14rpm to 38rpm

Vacuum

Rotary Pump	50L/min two stage rotary pump with oil mist filter
Turbo Pump	Internally mounted 70L/sec air cooled
Vacuum Measurement	Pirani gauge as standard, full range gauge available as an option
Ultimate Vacuum	5 x 10^{-5}mbar*
Sputter Vacuum Range	5x10^{-3} to 5x10^{-2} mbar*

*Typical ultimate vacuum of the pumping system in a clean instrument after pre-pumping and venting with dry nitrogen gas

Processes

Sputter Deposition Current	150 mA
Visual Status Indicator	A large status multi-color indicator light provides a visual indication of the state of the equipment, allowing users to easily identify the status of a process at distance.

The indicator LED shows the following states:
• Initialization • Process running • Idle • Coating in progress
• Process completed • Process ended in fault condition
Audio indication also sounds on completion of the process.

Services

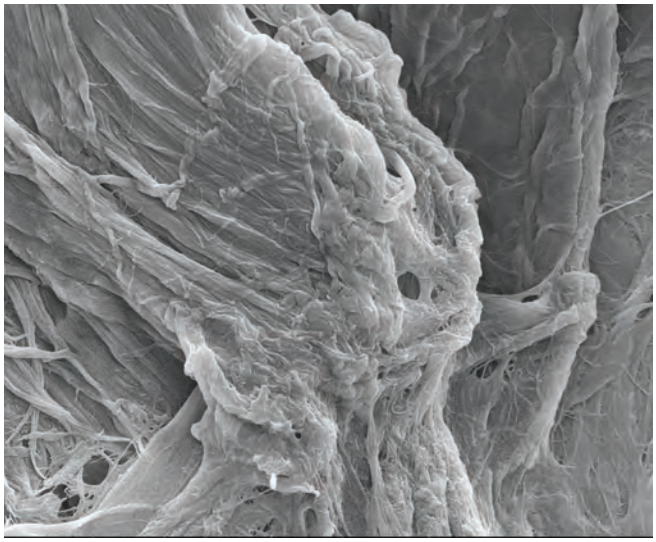
Gases	process gas argon, 99.999% Nominal 5psi
Vent Gas	Nitrogen (optional). Nominal 5psi

Pulsed cleaning for Aluminum sputtering

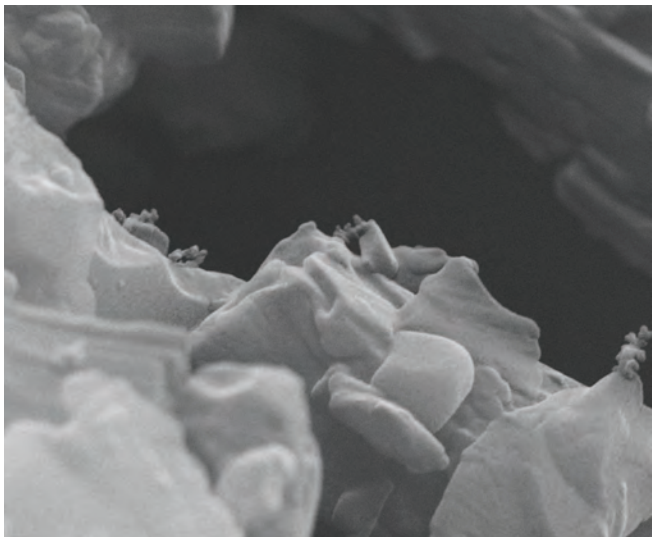
Aluminum (Al) rapidly forms an oxide layer which can be difficult to remove. The Q300T D Plus has a special recipe for Aluminum that reduces the oxide removal time and prevents excessive pre-sputtering of the target.

Film thickness monitor

The Q300T D Plus can be fitted with an optional dual film thickness monitor (FTM), which measures the coating thickness on two quartz crystal monitors located within the chamber. The thickness measured on the monitor can be correlated to the thickness on the substrate using a mathematical formula built into the software; this allows the user to control the thickness of material deposited on to the substrate. For example, the Q300T D Plus can automatically terminate a coating profile when the required thickness has been achieved. Alternatively, the process can be terminated by time.



10nm Au on Filter Paper



10nm Au on Salbutamol

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Q300T D Plus *(continued)*

ORDERING INFORMATION

Q300T D Plus		
	Dual Target Sequential Sputtering System; includes a 57 mm Ø x 0.3 mm chromium (Cr) target and a 57 mm Ø x 0.1 mm thick gold (Au) target . A flat rotation stage for 4"/100 mm wafers is included.	each
Rotary pump requirements (needs to be ordered separately)		
91003	Edwards RV3 50L/s two-stage rotary pump, with vacuum hose, coupling kit and oil mist filter	each
6548	XDS 5 Scroll Pump	each
6550-A	Diaphragm pump. A "dry" alternative to the standard 91003 oil-based rotary pump complete with vacuum hose, coupling kit and oil mist filter	each
Specimen stages		
6790-S	Swinging arm stage drive, a stage drive and positioning mechanism which positions the stage under the correct target. Also provides rotation drive to the stage. Rotation Speed Max 38 rpm Min 14 rpm	each
6800-S	Rotating specimen stage for 6" (152 mm) wafers, with rotation variable between preset limits.	each
6801	Rotating 50 mm Ø specimen stage with adjustable tilt. The platform has six specimen stub positions for 15 mm, 10 mm, 6.5 mm or 1/8" pin stubs. The stage rotation speed is variable between preset limits. The target to stage height is variable between 0 mm and 42 mm for the standard stage. When used with the extended height cylinder the target to stage height would be an additional 87 mm.	each
6802	50 mm Ø variable height specimen stage with six stub positions for 15 mm, 10 mm, 6.5 mm disc stubs or 1/8" pin stubs. Stage rotation speed variable between preset limits. Note: Target to stage height is variable between 10 mm and 53 mm for the standard stage. The stage is supplied with two mounting pillars; one provides 10 mm to 32 mm target to stage distance and the other 31 mm to 53 mm. An adjustable stop is used to set the height. When used with the extended height cylinder (optional accessory) the target to stage height would be an additional 87 mm.	each
6803	50 mm Ø rotary tilting stage. A rotary planetary style with a variable tilt angle from horizontal to 30 degrees. The platform has six positions for either 6.5 mm, 10 mm and 15 mm disc stubs or 1/8" pin stubs. Rotation speed is variable between preset limits. Note: depending upon specimen height, this stage may require the optional extended height cylinder.	each
6804	A 90 mm Ø specimen stage for glass microscope slides (up to two 75 mm x 25 mm slides or a single 75 mm x 50 mm slide). The stage can alternatively accommodate up to six 1/8" SEM pin stubs. The stage rotation speed is variable between preset limits. A gear box is included to allow the optional FTM to be used.	each

For our complete selection of specimen stages, please see the **Specimen Stage Selection Guide** on page 49 >>>>

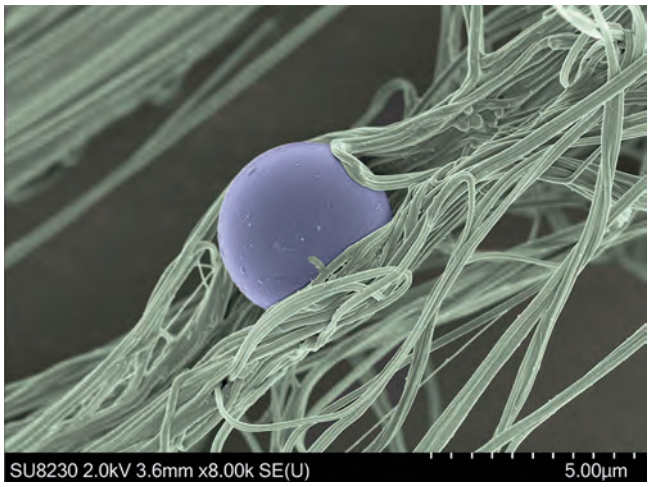
Options and Accessories

6805	Dual channel film thickness monitor (FTM). A fully integrated system using the Q300T D Plus touch screen display for the control and display of all FTM functions. The FTM allows for the automatic termination of the metal sputtering process at a pre-selected thickness value. The rate for the sputtering processes is displayed in nm/min, with a resolution of 0.1 nm. Two FTM crystal holders are fixed in the chamber to give optimal position for both targets and to coat one material per crystal. Operating crystal frequency is in the 5 MHz to 400 kHz operating range. Includes two spare quartz crystals	each
6806	Spare quartz crystal.	each
6807	Extended height vacuum chamber (214 mm in height, the standard chamber is 127 mm high). Ideal for increased source to specimen distance and for coating of larger specimens.	each
6808	Vacuum spigot allows more convenient connection of the vacuum hose to the rear of the Q300T D Plus when bench depth is limited.	each
6809	A lockable emergency stop (e-stop) switch which can be mounted on top of the system in a position easily accessible for the operator. It is provided with a key to release the knob after activation. Note: the addition of the e-stop does not inhibit or replace the normal On/Off switch function. The e-stop can be retrofitted to existing systems.	each
6810	Full range, active vacuum gauge capable of measurement over the range of 1000 mbar to 5 x 10-9 mbar. Typical ultimate vacuum of the Q300T D Plus is 5 x 10^{-5} mbar. Note: this must be factory fitted.	each
6811	Coating shields. Can be fitted to protect large surfaces from coating deposition and can be easily removable for cleaning.	each
6812	Spares kit, including: spare standard glass cylinder, one chromium (Cr) and one (Au) sputtering target, vacuum tubing with coupling insert, argon gas tubing, two sputter head magnets, rotary pump oil mist filter, FTM quartz crystal and fuses.	each

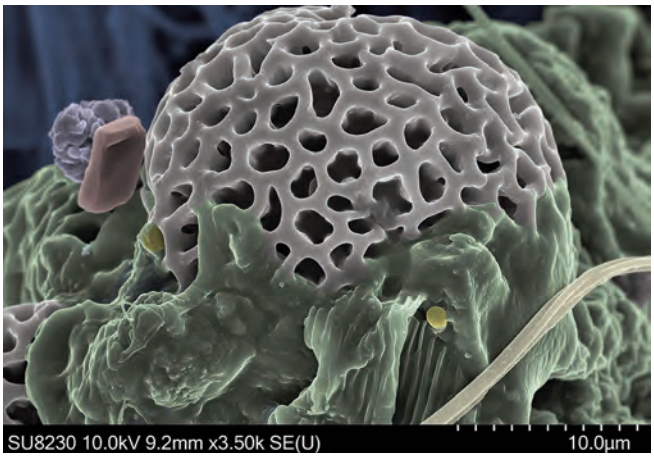
Sputter targets

Note: The Q300T D Plus is fitted with a 57 mm diameter 0.3 mm thick chromium (Cr) target and a 57 mm diameter 0.1 mm thick gold (Au) target as standard. Other optional targets are available:

3409	57mm Ø x 0.76mm Aluminum	each
3410	57mm Ø x 0.1mm Gold	each
3411	57mm Ø x 0.1mm Gold/Palladium (80/20)	each
3411-3	57mm Ø x 0.3mm Gold/Palladium (80/20)	each
3412	57mm Ø x 0.1mm Platinum	each
3413	57mm Ø x 0.1mm Nickel	each
3414	57mm Ø x 0.1mm Silver	each
3415	57mm Ø x 0.1mm Palladium	each
3416	57mm Ø x 0.1mm Copper	each
3417	57mm Ø x 0.3mm Chromium	each
3418	57mm Ø x 0.5mm Tungsten	each
3419	57mm Ø x 1.5mm Chromium	each
3420	57mm Ø x 0.2mm Tungsten	each
3421	54mm Ø x 1.5mm Carbon	each
3422	57mm Ø x 0.1mm Aluminium	each
3423	57mm Ø x 0.1mm Platinum/Palladium (80/20)	each
3424	57mm Ø x 1.5mm Titanium	each
3425	57mm Ø x 0.3mm Platinum/Palladium (80/20)	each
3426	57mm Ø x 0.3mm Gold	each
3427	57mm Ø x 0.3mm Gold/Palladium (80/20)	each
3428	57mm Ø x 0.3mm Platinum	each
3429	57mm Ø x 0.5mm Titanium	each
3430	57mm Ø x 0.1mm Ironeach	each
3431-2	57mm Ø x 0.2mm Iridium	each
3431	57mm Ø x 0.3mm Iridium	each
3432	57mm Ø x 0.1mm Cobalt	each
3433	57mm Ø x 0.1mm Tin	each
3434	57mm Ø x 0.1mm Molybdenum	each
3435	57mm Ø x 0.3mm Magnesium	each
3436	57mm Ø x 0.1mm Tantalum	each
3437	57mm Ø x 3mm Indium Tin Oxide (90/10)	each



Algae spore in spider web, spore size 5 µm coated with 2nm Cr followed by 1nm Au mag x 8k



Radiolata, colorized

Maize root starch granules

Coaters and Coater Target Replacement Parts

EMS 450 Carbon Coater

Replaced by the Q150R E Plus. Parts and accessories for the EMS 450 are listed below.

Carbon

91045	Carbon String, 1 meter	meter
91046	Carbon Cord, 1 meter	meter

Replacement Parts

91013	Glass Cylinder 165mm (6")	EMS 450, 500, 550
91014	"L" Gaskets to suit 165mm (6") cylinder EMS 450, 500, 550	1 pair

EMS 500, 550, 575, 650 and 675 Sputter Coaters and EMS 975 and 975S Large Chamber Turbo Evaporator

EMS is pleased to offer the 150 and 300 series sputter coater and combined carbon and sputter coater.

- **Q150R ES Plus – a combined system with sputtering and carbon fibre coating replaces the EMS 500 and 550.**
- **Q150T S Plus replaces the EMS 575X**
- **Q300T D Plus replaces the EMS 575XD**
- **Q300R T Plus and Q300T T Plus replace the EMS 600, EMS 650, and the EMS 675X**

Accessories

92045	EMS 50 Water Chiller	

Replacement Targets

EMS strives to maintain accurate pricing. However, due to fluctuations in precious metal prices, pricing on products containing precious metals is not guaranteed. We will contact you if there is a discrepancy.

91010	Gold Target	EMS 500, 550, 575T	each
91011	Gold/Palladium Target	EMS 500, 550, 575T	each
91012	Platinum Target	EMS 500, 550, 575T	each
91030	Gold Targets*	EMS 650, 675X	x3
91031	Gold/Palladium Targets*	EMS 650, 675X	x3
91032	Platinum Targets*	EMS 650, 675X	x3
91013	Chromium Targets*	EMS 675X	x3
91014	Tungsten Targets*	EMS 675X	x3

(*Recommended change as set of three)

Replacement Parts

91033	Glass Cylinder 225mm (8")	EMS 650, 675X, 975, 975S
91034	"L" Gaskets to suit 225mm (8") cylinder EMS 650, 675X, 975, 975S	1 pair

Replacement Source

91077	Carbon Rods (6.15mm Dia.),	EMS 975, 975S	12/pack

Replacement Parts for EMS 750 and 775 Freeze Driers

91013	Glass cylinder 165mm (6")	each
91014	"L" Gasket to suit 165mm (6") cylinder (1) pair	each
91085	Desiccant Containers (set of 3)	3/pk
91086	Slushing Pot	each
90032	Copper Discs	each

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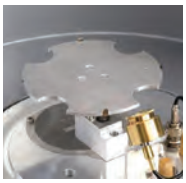
Selection Guide: Specimen Stages for EMS Equipment

The EMS line of specimen stages meets most requirements. All are easy-change, drop-in style (no screws) and are height adjustable (except rotary planetary stage). Examples:

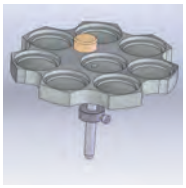
Cat #	Stage Type	Description	Compatible Equipment
4500-1	50mm	Standard stage with six stub positions for 15 mm or 6.5 mm or 1/8" pin stubs (same as #3330, 6401, 6552)	All Q Series
4500-2	Tilt	Rotate-tilt stage with six stub positions for 15 mm or 6.5 mm or 1/8" pin stubs. Tilts Up to 90° from horizontal (same as #3340, 4519, 6400-S, 6551)	All Q Series
4500-3	4" Wafer	Adjusts to accept 2", 3", 4" wafers comes with **4500-6**, a 4" stub holder to accept up to 18 1/8 pin stubs (same as #6549)	All Q Series
4500-4	6" Wafer	Adjusts to accept 4" & 6" wafers comes with **4500-7**, a 6" stub holder to accept up to 27 1/8 pin stubs (same as #6547)	Q300
4500-5	8" Wafer	Adjusts to accept 6" & 8" wafers comes with **4500-8**, an 8" stub holder to accept up to 54 1/8 pin stubs	Q300T T Plus Q300R T
4500-6	4" Stub Holder	A 4" stub holder to accept up to 18 1/8 pin stubs	All Q Series
4500-7	6" Stub Holder	A 6" stub holder to accept up to 27 1/8 pin stubs	Q300T T Plus Q300R T Q300T D Plus
4500-8	8" Stub Holder	An 8" stub holder to accept up to 54 1/8 pin stubs	Q300T T Plus Q300R T
4500-9	4" Wafer & Offset Gearbox	A combination of **4500-3** and a small gearbox to offset the sample position Enable even coating of up to a 4" sample size. (same as #3360, 4522)	Q150T Plus Q150R Plus
4500-10	Fiber Stage	A stage accept single fibers or pins up to 1 mm dia. rotating horizontally to achieve all round coating	Q150T Plus Q150R Plus
4500-11	6" Square Wafer	Stage to accept 6" square wafer or Masks	Q300T T Plus Q300R T
4500-12	Rota Cota	"Rota Cota" planetary stage with six stub positions for 15 mm or 6.5 mm or 1/8" pin stubs. Tilts up to 30° from horizontal (same as #4521, 6402, 6553)	Q150T Plus Q150R Plus
4500-13	8 Place Stub	8 places for 25 or 30mm Polished embedded samples. Includes a polished Brass Tally	All Q Series
4500-14	14 Place Stub	14 places for 25 or 30mm Polished embedded samples. Includes a polished Brass Tally	All Q Series
4500-15	9 Place Coverslip	A Stage to accept 9 20X20 cover slips. The top part of stage lifts off and has a mechanism to lift the cover slips for easy removal	All Q Series
4500-16	4 Place 25mm Stub	4 Place 25mm Stub Stage with locking screws. May be fitted to 4500-12 rota cota stage	All Q Series
4500-17	Slide Stage	Microscope slide stage for up to two 75 mm x 25 mm slides or eight stub positions for pin stubs. (same as #3370, 4520, 6403, 6554)	All Q Series

4500-2 Tilt Angle



4500-3 4" Wafer

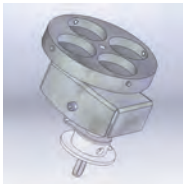
4500-12 Rotary Planetary



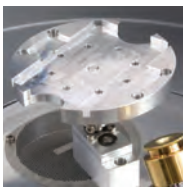
4500-13 8 Place Stub

4500-14 14 Place Stub

4500-15 9 Place Coverslip



4500-16 4 Place 25mm Stub

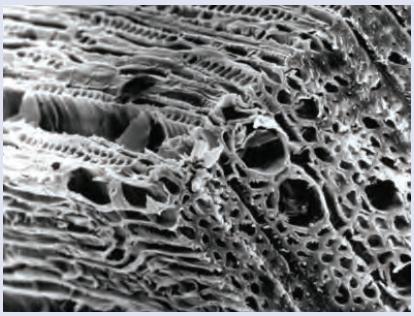


4500-17 Glass Microscope

What is...
Critical Point Drying?

Critical Point Drying is so named as it includes, as part of its process, the occurrence known as the continuity of state for which there is no apparent difference between the liquid and gas state of a medium, the surface tension between this interface reducing to zero. This occurs at a specific temperature and pressure with resulting density, and is known as the Critical Point. This condition of zero surface tension can be used to dry Biological Specimens, avoiding the damaging effects of surface tension.

In biological specimens we are mainly concerned with the removal of water. Unfortunately, the critical point for water of +374°C and 3212 p.s.i. is inconvenient, and would cause heat damage to the specimen. The most common and convenient transitional medium for critical point drying is Carbon Dioxide (CO_2), which has a critical point at 31°C and 1072 p.s.i. However, it is not miscible with water, and therefore, we have to involve a third medium, commonly Acetone, which is termed the intermediate fluid. We can now convert our transitional fluid, typically CO_2, from liquid to gas without surface tension at the critical point.



Mature Spruce Wood

Critical point dried block of mature spruce wood block, demonstrating transverse, tangential and radial views of tracheids and vessels.

Techniques and Applications

A summary of the critical point drying method

Critical point drying is an established method of dehydrating biological tissue prior to examination in the Scanning Electron Microscope. The technique was first introduced commercially for SEM specimen preparation by Polaron Ltd in 1971. The original design concepts, which included a horizontal chamber, are still embodied in the design of the E3100 CPD model.

In recent years we have introduced two further models: the K850, which features built-in chamber cooling and heating, and the K850WM, which is designed for drying a 100mm/4" silicon wafer.

All three models have found general acceptance in many laboratories throughout the world. Together, these critical point dryers offer the user a choice most suited to the particular specimen preparation requirements.

The phase diagram shows the pressure to temperature ranges where solid, liquid and vapor exist. The boundaries between the phases meet at a point on the graph called the triple point. Along the boundary between the liquid and vapor phases it is possible to choose a particular temperature and corresponding pressure, where liquid and vapor can co-exist and hence have the same density. This is the critical temperature and pressure.

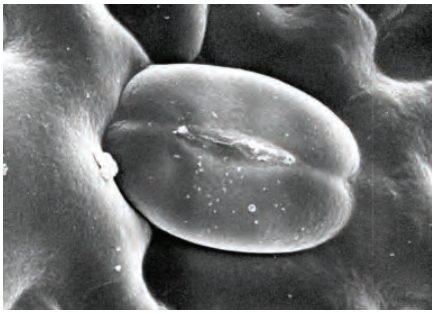
Critical point drying relies on this physical principle. The water in biological tissue is replaced with a suitable inert fluid whose critical temperature for a realizable pressure is just above ambient. The choice of fluids is severely limited and CO_2 is universally used today, despite early work with Freon 13 and nitrous oxide.

With CO_2 a critical point of approximately 35°C can be achieved at a pressure of around 1,200psi. Therefore if the water is replaced with liquid CO_2 and the temperature then raised to above the critical temperature, the liquid CO_2 changes to vapor without change of density and therefore without surface tension effects which distort morphology and ultra structure.

Since liquid CO_2 is not sufficiently miscible with water, it is necessary to use an intermediate fluid which is miscible with both water and liquid CO_2. In practice intermediate fluids commonly used are methanol, ethanol, amyl acetate and acetone.

The advent of Scanning Electron Microscopy (SEM) in the study of surface morphology in biological applications made it imperative that the surface detail of a specimen was preserved. Air (evaporative) drying of specimens can cause severe deformation and collapse of structure - the primary cause of such damage being the effects of surface tension. The specimen is subject to considerable forces, which are present at the phase boundary as the liquid evaporates. The most common specimen medium, water, has a high surface tension to air; by comparison that for acetone is considerably lower. The surface tension could be reduced by substitution of a liquid with a lower surface tension with thereby reduced damage during air-drying. However, the occurrence of what is known as 'continuity of state' suggests a drying technique for which the surface tension can be reduced to zero. If the temperature of liquefied gas is increased the meniscus becomes flatter indicating a reduction in the surface tension. If the surface tension becomes very small the liquid surface becomes very unsteady and ultimately disappears.

When this 'critical point' is reached, it is possible to pass from liquid to gas without any abrupt change in state.



Stomatal Pore on Xerophyte Leaf Surface

Critical point dried epidermis of a xerophyte (cactus), demonstrating raised stomatal pores.

Barley Leaf

Trichomes and stomatal pores on the epidermal surface of a barley (Hordeum vulgare) leaf. Some very fine wax crystallites are also just visible on the surface of the leaf.

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Techniques and Applications

Critical Point Drying Principles

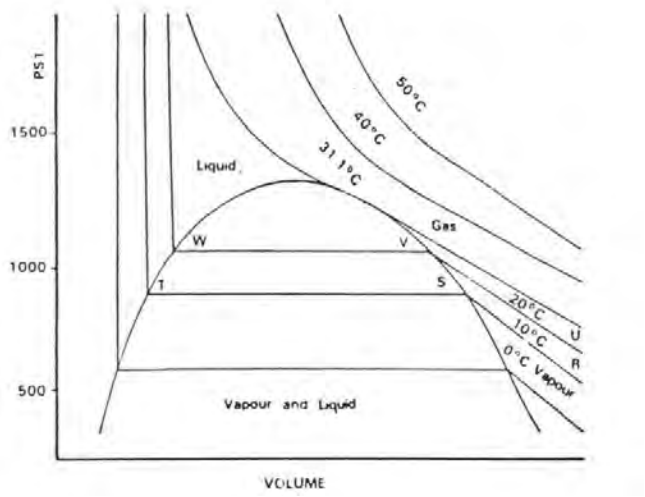
If a specimen had been in the liquid during this process it would have experienced a transition from a 'wet' to a 'dry' gas environment without being in contact with a surface, in this way avoiding the damaging effects of surface tension.

This is termed Critical Point Drying (CPD), the basis of which are the classic experiments carried out over 100 years ago during investigations on the liquification of gases.

The Critical Phenomena

The principle of the experiments, which were initially carried out using carbon dioxide (CO_2), was to measure the change in volume with the application of pressure, of a fixed mass of gas, while maintaining a constant temperature. This was repeated for a range of different temperatures.

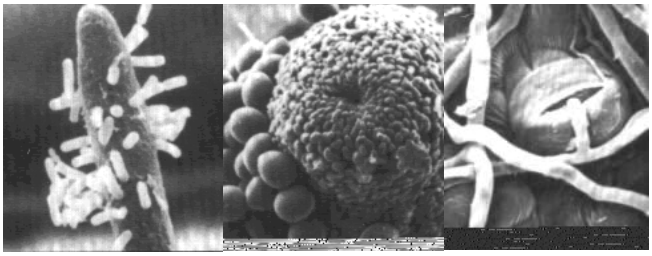
The results are best understood by considering the graph obtained from plotting pressure (P) against volume (V) for the series. This is shown in Figure 1; the curves obtained are termed 'isothermals'



Consider first the 10° C isothermal at low applied pressure. The CO_2 is gaseous (vapor) and generally exhibits the characteristics of a gas (Boyle's Law) over the range from 'r' to 's'. From point 's' a very slight increase in pressure results in a change from vapor state to the liquid state. This is the phenomena of saturation. From 's' to 't' the pressure is virtually constant while the volume is decreasing and at 't' the substance is all liquid.

From point 't' the graph becomes almost vertical indicating significant application of pressures for very little change in volume, liquids being virtually incompressible.

The 20°C isothermal has similar general characteristics, however there is less difference between points 'v' to 'w' compared to the difference between equivalent points 's' to 't' on the 10°C isothermal; these points representing the difference in volume occupied between the vapor phase and the liquid phase.



Fruit body neck with spores adhering to the sides

Bacteria adhering to the tip of a fungus.

Powdery Mildew, hyphal filament on leaf surface.

This indicates that the densities of the saturated vapor and liquid are approaching each other, also the slight departure from the vertical 'w' shows the compressibility is greater than that at higher pressures. This shows that the properties of the liquid and gas states of the substance are becoming similar and will ultimately coincide. This in fact is realized at the 31.1°C isothermal, which does not show any horizontal discontinuity. The temperature at which this occurs is termed the *Critical Temperature* and has an associated *Critical Pressure and density* and hence for a particular mass of gas, a *Critical Volume*. If a liquid was heated in a closed system so that the critical pressure could be attained, at the critical temperature, any visible meniscus would disappear; the surface tension would be zero and it would not be possible to distinguish between the properties of a liquid or a gas. We therefore have continuity of state. Above this temperature the gas cannot be liquified by the addition of pressure and strictly speaking a substance should only be classified as a gas above its critical temperature, below this temperature where it could possibly be liquified by the application of pressure, it is more precisely termed a vapor.

The critical phenomena can be utilized as a drying technique as it achieves a phase change from liquid to dry gas without the effects of surface tension and is therefore suitable for delicate biological specimens.

However, it is not surprising that the initial investigations were on CO_2 as will be apparent from Figure 2, showing a table of critical constants for some common substances. Even the practical achievement of the critical conditions would not assist the biologist, as the specimens would suffer significant thermal damage if we attempted to apply the technique direct for the removal of water from specimens.

CRITICAL CONSTANTS

Substance	Temp. C	P.S.I
HYDROGEN	-234.5	294
OXYGEN	-118	735
NITROGEN	-146	485
CARBON DIOXIDE	+31.1	1072
CARBON MONOXIDE	+141.1	528
WATER	+374	3212

continues

Techniques and Applications

Critical Point Drying Principles (continued)

Therefore CO_2 remains the most common medium for the CPD procedure and is termed the 'Transitional Fluid'. However, CO_2 is not miscible with water and therefore water has to be replaced in the specimen with another fluid which is miscible with CO_2, this is termed the 'Intermediate Fluid'.

Ideally it will be able to replace the water in the specimen, and also serve as the 'Dehydration Fluid'. This is not exclusively the case, and additional steps may be used for particular circumstances.

However, where it is being utilized for both processes, texts may refer to it under the different headings, dehydration and intermediate, depending at what stage it is being used in the specimen preparation schedule. Prior to any of these stages chemical fixation of the specimen must be carried out (normally using glutaraldehyde -osmium procedures).

NOTE

The whole discipline of specimen preparation (chemical or vapor fixation) prior to the transitional stage is only mentioned in its most basic terms, procedures vary according to the type and nature of the specimens. Further references should be obtained.

a) Intermediate Stage

As mentioned previously this involves dehydration and intermediate fluids, the following is a possible schedule.

(Wet Specimen) H_2O ➡ Acetone ➡ CO_2 ➡ C.P.D. (Dry Specimen)

The specimen is usually processed through varying concentrations of dehydration fluid, culminating in complete replacement of the water with this intermediate fluid. Because it has a low surface tension the specimen is less likely to experience damage due to evaporation while transferring to the chamber, also being miscible with CO_2 (the Transitional Fluid) ensures satisfactory conditions after flushing (purging) for the CPD process to commence.

(Wet Specimen) H_2O ➡ Acetone ➡ 30%* 100% ➡ CO_2 ➡ CPD (Dry Specimen)**

Note:
*50/60/70/80/90 typically 10 minutes each
** Flush Typically 3 times
The table (Figure 3) gives an indication of some intermediate fluids. (Water is 73 Dynes/cm.)

Critical point drying stages

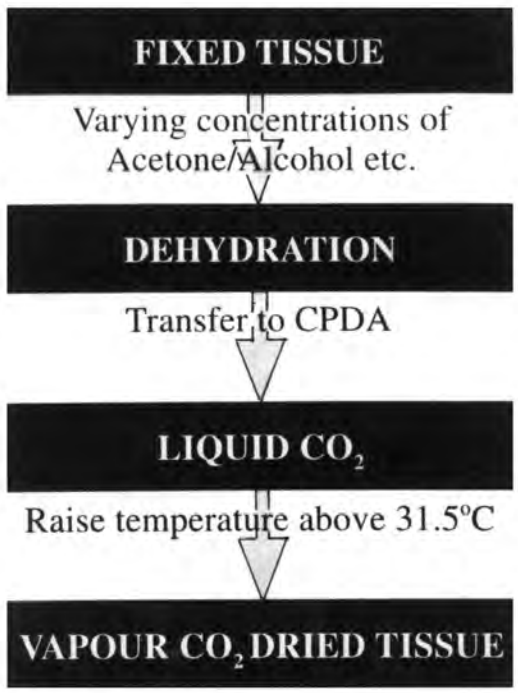


Figure 3: Dehydration Intermediate Fluids for CPD

SUBSTANCE	SURFACE TENSION (DYNES/CM)
ETHANOL	23
ACETONE	24
FREON (113)	19

Having transferred the specimen to the chamber in the Intermediate Fluid, the chamber is flushed several times to replace it with the Transitional Fluid. The process from which the complete techniques derives its name CPD can now be initiated.

CO_2 grades required for critical point drying

Generally speaking, the grade we recommend is 'normal' grade - that is the one most commonly offered by industrial gas suppliers.

In most parts of the world, 'normal' grade of CO_2, from the suppliers, is specified as 'N4.5' or 99.995% minimum purity with a maximum level of 50ppm of impurities.

There are, however, two other grades available by special order from most gas suppliers. One is 'N4.0' or 99.99% (less pure than 'normal' grade). The other is 'N5.5' or 99.9995% minimum purity. The N5.5 purity is easier to find in those parts of the world where there is high level of activity in electronics, since these customers often demand gases with higher purities.

We are not aware of anyone who has ever reported either superior results using N5.5 purity vs N4.5, or inferior results using N4.5 vs N5.5. However, we do want our customers to have the benefit of such detail about liquid carbon CO_2 procurement in the event they should ever find reason to believe that their particular specimens might benefit from the higher purity product.

Remember, the requirement is for LIQUID carbon dioxide and NOT gaseous carbon dioxide. For this reason a cylinder with an internal 'siphon' must be specified. A siphon cylinder is normally denoted by a white stripe painted along its length. No pressure regular is needed.

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Techniques and Applications

Critical Point Drying Principles (continued)

(b) Transitional Stage

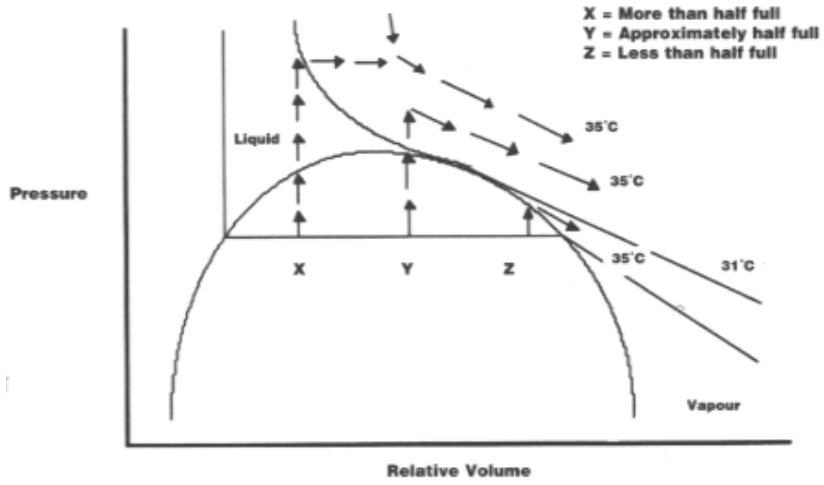
As discussed previously (see Figure 1) the conditions for which the critical point passage can be obtained for CO_2 are 31.1°C and 1072 psi. However, it must be remembered that these isothermals are obtained from a fixed mass of gas and an applied pressure for a series of constant temperatures.

In the laboratory application of CPD we have a fixed volume which is filled with the transitional fluid. Some typical examples of which are given in figure 4.

Figure 4:
Transitional Fluids for CPD

Substance	Temp. C	P.S.I
CARBON DIOXIDE	+31.1	1072
FREON 13	+28.9	562
FREON 23	+25.9	495
WATER	+374	3212

Pressure is obtained by the effect of applying heat and while it can be readily appreciated that we can take a liquid from below its critical temperature and obtain the transition to gas above its critical temperature, an understanding of the relevant 'start' and 'end' points and the cycle involved is required in evaluating the design and performance of CPD equipment. It is still useful however, to utilize these CO_2 isothermals as indicated in figure 5 with the Superimposed 'arrows' showing differing conditions for the CPD device.



It is already acknowledged that these circumstances are not exactly comparable. For example, during operation of the CPD we would fill at CO_2 cylinder pressure and at ambient temperature: not at saturated vapor pressure. At a lower temperature decompression is as a result of venting and the subsequent reduction in mass of gas, not reduction in externally applied pressure. The relative volume is determined by the initial level of liquid in relationship to the total free volume available (this being the chamber plus sample “boat” etc.)

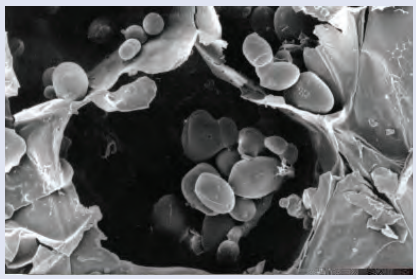
If we consider 'X' with the liquid CO_2 more than half filling the total available volume and we heat from 10°C to 35°C then we will make the transition from liquid to gas. The pressure rise will be rapid as the liquid will expand and the level will increase before the critical temperature is reached. This is termed 'going around' the critical point. Usually (as in the case of instruments supplied by Electron Microscopy Sciences) a pressure-bursting disc is employed to prevent excessive pressure increase.

For condition 'Y' with approximately a full pressure chamber, the liquid level will remain relatively constant, its density decreasing and that of the vapor increasing, and becoming the same when its critical temperature has been reached, together with the corresponding critical pressure.

Looking at condition 'Z' with the pressure chamber less than half full. The level will fall and vaporization will occur before the critical temperature is reached, also the specimens may be uncovered and subjected to unwanted evaporation.

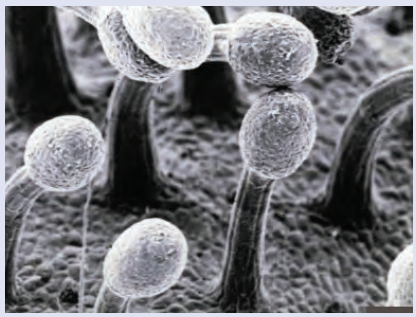
Ideally, we wish have a situation where the liquid fills the specimen chamber, while still only accounting for approximately 50% of the total volume available. This will ensure that specimens are not uncovered during initial flushing stages and in addition this should enable critical constants of temperature, pressure, and density to be achieved relatively simultaneously without excessive pressure or evaporation conditions occurring.

It is also advisable to maintain a temperature somewhat above the critical temperature during decompression, this will avoid the possibility of gas recondensing. It is also important to control the decompression rate itself as there is evidence that rapid pressure equalization can cause specimen damage.



Starch Grains in Potato Tuber

Critical point dried fractured cell from the tuber of potato (Solanum tuberosum), demonstrating thin cell walls starch grains (amyloplasts).



Glandular Trichomes on Modified Leaf Surface of Butterwort

An insectivorous plant, the butterwort (Pinguicula vulgaris) has modified leaves which bear tiny granular trichomes which trap insects. The capitate head of the trichome then secretes protease enzymes to digest the insect parts.

Barley Root Tip

Critical point dried tip of barley (Hordeum vulgare) root, demonstrating root cap cells (calyptra) and slightly deformed (compressed) root hairs (Pili).

E3100 Critical Point Dryer

QUICK OVERVIEW

The E3100 large chamber critical point dryer has been an industry standard for over 35 years and is used in numerous scanning electron microscopy (SEM) laboratories around the world. Primarily used for critical drying of biological and geological specimens, the E3100 can also used for the controlled drying MEMs, aerogels and hydrogels.

The design of the E3100 features a large, horizontal pressure chamber measuring 63.5 mm internal diameter x 82 mm in length. The chamber has an external water jacket for temperature control and specimens are introduced via a removable rear door. The front of the chamber is fitted with a 25 mm diameter window which gives an unsurpassed view of the liquid level during the critical point drying process.

KEY FEATURES

- **Proven reliability - over 6,000 critical point dryer installations world-wide**
- **Simple robust construction - easy to maintain - many critical point dryer users carry out their own routine maintenance**
- **Horizontal chamber and large viewing window - excellent visibility of the fluid level and drying process**
- **Large robust valves for draining of fluids, ingress of CO_2 and venting of gas - very durable; the rapid ingress of CO_2 helps prevents pre-drying of specimens**
- **Safety - every critical point dryer unit is pressure tested to 2,500psi and a certificate is issued. A pressure bursting disc is also fitted to safeguard against misuse**
- **Specimen handling - optional specimen holders for coverslips and TEM grids. Porous pots are available for fragile or very small specimens**
- **Three-year warranty**

Temperature control

Dial gauges display pressure in the chamber and the temperature of water circulating through the jacket. Three pressure valves permit easy connection to the liquid CO_2 cylinder and allow liquid agitation and venting of the chamber.

A source of hot running water is essential. Cooling is also useful, especially for sequential critical point drying process runs and/or in laboratories where the room temperature may be high.

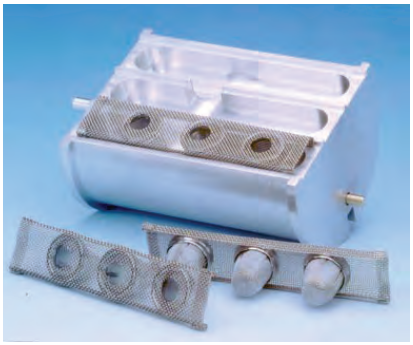
The temperature of the E3100 chamber is raised with a hot water supply. Mains water can be used but a more elegant method involves the use of the optional E4860 Recirculating Heater/Chiller which can be used to pre-cool the chamber to below ambient temperature prior to loading specimens and then to heat the chamber to the critical temperature.

Safety

Operator safety is of course an important consideration with all pressure vessels. If during the critical point drying process the pressure and temperature are inadvertently exceeded, a safety bursting disc is incorporated in the chamber support. The design has been independently type-tested to proof pressures in excess of the working pressure and bursting disc rupture pressure.

Specimen holder (boat)

An important feature is the design of the E3100 transfer boat. This permits specimens in the intermediate fluid to be transferred to the chamber of the critical point dryer. On sealing the chamber, the intermediate fluid begins to drain and can be replaced with liquid CO_2. In this way the specimens are never allowed to dry out during the loading and transfer stage of the critical point drying process.



EMS 3100 Specimen Boat

The E3100 is supplied with the E3100-01 tissue boat which has three slots each with three tissue baskets, making a total of nine. Optional holders are available and are listed under Ordering Information.

Bonded chamber seals – Nitrile or EPDM?

The EMS 3100 is fitted with a standard nitrile bonded window and door seals. Nitrile is a good general material due to its ability to withstand attack by solvents, such as ethanol. However, if acetone is used as the transition fluid then the EPDM seals have been found to be more resistant to chemical attack by that solvent.

If you are planning to use acetone as the transition fluid, please state this on the order and EPDM bonded seals will be fitted.

For existing instruments, both Nitrile and EPDM bonded seal can be ordered as spare parts.

E3100 Critical Point Dryer *(continued)*

OPTIONS AND ACCESSORIES

Glass microscope coverslip holder (option):

Specially adapted boats allow glass coverslips to be held firmly during drying. The E3000-02 is designed for the E3000 and has a maximum capacity of seven coverslips. Likewise, the larger E3100-02 coverslip boat is available for the E3100 'Jumbo' Critical Point Dryer and has a carrying capacity of 21 coverslips.

Coverslip Holder

TEM grid holder (option):

The E3000-1 holder for 3.05mm grids and the E3000-2 grid holder for 2.3mm grids can be used with all Electron Microscopy Sciences critical point dryers. Maximum number of grids is three.

TEM Grid Holder

Porous pots with lids (option):

E800A solvent-resistant porous pots (12.7mm x 15.5mm) with lids are ideal for very small or very delicate specimens.

Porous Pots

Service Kits:

Service kits are available; see the ordering table below. Please call our service department for specific questions.

E3100-01 is included as standard):

- E3100-1 Specimen holder for 3.05mm grids
- E3100-2 Specimen holder for 2.3mm grids
- E3100-01 Specimen holder for tissue (boat)
- E3100-02 Specimen holder for coverslips
- E800A Porous pots with lids 12.7mm x 15.5mm (pack of 10) for micro-specimens
- E4860 Recirculating Heater/Chiller to control heating and cooling cycle (please specify voltage)

For more information on the E860 Recirculating Heater/Chiller, see page 5.

Service Kit

Site Requirements

Site selection: The apparatus should be positioned in the laboratory with convenient access to:

- Hot and cold water supply (if the optional E4860 Recirculating Heater/Chiller are not used)
- Mains power supply (for E4860 only)
- Fume cupboard or window, or an area of good ventilation
- Space for CO_2 siphon cylinder

CO_2 Cylinder: The E3100 requires a cylinder of liquid CO_2 fitted with a siphon tube (indicated by a vertical white stripe on the cylinder). If there is any doubt regarding the presence of a siphon tube, advice should be sought from the gas supplier.

Cylinder connection threads vary from country to country and even between manufacturers in the same country. For example, the transfer pipe supplied is fitted with ¼" British Standard Pipe (BSP) and 0.86" x 14 TPI union. These are standard threads for the UK and generally in the rest of the world, but will not fit cylinders in the USA.

Heating and cooling: Use a mixer to the laboratory hot and cold water outlets, terminating with a 6mm/¼" hose connection for the PVC tubing supplied. A 'Y' piece connected to the hot and cold water taps is also suitable.

The E3100 requires both hot and cold water during the operating cycle. Cooling facilitates filling of the work chamber with liquid CO_2, and heating is required to take the liquid above its critical point.

Good control of the water temperature is essential for good results, hence the recommended use of the the E4860 Recirculating Heater/Chiller which gives precise control of cooling and heating.

Space requirement: A minimum bench space of approximately 230 x 230mm is required.

ORDERING INFORMATION

E3100	Large Chamber Critical Point Dryer Chamber dimensions: 63.5mm Ø x 82mm length	each
Supplied with:	E3100-01 Specimen holder for tissue (boat) 1m liquid CO_2 delivery tube O ring and L gasket set (including window and door bonded seals) Spare bursting disc and retaining copper (Cu) washer Steel bar for tightening/untightening the door Flat wrench (for removing the window retaining ring) Comprehensive manual Pressure test certificate	
E3100-061	Service Kit for E3100	Kit

K850 Critical Point Dryer with Thermoelectronic Heating and Adiabatic Cooling

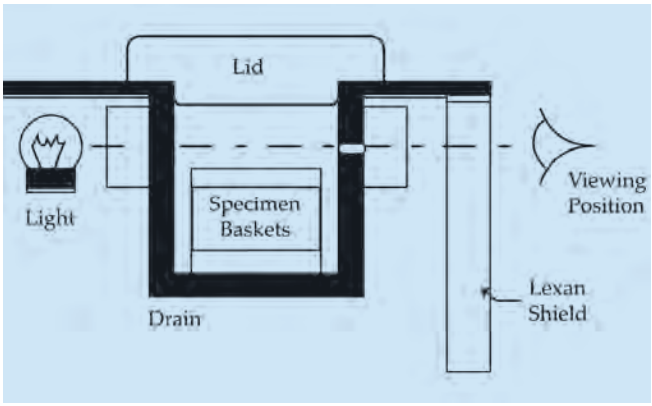
The K850 Critical Point Dryer is designed for use with CO_2, having first replaced any water in the specimen by a series of dehydration, often in the same fluid such as Acetone, which will also be the intermediate fluid.

(Wet Specimen)–Water–Acetone–30%–100%–CO_2–C.P.D.–(Dry Specimen)

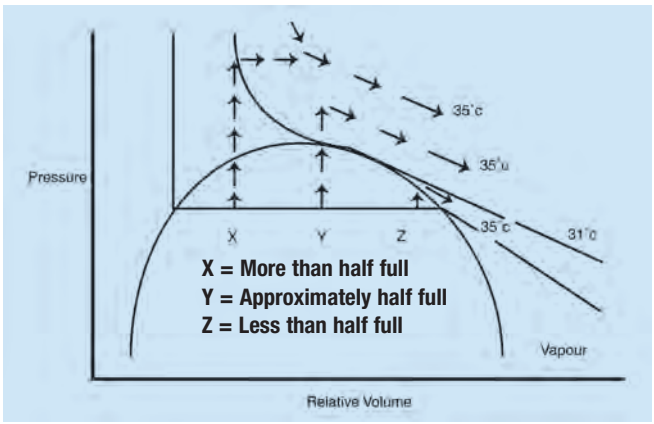
The specimens for critical point drying are located in the pressure chamber of the K850. The chamber is pre-cooled to allow it to be readily filled with liquid CO_2 from a gas cylinder. The chamber is then heated to just above the critical temperature with subsequent critical pressure being achieved. The CO_2 gas is vented through a needle valve, to avoid specimen distortion.

The K850 is fitted with thermoelectronic Heating and Cooling and Temperature control of +5°C on Cooling, and +35°C on Heating. This ensures the critical point is accurately obtained, avoiding excess pressures or temperatures, or the need to rely on pressure relief valves to control pressure during the heating cycle. The chamber is vertical, with top loading, to ensure specimens do not become uncovered during the drying process, with a side viewing port to locate the miniscus for the correct level when initially filling the chamber.

The K850 is fitted with a fine let down needle as standard and flow gauge is no longer required.



Cross-sectional view of chamber, showing miniscus viewing position.



FEATURES

- Vertical chamber with top filling and bottom draining.
- Normal operating temperature 35°C pressure 1500 psi.
- Thermoelectric Peltier cooling and heating.
- Fine control needle valve pressure letdown.
- Illuminated chamber with side viewing port and protective 'Lexan' shield.
- Stirrer system for enhanced solvent exchange.
- Temperature monitoring and control with thermal cut-out protection.
- Pressure monitoring with pressure relief valve and rupture disc protection.
- Polycarbonate safety shield.

SPECIFICATIONS

Instrument Case	450mm (W) x 350mm (D) x 175mm (H)
Weight	12Kg
Specimen Chamber	30mm (Dia.) x 40mm (H) (Tested to 3000 psi)
Temperature Gauge	0-120°C
Thermal Cut-Out	40°C
Pressure Gauge	0-3000 psi
Pressure Relief	At 1500 psi
Rupture Disc	At 1900 psi
Peltier Cooling/Heating	+5°C to +35°C
Two On/Off Valves	Inlet/Outlet/Cool/Vent Needle Valve Letdown
Supply	115V 60Hz (6 Amp Max) 230V 50Hz (3 Amp Max)
Services	Requires CO_2 gas cylinder direct connection by high pressure hose. (High pressure hose included with instrument.)

ORDERING INFORMATION

91090	K850 Critical Point Dryer complete	each

Replacement Parts

91091	Mesh Basket	each
91092	Porous Spec Pots	10/pack)

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Fax (215) 412-8450 or 8452 • email: info@emsdiasum.com or stacie@ems-secure.com • www.emsdiasum.com

K850WM Large Chamber Critical Point Dryer

The K850WM is compact, bench-top instrument designed to critical point dry a complete 150mm/6" wafer. A convenient wafer holder allows rapid transfer and ensures that pre-drying does not occur.

FEATURES

- **170mm diameter chamber - optimized for wafer/MEMS drying**
- **Vertical chamber with top-loading and bottom draining - ensures specimens do not become uncovered during drying**
- **Thermoelectric heating - accurate temperature control**
- **Fine control needle valve pressure let down - precise control**
- **Temperature monitoring and control with thermal cut-out protection**
- **Pressure monitoring with safety cut-out for over pressure**
- **Three-year warranty**

The K850WM has built-in heating and water cooling using the E4860 Recirculating Heater/Chiller. This combination will give temperature control of +5°C cooling and +35°C during heating. This ensures the critical point is accurately obtained, avoiding excess pressures or temperatures, or the need to rely on pressure relief valves to control pressure during the heating cycle.

The K850WM has a vertical chamber which allows top-loading of specimens. A viewing port is fitted in the top plate for specimen observation. The specimen exchange mechanism is simple to use and ensures the specimen remains under liquid during loading.

Specimen handling

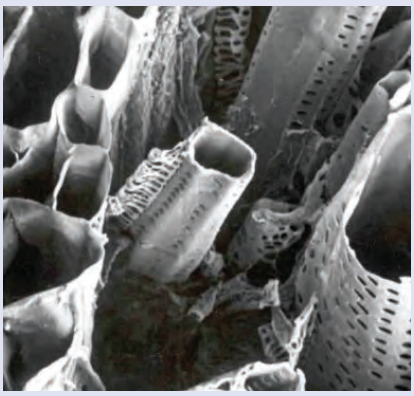
100mm or 150mm diameter wafers are held in a PTFE holding tray. The tray including wafer is immersed in acetone in order to remove all moisture from the specimen. After dehydration, the wafer and holder are transferred into the pre-cooled specimen chamber using the wafer transfer device. On completion of the critical point drying process, the wafer is removed from the chamber using the transfer device prior to further processing.

ORDERING INFORMATION

91090-WM	K850WM Large Chamber Critical Point Dryer	each

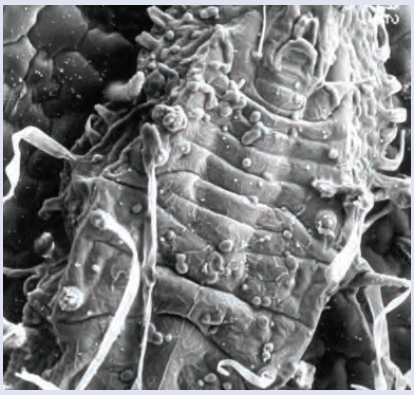
Requirements

E4860	Recirculating Heater/Chiller (for cooling chamber)	each
E3102	Carbon Dioxide bottle heating system	each



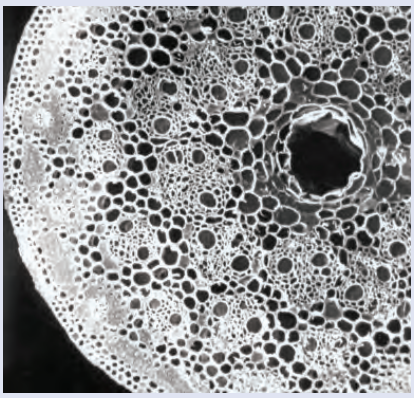
Mature Barley Root

Critical point dried transverse fracture of a mature barley (Hordeum vulgare) root, demonstrating central stele and surrounding cortical cells. Root hairs (Pili) are also obvious.



Aphid

Critical point dried aphid on a leaf surface.



Bamboo Stem

Transverse fracture of the stem of young bamboo (Bambusa sp), demonstrating xylem and phloem bundles and heavily thickened (lignified) epidermal and hypodermal cells.

What is... Cryogenic Specimen Preparation?

In this instance we are referring to frozen hydrated bulk specimens for SEM, commonly termed Cryo-SEM. When biological specimens are prepared by alternative methods, such as critical point drying, they may collapse and distort due to the removal of their water content. In addition diffusible elements are often removed or relocated, affecting the validity of subsequent X-ray microanalysis.

Cryo-SEM offers the best solution to this and in addition allows observation and analysis of liquid, semi-liquid and beam-sensitive specimens, such as emulsions, suspensions and foams. Cryo preparation is increasingly being used with FIB/SEM instruments for a wide range of specimen types, including some materials where low temperature milling conditions are desirable.

For biological and other "wet" specimens rapid freezing is essential in order to reduce morphological distortion, a key consideration for structural observation.

The aim of fast freezing is to reduce the size of ice crystals within specimens by reaching as quickly as possible the point at which recrystallization takes place (for pure water this is in the order of -130°C) and maintaining the specimen below this temperature during transfer, preparation and observation.

For larger specimens commonly used in SEM and FIB/SEM rapid freezing is normally done by plunging into liquid nitrogen in its 'slushy' form at -210°C. This is the standard method supplied with the PP3010, but it is also fitted with an "advanced specimen handling" system which allows specimens that have been frozen by alternative (faster) freezing methods to be manipulated and loaded under liquid nitrogen and then transferred under vacuum into the PP3010 for subsequent processing and observation.

Techniques and Applications

Cryo-SEM – the advantages

The Scanning Electron Microscopist is faced with the inescapable fact that liquid is a fundamental part of practically all lifesciences – and many materials – specimens. Since water occupies up to 98% of some animal and plant tissues it represents a most formidable specimen problem to most Scanning Electron Microscopists.

Cryo-SEM is a quick, reliable and effective way to over come these not inconsiderable SEM preparation problems. Additionally the technique is widely used for observing 'difficult' samples, such as those with greater beam sensitivity and of an unstable nature. An important application, often overlooked, is the ability to use cryo-SEM to study dynamic processes (industrial or otherwise) by using a series of time resolved samples.

Naturally the advent of various "higher pressure" modes, such as VP, LV and ESEM has allowed such samples examined in SEM without resorting to freezing or drying methods. However, cryo-SEM is still by far the most effective method of preventing sample water loss, which will in fact occur at any vacuum level –even with Peltier stages fitted to the SEM and the careful addition of water vapor in the SEM chamber. Cryo-SEM also a number of a additional advantages, including the ability to fracture and selectively remove surface water (ice) by controlled specimen sublimation.

Why choose cryo-SEM?

The limitations of conventional 'wet processing' include:

- Shrinkage and distortion
- Extraction of soluble materials
- Relocation of highly diffusible elements
- Mechanical damage (fragile specimens can be damaged during conventional processing)
- Slow (24 hours or longer)
- Toxic reagents are required (fixatives, buffers etc)

Advantages of cryo-SEM:

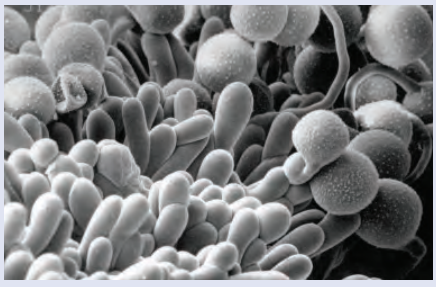
- Specimen viewed in fully hydrated state
- Soluble materials are retained
- Less relocation of highly diffusible elements
- Little or no mechanical damage
- Time lapse experiments and evaluating industrial processes at timed intervals
- Usually no exposure to toxic reagents
- Rapid process
- High resolution capability (compared to low-vacuum techniques)
- Extra information obtained by low-temperature fracturing (compared with conventional and low-vacuum methods)
- Good for liquid, semi-liquids and beam sensitive specimens
- Ability to selectively etch (sublimate to reveal information)
- Ability to 'rework' specimen (eg re-fracture and coat)

Zoological

Frozen hydrated aphid

In comparison with the critical point dried aphid, this image shows that there is no distortion of the abdomen nor any other parts of the aphid following freeze drying.

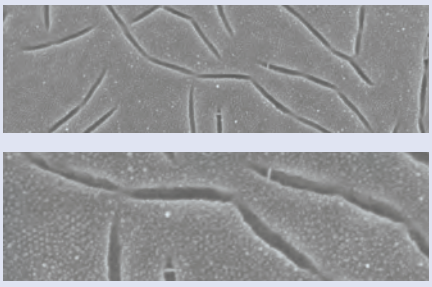
Botanical



Pollen of cactus Zygocactus truncatus

Germinating pollen grains of Zygocactus truncatus.

Fungi



Baker's yeast (*Saccharomyces cerevisiae*)

The specimen was rapidly frozen in nitrogen slush, fractured and coated with 4nm of platinium (Pt). 10nm yeast cell transmembrane particles (in hexagonal arrays) can be observed.

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Techniques and Applications

A summary of the cryo-SEM preparation technique

Cryo preparation techniques for scanning electron microscopy (SEM) have become essential for the observation of wet or 'beam sensitive' specimens. Using such techniques removes the need for conventional preparation techniques, such as critical point drying or freeze-drying, and allows observation of the specimen in its 'natural' hydrated state.

The specimen is rapidly cooled and transferred under vacuum to the cold stage of the preparation chamber, which is mounted onto the SEM chamber. The preparation chamber is pumped either with a rotary pump (PP2000) or by a specially designed turbomolecular pumping system (PP2000T). The specimen can be fractured, sublimated ('etched') to reveal greater detail, and coated with metal by sputtering or with carbon by thermal evaporation.

Finally, the specimen can be moved under vacuum into the SEM chamber where it is easily located on a cold stage specifically tailored to the SEM. At all stages of the procedure the specimen is maintained at a 'safe' temperature of typically lower than -140°C.

Typical applications

Biological sciences including botany, mycology, zoology, biotechnology and biomedical – plus economically import agricultural sciences.

More recently cryo-SEM is becoming an essential tool for pharmaceutical, cosmetics and healthcare industries, where it is used in basic applied research and for routine QA of many products, such as creams, cosmetics and drug delivery systems.

Cryo-SEM has long been a standard preparation method in the food industry. Of interest are multi-phase products, such as ice cream, confectionery and dairy products.

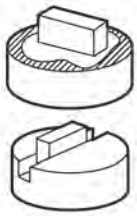
Botanical: Cryo-SEM is the perfect method for highly hydrated botanical material.

Some specimen mounting techniques for cryo-SEM

Surface mounting

This technique is used for leaf specimens etc. Roughen stub surface with fine emery paper. Specimen is laid on top of mounting media.

Edge mounting



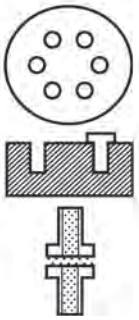
This technique is used for edge observation and fracture. Roughen surface of stub with fine emery paper. Specimen is placed on its edge in a machined slot and secured with mounting media.

Film emulsion mounting

This technique is useful when a small specimen would be obscured by the Tissue-Tek mounting media, or when specimens need to be recovered. Specimens need to be slightly damp to use this method (good for nemotode worms).

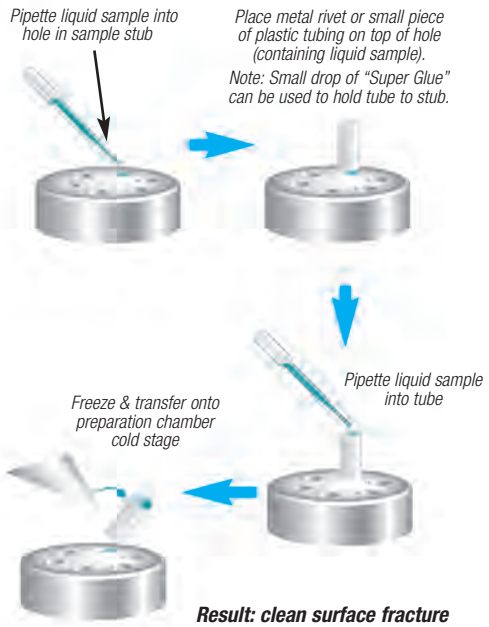
The specimen is laid on surface so that its dampness slightly dissolves the film emulsion allowing the specimen to adhere to the film surface. Exposed unused film with the emulsion side uppermost is secured to the stub with mounting media. It may be useful to scrape off the protective coating of the film emulsion first to assist conductivity.

Rivet mounting



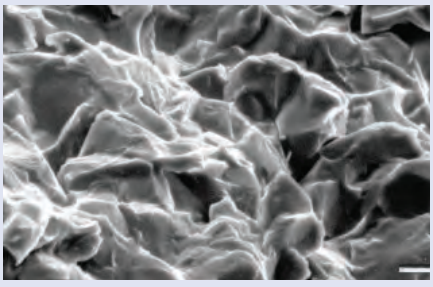
For liquids and for when specimens need to be frozen off the stub to achieve fast freezing rates. The rivet is placed in the hole and filled with liquid prior to freezing. If the specimen needs to be frozen away from the stub, two liquid-filled rivets are held together and then frozen prior to transfer onto the stub.

Alternative rivet mounting method



Result: clean surface fracture

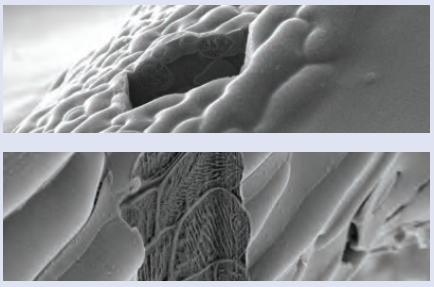
Geological



Wax crystals in gas oil

When cooled to a temperature below about 2°C, the waxes in fuel oils such as this tend to crystallize out. Wax crystal size and shape can be varied by altering the rate at which the oil is cooled.

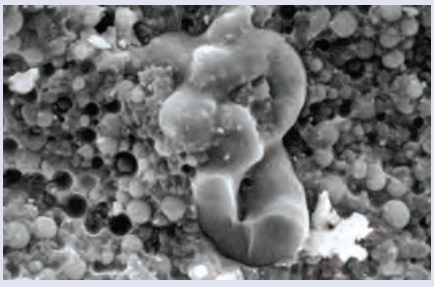
Cryo-DualBeam



Arabidopsis plant

Cryo-FIB/SEM. Image courtesy of Hannah Edwards and Arabidopsis plants provided by Darren Wells, Centre for Plant Integrative Biology, School of Biosciences, University of Nottingham, UK.

Polymers



Stable emulsion of a hydrophobic polymer

This image illustrates a stable emulsion of a synthetic liquid polymer dispersed in an aqueous continuous phase.

CRYO-SEM & CRYO-FIB/SEM PREPARATION SYSTEMS

OVERVIEW

The PP3010 is a highly automated, easy-to-use, column-mounted, gas-cooled cryo preparation system suitable for most makes and models of SEM, FE-SEM and FIB/SEM.

The PP3010 has all the facilities needed to rapidly freeze, process and transfer specimens. The cryo preparation chamber is turbomolecular pumped and includes tools for cold fracturing, controlled automatic sublimation and sputter coating. After processing, the specimen is transferred from the cryo preparation chamber onto a highly stable SEM cold stage for observation. Cold trapping in the cryo preparation chamber and SEM chamber ensures the whole process is frost-free. Specimen process times are typically between five and ten minutes.

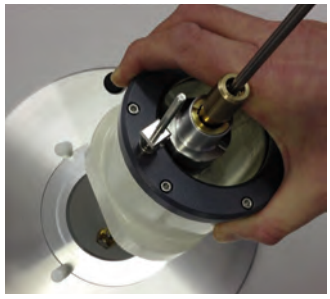
KEY FEATURES

- High resolution performance on SEM, FE-SEM and FIB/SEMs
- Totally gas cooled, including cryo preparation chamber – no boiling nitrogen on the SEM
- Efficient cooling (down to at least -190°C)
- 24 hours plus run times on one fill of LN2 are typical – allowing unattended overnight operation (at typical operating temperatures)
- Large recipe driven touch-screen interface
- Automated sublimation, coating and system start up
- Superb specimen visibility (including preparation chamber CCD camera)
- Fully compatible with SEM beam deceleration/stage bias modes up to 5kV
- Off column cooling and pumping systems – minimum mass on the SEM
- On-screen data logging and diagnostics
- Pumped storage of the cryo transfer device
- Prepdek® workstation – self contained work area, extra bench space not required
- Cryo workflow options
- Specialist support and three-year warranty

PRODUCT FEATURES

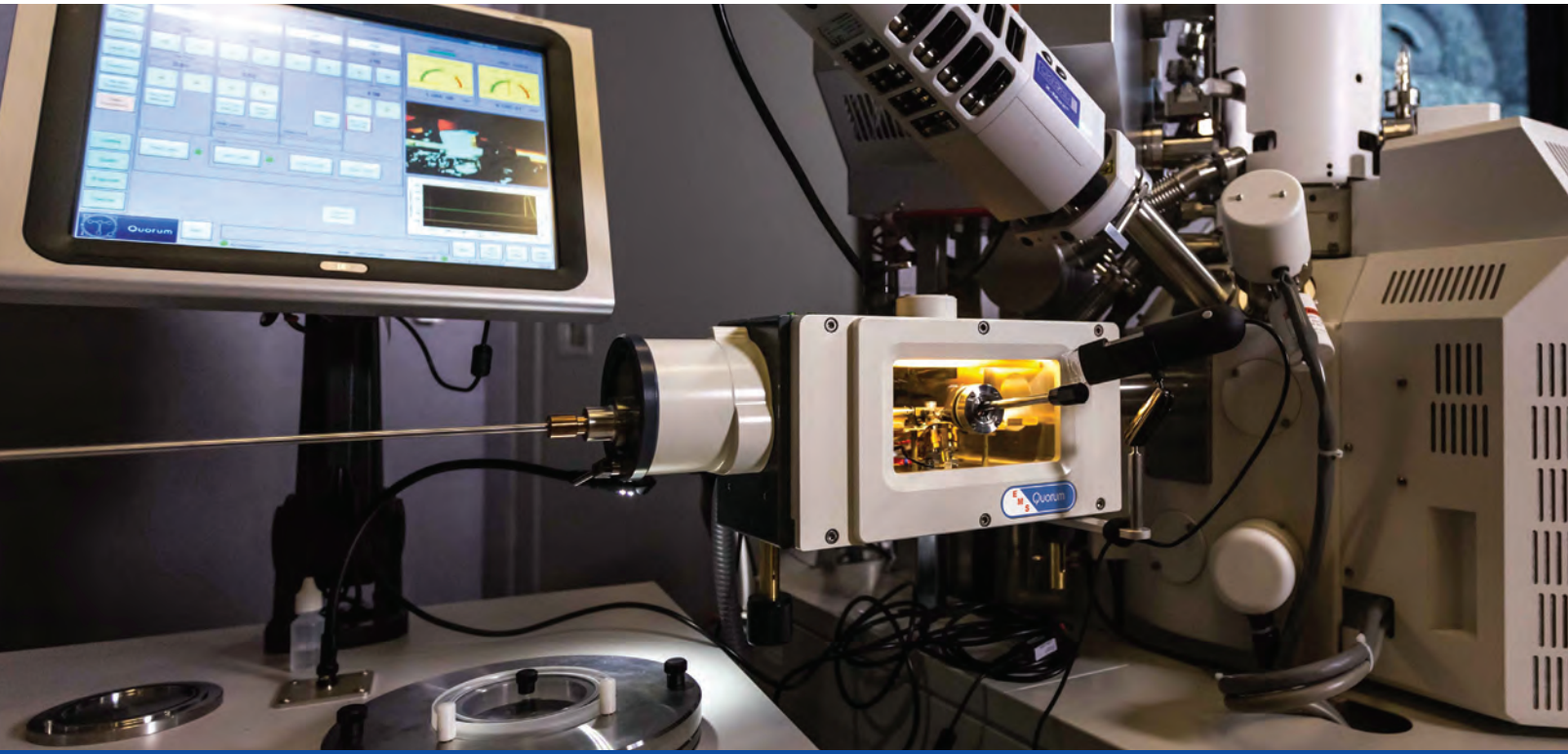
Mounting, Freezing and Transferring Specimens — easy with the Prepdek® Workstation

The PP3010 Prepdek® workstation is fitted with a slushy nitrogen freezing station, connected to the pumping system. Rapid freezing reduces ice crystal damage and results in improved specimen preservation. For handling pre-frozen material the Prepdek® freezing system allows specimens that have been frozen by alternative freezing methods (or stored field specimens) to be manipulated — in or just above liquid nitrogen — and then transferred under vacuum into the PP3010 preparation chamber for subsequent processing and observation.



Slushy nitrogen freezing station

Additionally the TEM Prep Slusher and Glove Box Interface/Airlock options allow workflow amongst a range of other platforms, including cryo-TEM, cryoultramicrome, XPS and glove box.



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Cryo Transfer Device – Including Vacuum Storage

The vacuum transfer device is compact (fits easily into one hand), reliably vacuum-tight and has a bayonet connection to the specimen shuttle to ensure rapid pick up and transfer.

Set into the Prepdek® work surface is a pumped storage tube for the cryo transfer device (see Prepdek® workstation section below).

Specimen Stubs, Shuttles

The PP3010 is supplied with universal 10 mm specimen stubs with surface slots, holes and a flat area – useful for most specimen types. Blank and slotted stubs are also included. In addition a range of optional holders is available, including shuttles for large specimens and top-loading holders for high pressure freezing, TEM Autogridstm (for cryo-FIB/SEM applications) and clamping shuttles for hard specimens.

Cryo Preparation Chamber

The cryo preparation chamber is connected directly to the microscope and includes a highly efficient nitrogen gas cold stage, extensive cold trapping and facilities to fracture, sublimate and sputter coat specimens. The chamber is fitted with two fully integrated and interlocked gate valves. The outer load-lock valve includes a pumped airlock which accepts the cryo transfer device – the inner SEM valve ensures rapid high-vacuum to high-vacuum specimen exchange.

Highly Efficient Gas Cooled Stage and Cold Traps

At the heart of the cryo preparation chamber is a nitrogen gas cooled specimen stage. The stage has a dovetail fitting to accept a cryo shuttle and can be precisely controlled over a temperature range from 100°C to -190°C or lower. Large gas cooled cold traps located above, below and behind the specimen stage ensure clean, high vacuum conditions in the chamber.

Both the cold stage and cold traps are cooled with the fully integrated CHE3010 off-column cooling system (see below), which at normal operating temperatures give typical hold times of at up to 24 hours between fills (provided the nitrogen gas is dry).

High Visibility – Plus CCD Camera

There is superb visibility into the preparation chamber. In addition to the large front window (75 x 150 mm), there are two top viewing ports. The chamber is lit by three LEDS and a CCD camera allows the specimen cold stage area to be viewed on the control screen and the images saved.

An optional stereo microscope can be fitted to the cryo preparation chamber.

Cold Fracturing

Twin fracturing tools manipulators (actively cooled) are available and allow a range of specimen types to be cold fractured.

The PP3010 is fitted as standard with a front mounted fracturing and manipulation device. The ball-jointed mount offers flexible movement of the blade which can be used both as a surface pick (probe) and a fracturing knife.

An optional micrometer-advanced fracturing tool with rigid blade is available, in addition to the standard front-mounted tool.

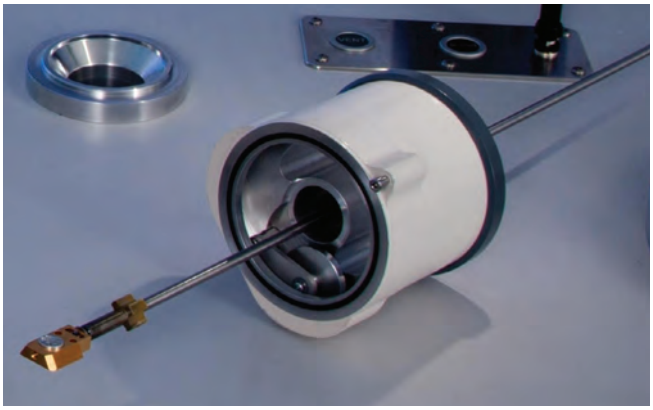
Fractured fragments are captured in the large cold trap located below the specimen stage.

Automatic Sublimation and Sputtering

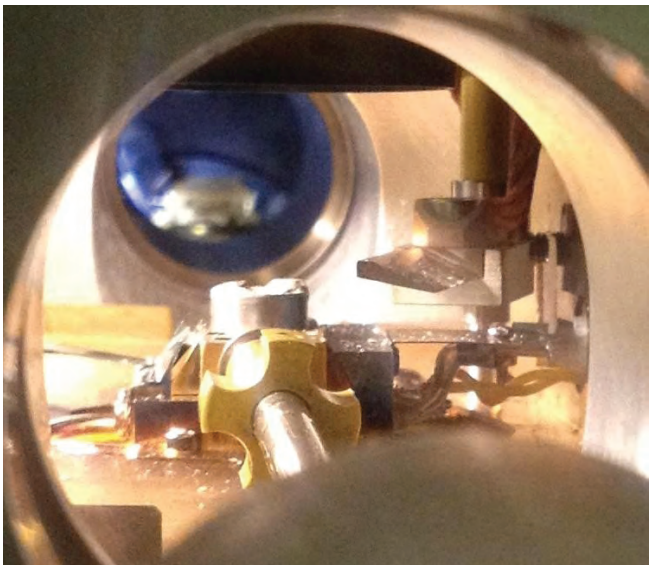
Sublimation temperatures and times can be preset and stored for easy retrieval. The process is fully automatic and graphically displayed on the control screen, showing the actual verses the predicted temperature curves.

The high resolution sputter coater is based on the market leading series of bench top coaters. The coating system will give fine grain films essential for FE-SEM applications. A platinium target is fitted as standard – optional metals include gold, gold/palladium, chromium and iridium. An optional fully integrated carbon fiber evaporation head can also be fitted.

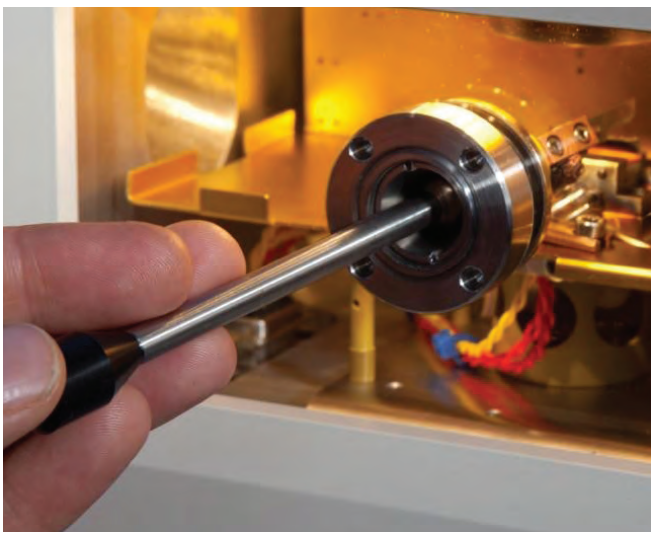
An optional terminating film thickness monitor is available.



Specimen transfer device

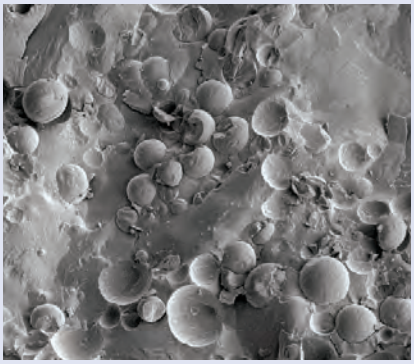


View during specimen transfer

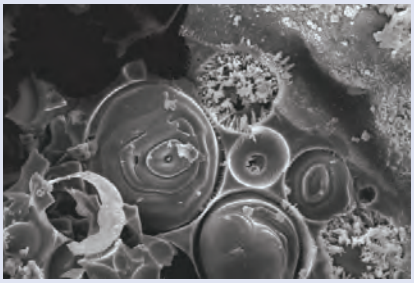


Front-mounted fracturing and specimen manipulation tool

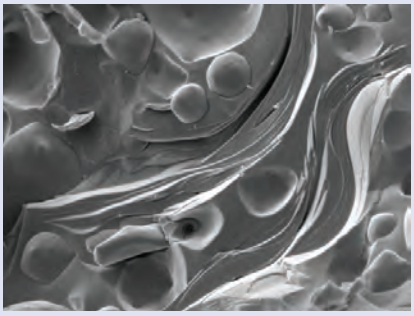
CRYO-SEM & CRYO-FIB/SEM PREPARATION SYSTEMS



Mayonnaise
Image courtesy of FEI Company.



Shaving Cream
Fractured at -140ºC, sublimated at -90ºC for 3 minutes and coated with 5nm of platinum.



Face Cream

Anti-aging face cream. Specimen rapidly frozen in slushy nitrogen, fractured at -140°C and sputter coated with 5nm of platinum

Turbomolecular Pumping – High Vacuum Performance

The preparation chamber is pumped by a remotely-positioned 70 L/s turbomolecular pumping system. Typical preparation chamber vacuums when cold are in the region of 10^{-7}mbar or better. Positioning the turbomolecular pump away from the SEM ensures total elimination of mechanical vibration and has the advantage of significantly reducing the total cryo system mass connected to the SEM. A vacuum buffer tank (remotely located in the Prepdek®) is automatically pumped when required. The pumping system is connected to the preparation chamber by flexible stainless-steel bellows, which allows flexible positioning of the pumping system.

A 5 m^3/hr rotary vacuum pump is required to "back" the turbomolecular pump and for slushing and rough pumping operations. The rotary pump can be located up to five meters from the system, allowing remote location if required. Dry pumping alternatives are available – see Ordering Information.

Prepdek® Workstation

The Prepdek® workstation has been designed to allow specimen mounting, freezing (plus pre-frozen specimen manipulation) and transfer device storage on one ergonomically designed work surface. The control electronics are mounted in a sealed but accessible cabinet beneath the Prepdek®.

Set into the work surface is a pumped storage tube which allows the cryo transfer device to be stored under vacuum conditions when not in use.

Panel PC Touch Screen User Interface

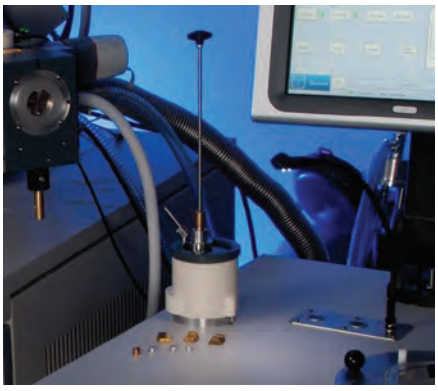
The PP3010 is controlled using a large touch screen panel PC, mounted on the Prepdek® workstation. User-defined 'recipes' can be entered and stored for instant future access. The screen can be set to suit operator preferences; for example, vacuum measurement can be displayed in millibar, Pascal or Torr.

Many of the key steps in the specimen preparation process are automated (system set up, gas flow control, sublimation and sputter coating).

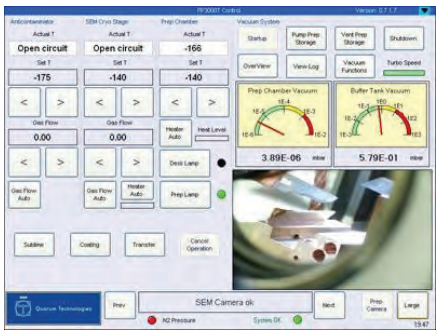
SEM Cold Stage, Cold Trap and Cooling System

A highly stable, thermally isolated, nitrogen gas-cooled stage attaches to the SEM stage. The SEM stage and cold trap are cooled by separate cold gas circuits – both capable of reaching temperatures of -190°C or lower. This configuration allows the operator to select stage and cold trap temperatures that are optimized for specific specimens. For example, for some non-biological materials, it is useful to hold the specimen at very low temperatures – for example, a cold stage temperature of -175°C. This is possible with the PP3010, as cold trap temperatures of -190°C or lower can be selected, but not possible with conduction cooled

Remotely mounted turbomolecular pumping system



When not in use, the cryo transfer device can be stored under vacuum in the pumped storage tube, located on the Prepdek® work surface



Typical screen view during operation (with camera image minimized)

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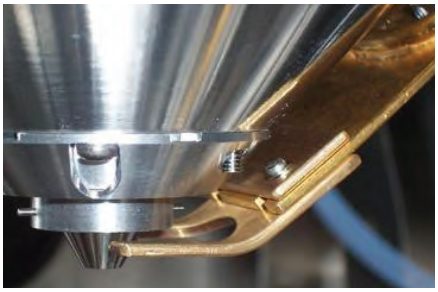


Gas-cooled SEM cold trap (temperatures down to -190°C). Tailor-made to suit each SEM

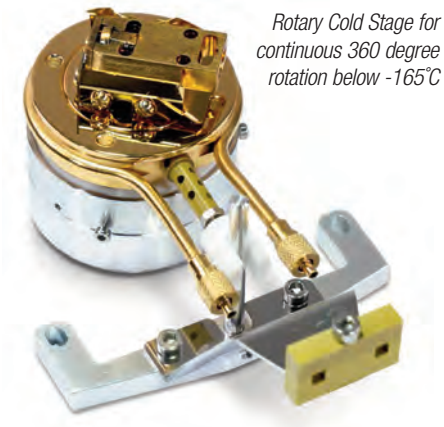
systems. The SEM cold stage has a temperature range of down to -190°C and a temperature stability of < 0.5°C.

Compatibility with SEM Stage Bias Mode
The PP3010 cold stage is fully compatible with SEM stage bias/beam deceleration modes of up to 5kV.

CHE3010 Off-Column Cooling
The CHE3010 is a fully integrated, remotely mounted cooling system which comes as standard with every PP3010. The CHE3010 is used to cool the SEM stage, SEM cold trap and cryo preparation chamber cold stage and cold traps and will typically reach temperatures down to -90°C or lower.

The CHE3010 is remotely positioned (typically on the floor behind the microscope) and at normal operating temperatures can run for up to 24 hours between fills. This greatly simplifies the cryo process (no more checking on dewar status and topping off), but also allows overnight, unattended operation – particularly useful for some automated FIB/SEM "slice and view" protocols.

Single Port Interface to the SEM or FIB/SEM
Where SEM geometry allows, both the cryo preparation chamber and the SEM cooling system can be fitted to a single chamber port (the minimum port diameter is 38 mm). This gives a tidy installation and frees up a valuable chamber port.



Rotary Cold Stage for continuous 360 degree rotation below -165°C

OPTIONS AND ACCESSORIES

Rapid Warming Tower for the CHE3010
This device is meant to facilitate a rapid warming of the CHE3010 (Cryo-Heat Exchanger) associated with the PP3010 Cryo-SEM preparation system. The Rapid Warming Tower in conjunction with a 1 liter/min Nitrogen gas flow rate dramatically reduces the lag time before the SEM or Prep chamber components return to room temperature so venting can occur. A process that normally takes hours can be completed in minutes, allowing maintenance or reconfiguring the SEM back to room temperature operation. Accepts many common, locally obtained hair dryers. (Hair Dryer not included).

Specimen shuttles and stubs
The PP3010 is supplied with a selection of holders, and a range of additional specimen shuttles and stubs is also available. (See Ordering Information for details).

Carbon Evaporation and Film Thickness Monitor
A carbon evaporation attachment and a terminating film thickness monitor can be fitted. Both are fully integrated (no external control boxes required).

Pressurized LN_2 Dewar
The PP7450/60L is a highly recommended option that generates dry nitrogen gas used for cooling the SEM cold stage & cold trap and cryo preparation chamber and cold shields. In addition, LN_2 can be decanted for slushing (freezing). During normal operation the PP7450/60L will generate dry nitrogen gas for up to eight days usage.

If the PP7450/60L is not included, appropriate, locally sourced, nitrogen gas cylinders can be used. It is important to ensure that it has low moisture content – if in doubt, please contact us.

Cryoflow Work Options

Glove Box Valve/Airlock Interface
The airlock is connected to a glove box using a generic NW fitting and for most applications requires a suitable pumping system (rotary pump or turbomolecular plus diaphragm pumping system).

The airlock is designed to accept the PP3010 vacuum transfer device.

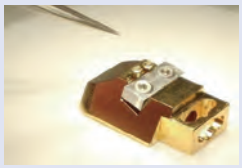
For full details of this and other accessories please see Ordering Information.

TEM Prep Slusher Option
Offers an easy, convenient way of transporting pre-frozen specimens to and from the PP3010.

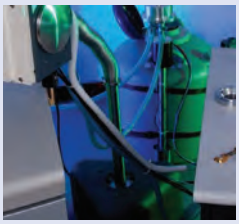
- Conveniently locates into the Prepdek® workstation of the PP3010
- Freely transportable, e.g. between high pressure freezer, cryoultramicrotome and the PP3010
- Ideal for loading/unloading TEM grids and grid holders
- Tilting holder for cryo shuttles (holders). Allows the easy transfer of specimens from external freezers (e.g. high pressure, jet, slam etc)
- Option for PP3010 and previous PP3000T and PP2000/PP2000T models

Pre-Frozen Sample Loading Jig for PP3010
This loading jig allows you to comfortably load pre-frozen samples, ie: HPF or Rivets, into the PP3010 specimen shuttles (not included). The loaded shuttles can then be transferred to the PP3010 slushing pot on the Prepdek®. Includes the LN_2 container, Lexan cover, loading jig, and a short transfer rod.

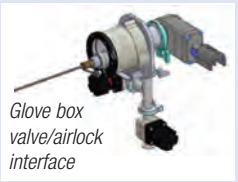
Rapid Warming Tower



Specimen shuttle



Gas cooling dewar and turbo pump

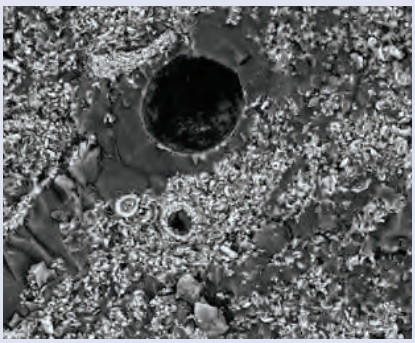


Glove box valve/airlock interface

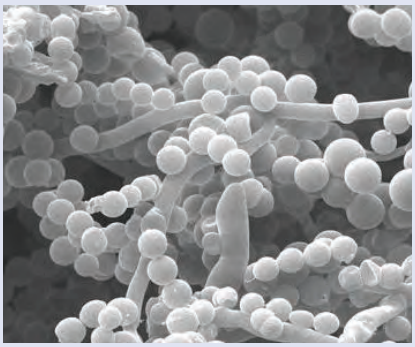
Cryo preparation chamber with cryo transfer device fitted

Pre-Frozen Sample Loading Jig

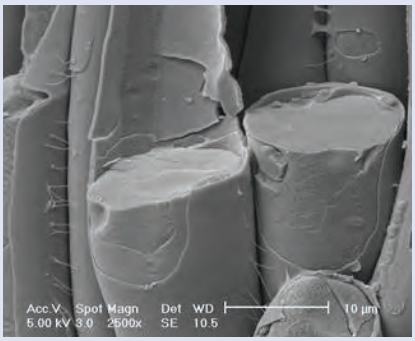
CRYO-SEM & CRYO-FIB/SEM PREPARATION SYSTEMS



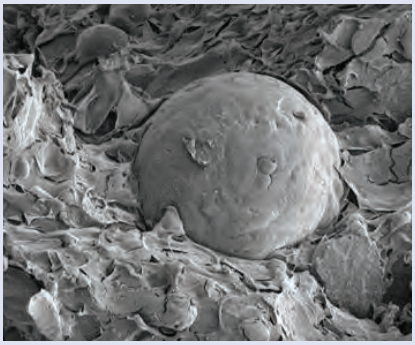
Cross-section of oil/water/rock.



Cryo prepared image of blue stilton cheese (Penicillium roqueforti).



Cross-section through plant palisade cells.



Cross-section image through sunscreen

SPECIFICATIONS

Cryo Preparation Chamber (column-mounted)

Gas cooled preparation chamber with a twenty-four hour run time between fills	**Yes**
Two integral gate valves (loading and SEM) with appropriate electrical interlocks	**Yes**
Variable temperature gas-cooled specimen stage	**Yes**
Large cold shield above, below, behind the cold stage	**Yes**
Robust micrometer-fed fracturing knife (actively cooled)	**Option**
Side-mounted surface knife/probe (actively cooled). A range of scalpel blades can be fitted to suit different specimen requirements	**Yes**
Automatic sublimation (controlled and viewed on the touch screen)	**Yes**
Fully automatic, high resolution sputter coater with platinum (Pt) target. (Other targets, including gold (Au), gold/palladium (Au/Pd), chromium (Cr) and iridium (Ir), are available as options.) Sputtering controlled and viewed on the user touch screen	**Yes**
Carbon fiber evaporation head and power supply	**Option**
Large front viewing window (150 x 78mm) plus top viewing ports	**Yes**
Preparation chamber camera (CCD)	**Yes**
Vacuum transfer device	**Yes**
Chamber illumination — three LEDs	**Yes**

Pumping System and Controls

Remotely-mounted turbomolecular pumping system (70L/s). Includes: vacuum buffer tank, vacuum valves and stainless-steel bellows connection to the preparation chamber. Typical preparation chamber vacuum when cold: 10^{-7} mbar	**Yes**
Single 50L/m rotary pump required	**Order separately**

SEM Cooling Dewar, SEM Cold Stage and Cold Trap (anticontaminator)

Gas-cooled nitrogen cold stage assembly (-190°C). Temperature stability of >0.5°C	**Yes**
Separate gas-cooling circuits for SEM stage and SEM anti-contaminator	**Yes**
21L capacity, off-column cooling dewar with run time between fills of up to 24 hours	**Yes**
SEM CCD camera-fitted when space allows	**Yes**
LED lighting (interlocked)	**Yes**

System Control and Specimen Handling

Control via a color user touch screen monitor (15") mounted on the Prepdek® **Yes**

- Multi-ability user interface screen
- Quick, easy overview of system status
- User-definable "recipes" can be stored
- Quick access to videos outlining preparation techniques and system maintenance
- Fully automatic sputtering
- Automatic sublimation
- Quick, easy overview of system status
- CCD camera image of preparation chamber

Twin liquid nitrogen slushing and specimen handling system — ideal for handling pre-frozen specimens. Mounted on the Prepdek®	**Yes**
System electronics stored in a ventilated, sealed unit under the Prepdek®	**Yes**
Specimen shuttles (x2). E7449-9 multi-specimen stubs (pack of 10) and E7402 blank aluminium (Al) stubs (pack of 10). Other shuttles and stubs available – see Ordering Information	**Yes**

Specimen Shuttles and Stubs (Others available — see Ordering Information)

- (2) Specimen shuttles (to hold 10 mm diameter cryo stubs)
- Blank 10 mm stubs – pack of 10
- Multi-stubs 7 mm high (with holes and slots) – pack of 5
- Multi-stubs 5 mm high (with holes and slots) – pack of 5
- Dovetail holder shuttle
- Brass rivets for fracturing liquids – pack of 100
- Copper (Cu) stub with 3 mm x 3 mm slot – pack of 5
- Copper (Cu) stub with 1 mm x 3 mm slot – pack of 5 **Yes**

Installation and Training

Installation and training at the customer site	**Contact EMS**

Support and Other Information

Comprehensive start-up kit with key spares	**Yes**
Three-year warranty	**Yes**
SEM column interfaces and SEM stage adaptor (tailored to each microscope)	**Yes**

Some Options and Accessories (see Ordering Information for full list)

Terminating film thickness monitor (FTM)	**Option**
Self-pressurizing LN_2 dewar and regulator (for storage and venting)	**Option**
Carbon fiber evaporation head	**Option**
Wide range of specimen holders and specimen stubs	**Option**

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PP3010 Cryo-SEM/Cryo-FIB/SEM Preparation System (continued)

ORDERING INFORMATION

For a full quotation, including on-site installation and customer training, please contact us.

PP3010	**Turbo Pumped Cryo System for SEM, FE-SEM and FIB/SEM.** Includes 13297 Sircal gas dryer. For a full detailed description please contact us	each

Pumping

PP3010 has an integrated turbomolecular pump, but also requires a 13034 rotary pump or 20063 oil-free scroll pump

13034	Pfeiffer DUO-6 5m3/hr rotary vacuum pump with oil mist filter	each
20063	Edward NXDS6i oil-free scroll pump (replaces 13034 rotary pump)	each

Shipping

13064	Wooden crate and packing for export	each

Installation and Training

PP3010-I	Installation and training - Four day on site installation and customer training	
PP3010-T	Engineer costs - Travel from PA to customer site, including local hotels	

PP3010 Options and Accessories

PP7450	60 liter pressurized liquid nitrogen dewar. Used for generating dry nitrogen gas required to cooling the SEM stage and cold trap plus preparation chamber cold stage and cold traps. If not ordered, cylinder gas can be used (check purity requirement with EMS)	each
11000	Rotary Cold Stage: standard stage alternative, tilts up to 52°, rotates 360°, maintains desired cryotemperatures	each
10996	Glove Box Interface/Airlock – for vacuum or inert gas transfer	each
10997	TEM Prep Slusher option for transporting pre-frozen specimens to and from the PP3010	each
PP3050-SLJ	Pre-Frozen Sample Loading Jig for PP3010	each
13297 **13298**	Sircal nitrogen gas dryer 220-240V (100-110V part: 13298). *Note: useful if quality of the nitrogen gas source is unknown. Included with PP3010*	each
PP7424	Binocular stereo microscope with fitting to the PP3010 cryo preparation chamber. Note: the PP3010 preparation chamber is fitted with a CCD camera as standard. Both PP7424 and CCD can fitted together	each
20996	Carbon fiber evaporation head and power supply, including 100cm of high purity carbon fiber.	each
12147	Terminating film thicknesss monitor (FTM)	each
12145	Micrometer controlled fracturing device with tooled steel blade.	each
PP3050-RWT	CHE3010 Rapid Warming Tower	each
12340-SPARE	Cryo transfer device (spare) - one included with PP3010	each

Specimen Shuttles (dovetail). Some will accept 10mm dia.

AL200077B	Standard specimen shuttle with 10m hole for cryo stub. Two included with PP3010	each
12434	Blank specimen shuttle for large specimens. Total area: 290 mm^2	each
20718	Blank specimen shuttle with extended length for large specimens. Total area: 350 mm^2	each
20720	Shuttle for large, flat specimens (with light microscope-style stage clips)	each
13524	Shuttle for clamping hard, flat specimens. Suitable for flat specimens (front of shuttle with clamp lever) and cross-fracturing (sprung-loaded vice at rear of shuttle).	each
12013	For clamping, larger flat specimens (handle removed after loading specimen). Useful for loading pre-frozen specimens	each
25276-Q	Shuttle for clamping hard flat specimens (clamps for upright and flat mounting)	each
10245	Cryo shuttle for high pressure freezer ("Balzer") planchette-style holders	each
13054	Shuttle for clamping hard, flat specimens. Suitable for flat specimens (front of shuttle shown with clamp lever) and cross-fracturing (sprung-loaded vice)	each
20529	Top loading specimen holder shuttle (similar to AL200077B but stub clamping mechanism is located on the top – useful for handling pre-frozen specimens mounted on a stub). One included with PP3010	each
13419	Tilt-rotate shuttle. Tilt and rotation can be altered on the preparation chamber cold stage using system knife/probe	each
20530	Top loading, vice style specimen shuttle for directly clamping two 328116510 fracturing rivets	each
12406	TEM grid holder cryo shuttle, including cryo shield, for cryo-FIB/SEM applications. Takes two TEM "Autogrids"	each
12922	Cryo shuttle for FEI Polara™ cartridge	each
13359	STEM shuttle for 3mm TEM grid, includes grid location tool. For STEM detectors mounted below the SEM cold stage	each

Specimen Holder Stubs (10mm dia.) For use with appropriate shuttles

E7433	10mm diameter specimen stub for freeze fracture rivets (fits into 10246)	each
E7402	Specimen stub, aluminum (10mm dia. X 5mm high) blank, pkt of 10. One packet included with PP3010	each
E7449-5	Multi-purpose specimen stub with slots and holes, 10 mm dia. X 7 mm high (pack of five). One pack included with PP3010	each
11541	1 x multi-purpose specimen stub with slots and holes (10 mm dia. X 5 mm high) blank. Five included with PP3010	each
E7402	Aluminum stubs, 10 mm dia. x 5 mm, high, blank, pkt of 10. One packet included with PP3010	each
E7403	Specimen stub, copper (10mm dia. X 5mm high) blank, pkt of 10.	each
E7405	Specimen stub for clamping thin, flat specimens x 1	each
E7406	Specimen stub, copper with 3mm wide x 3mm deep slot, pkt of 5	each
E7407	Specimen stub, copper with 1mm wide x 3mm deep slot, pkt of 5	each
328116510	Rivets for liquid fracture (pkt 100). One packet included with PP3010	each

Spares Kit

13061	Two-years consumable and basic spares kit for PP3010	each

Sputtering Targets and Carbon Fiber

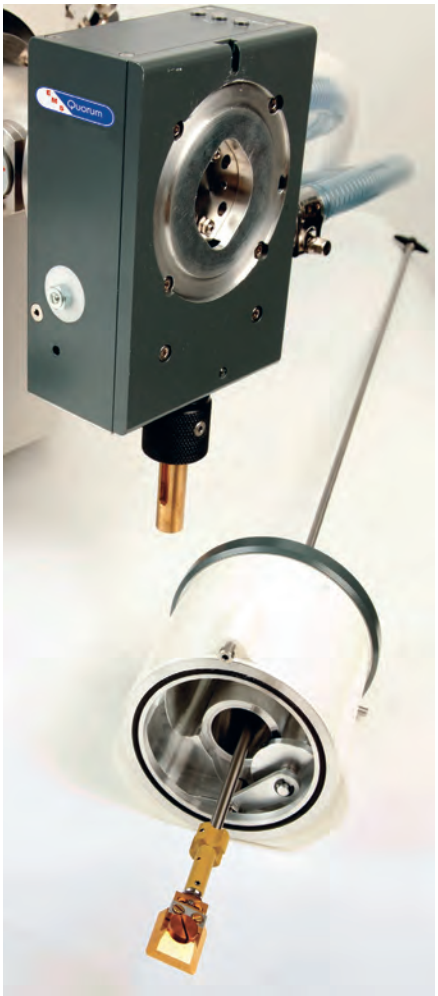
(All targets 24.5 mm in diameter) - all other target types available upon request

E7400-314A	Gold (Au) sputtering target, 24mm dia. X 0.2mm thick	each
E7400-314B	Gold/Palladium (Au/Pd) sputtering target, 24mm dia. X 0.2mm thick	each
E7400-314C	Platinum (Pt) sputtering target, 24mm dia. X 0.2mm thick. One included with the PP3010	each
E7400-314IR	Iridium (Ir) sputtering target, 24mm dia. X 0.3mm thick	each
E7400-314CR	Chromium (Cr) target 0.3 mm thick	each
91047-1	Carbon fiber cord - standard grade (1M)	each
91047-5	Carbon fiber cord - standard grade (10M)	each

Cryo Transfer Systems

Building on the success of the PP3010 cryo-SEM/FIB/SEM preparation system, we are pleased to announce three new related products for ambient and cryo temperature transfer.

PP3004 QuickLok



QuickLok and specimen transfer device

PP3004 QuickLok

Ambient temperature airlock for SEM, FIB/SEM, beamline and vacuum platforms

Quick Overview

The QuickLok provides a rapid way of transferring ambient temperature specimens into SEM, FIB/SEM or other suitable vacuum systems. A key feature of the QuickLok is the ability to vacuum transfer specimens that are sensitive to normal environmental conditions. The transfer device uses a sealed vacuum chamber which can be interfaced to a glove box for inert gas transfer or allow vacuum transfer from a wide range of platforms.

Key Features

- **Rapid specimen exchange**
- **Vacuum and inert gas transfer**
- **Field-retrofittable to most systems**
- **Upgrade path to CoolLok**
- **Custom designed holders available**
- **3 year warranty**

Specimen Holder Examples

Components

Mounted onto a suitable vacuum chamber port, the QuickLok consists of a loading chamber body with integrated controls for pumping, venting and transfer. A custom-designed interface flange and connections to the pumping system are included (see Pumping below).

The compact vacuum transfer device has an easy-release bayonet fitting to a dovetail-profile specimen holder (shuttle). Standard shuttles are included, but optional holders allow a range of specimen types to be handled.

Inside the microscope is a stage to accept the specimen shuttle. To aid specimen exchange an interlocked LED chamber light is mounted to the inside of the QuickLok interface.

Use

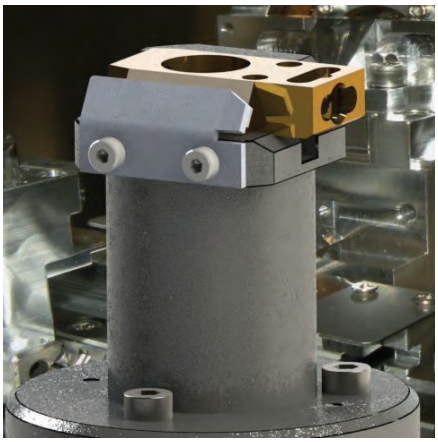
The specimen is mounted on a suitable holder and the transfer device fitted onto the QuickLok. The airlock and transfer device are then evacuated to a pre-set vacuum and the gate valve opened. The specimen is then guided onto the microscope stage.

For transfer from other vacuum systems, or a glove box, additional interface flanges are available on request.

Pumping

The QuickLok requires either a rotary pump or oil-free vacuum turbomolecular pumping station (see Options).

Simple controls for specimen exchange



QuickLok specimen stage and adaptor to SEM

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Cryo Transfer Systems (continued)

PP3005 SEMCool

Non-airlock cryo cooling for SEM, FIB/SEM, beamline and vacuum platforms

Quick Overview

The SEMCool is based on the PP3006 CoolLok but without the PP3004 QuickLok components. It is designed for cryogenic applications where airlock exchange of specimens into the microscope is not required.

Key Features

- Temperature range down to -190°C, with stability better than 0.5°C
- Off-column cooling with all-day runtime between fills
- Independent cooling of cold stage and cold trap
- Upgrade path to CoolLok
- 3 year warranty

Components

Specimen holders and transfer device: The compact vacuum transfer device has an easy-release bayonet fitting to a dovetail-profile specimen holder (shuttle). Standard shuttles are included, but optional holders allow a range of different specimen types to be handled.

Cold stage and cold trap: A highly stable, thermally isolated, nitrogen gas-cooled cold stage attaches to the microscope stage. The location and shape of the cold trap is tailored to suit the internal geometry of the microscope. Both cold stage and cold trap are capable of reaching temperatures down to -190°C with a stability of <0.5°C. For easy specimen exchange an LED chamber light is fitted.

The cold stage connects to the microscope stage using an adaptor and has a dovetail fitting to accept a specimen holder. When not in use the cold stage is uncoupled and stored within the chamber with the gas and electrical fittings connected.

Cooling dewar, trolley and controller: The cold stage and cold trap are cooled by a remotely-positioned, vacuum isolated 21 L dewar and heat exchanger assembly which at normal operating temperatures can run for up to 24 hours between fills. The gas lines between the dewar and the microscope interface are vacuum isolated for maximum thermal efficiency.

The cooling dewar sits on a floor-mounted trolley which also houses the monitor/controller for cold stage and monitor for cold trap, plus nitrogen gas flow controllers.

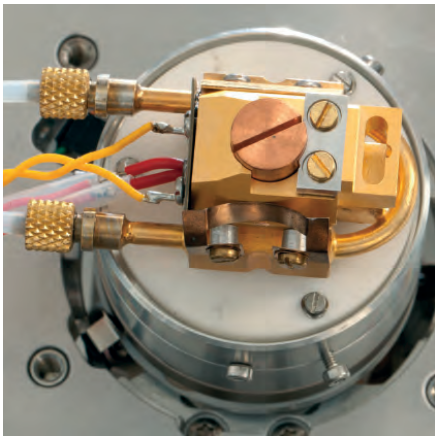
Use

Vent the SEM, locate specimen holder on the cold stage, re-pump the SEM and then cool down to the required temperature. To exchange specimen, warm to above 0°C and vent the SEM.

Pumping

The SEMCool requires a rotary pump to periodically evacuate the vacuum isolated lines (see Ordering Information).

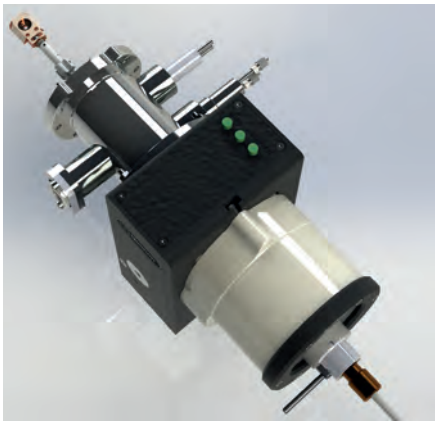
Temperature controller



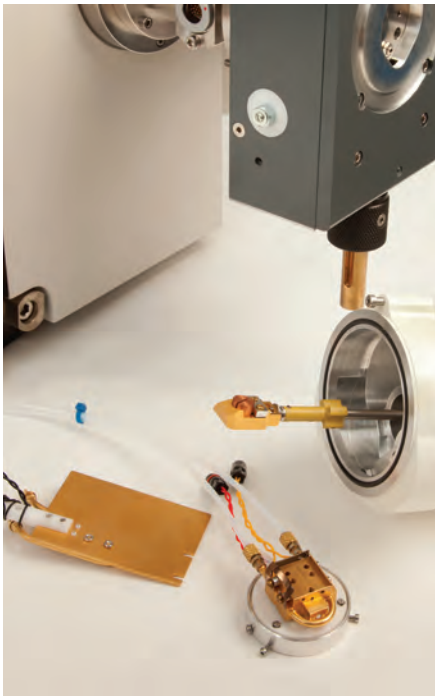
PP3005 SEMCool

Cold trap - adapted to installation

Controller and cooling system



PP3006 CoolLok



On-microscope components: airlock, cold stage, cold trap plus cryo transfer device

Load lock with vacuum isolated gas cooling lines

III Cryo Transfer Systems (continued)

PP3006 CoolLok

Cryo transfer systems for SEM, FIB/SEM, beamline and vacuum platforms

Quick Overview

The CoolLok offers rapid transfer and cryo temperature observation of specimens for SEM, FIB/SEM, beamline or other vacuum systems. Applications include thermal protection of beam-sensitive specimens and low temperature observation of materials such as plastics, polymers low-K dielectrics and hard-soft mixtures. The system can also be used for inert gas transfer of ambient temperature specimens from a glove box.

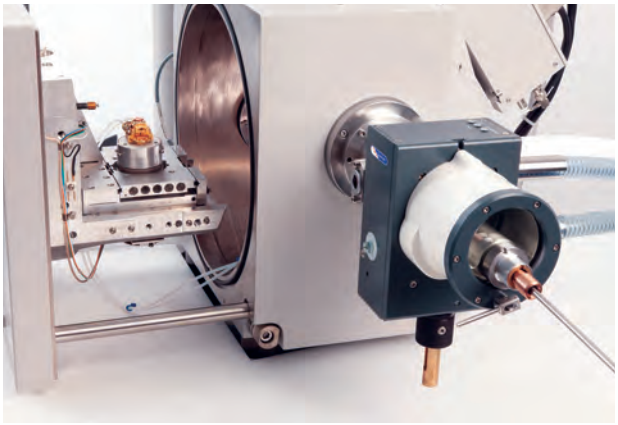
Please Note: The PP3006 is not a replacement for the PP3010, which is a full cryo preparation system. The PP3006 does not have a cryo preparation chamber and is designed for materials applications where cold fracturing and sputtering are not required.

Key Features

- **Rapid specimen exchange**
- **Temperature range down to -190°C with stability better than 0.5°C**
- **Off-column cooling with all-day runtime between fills**
- **Independent cooling of cold stage and cold trap**
- **Vacuum or inert gas transfer**
- **Rapid specimen freezing option**
- **3 year warranty**

Components

Vacuum airlock cold gas feedthrough Mounted onto a suitable vacuum chamber port, the CoolLok consists of a loading chamber body with built-in controls for pumping, venting and transfer. A custom-designed interface flange to the vacuum chamber and connections and fittings to the pumping system are included (see Pumping below). The interface has cold nitrogen gas feeds to and from the microscope cold stage and cold trap.



PP3006 installation example

Specimen holders and transfer device The compact vacuum transfer device has an easy-release bayonet fitting to a dovetail-profile specimen holder (shuttle). Standard shuttles are included, but optional holders allow a range of different specimen types to be handled.

Cold stage and cold trap A highly stable, thermally isolated, nitrogen gas-cooled cold stage attaches to the microscope stage. The location and shape of the cold trap is tailored to suit the internal geometry of the microscope. Both cold stage and cold trap are capable of reaching temperatures down to

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III Cryo Transfer Systems (continued)

PP3006 CoolLok (continued)

-190°C with a stability of <0.5°C. For easy specimen exchange an LED chamber light is fitted.

The cold stage connects to the microscope stage using an adaptor and has a dovetail fitting to accept a specimen holder. When not in use the cold stage is uncoupled and stored within the chamber with the gas and electrical fittings connected.

Cooling dewar, trolley and controller The cold stage and cold trap are cooled by a remotely-positioned, vacuum isolated 21L dewar and heat exchanger assembly which at normal operating temperatures can run for up to 24 hours between fills. The gas lines between the dewar and the microscope interface are vacuum isolated for maximum thermal efficiency.

The cooling dewar sits on a floor-mounted trolley which also houses the monitor/controller for cold stage and monitor for cold trap, plus nitrogen gas flow controllers.

Rapid freezing station (24429) With the standard CoolLok, specimen freezing is by contact with the microscope cold stage following transfer and therefore freezing rates are relatively slowly. This is suitable for hard, non-hydrated specimens, but for liquid-based material rapid freezing is essential to reduce the detrimental effects of ice crystal growth and to allow through-vacuum transfer onto the cold stage.

For these applications the optional nitrogen slush freezing station is required. However, for many applications (especially lifesciences) cold fracturing and sputter coating are essential process steps and require the advanced capabilities of the EMS PP3010 – a full cryo preparation system.

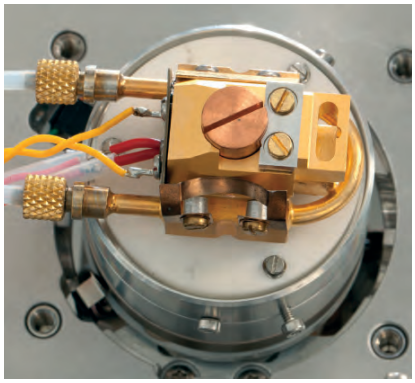
Use

The specimen is mounted on a suitable holder (shuttle) and the transfer device fitted onto the airlock and the dead space evacuated to a pre-set vacuum level. The gate valve is opened and the specimen guided onto the SEM stage.

For transfer from other vacuum systems, or a glove box, additional interface flanges are available on request. Vacuum transfers can be made from the optional 24429 trolley-mounted nitrogen slush freezing station, if fitted.

Pumping

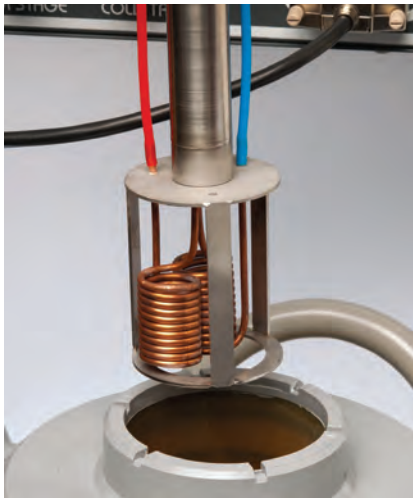
The QuickLok requires either a rotary pump or oil-free turbomolecular pumping station (see Options).



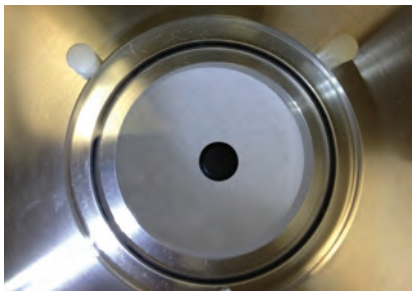
Cold stage

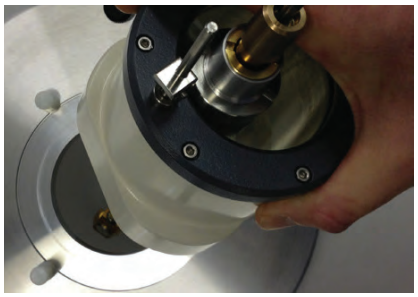
Cold trap - adapted to installation

Dewar and Controller



Heat exchanger





Plunge freezing in slushy nitrogen

III Cryo Transfer Systems (continued)

SPECIFICATIONS for PP3004, PP3005, PP3006

	PP3004	PP3005	PP3006
Temperature	Ambient	RT to -190°C	RT to -190°C
Cooling Runtime	N/A	Up to 24 hours	Up to 24 hours
LN_2 Dewar Capacity	N/A	21 liters	21 liters
Cool-Down Time to -190°C	N/A	Typically <15 minutes	Typically <15 minutes
Rapid Freezing (slushy LN_2)	N/A	Optional (24429)	Optional (24429)
Dewar Trolley Footprint	N/A	50 x 50 cm	50 x 50 cm
Airlock Weight	2.5 kg	2.5 kg	2.5 kg
Pumping Requirements	Rotary pump or dry pump	Rotary pump or dry pump	Rotary pump or dry pump
Nitrogen Gas	For venting and valve operation	Venting and cooling	Venting and cooling
Power Requirements (excluding pump)	300 W	300 W	300 W
Maximum Specimen Size	Flat specimens up to 23 x 26 mm. For taller specimens the maximum height will reduce from a mid-point of 9mm. Please contact us for more details.		

ORDERING INFORMATION *For a full quotation, including on-site installation and customer training, please contact us.*

PP3004	**QuickLok Ambient Temperature Transfer System Includes:**	
	Airlock assembly. Pump and vent and transfer controls, valve and fittings to the pumping system (see: Pumping below). Custom designed interface flange to the microscope vacuum chamber	
	Microscope dovetail stage to accept specimen shuttle. LED chamber light (interlocked)	
	Specimen transfer device for vacuum or inert gas transfer	
	Specimen holders. Specimen shuttle with holding clips, specimen shuttle blank, specimen shuttle (to hold a 10mm dia. specimen stub), blank 10 mm stubs – packet of 10	each
PP3005	**SEMCool Non-Airlock Low Temperature System Includes:**	
	Nitrogen gas cooled cold stage with heater and sensor and cold trap with temperature sensor. Temperature controllable with a range down to -190°C, 21 L liquid nitrogen dewar with trolley, heat exchanger and LED chamber light. Pump fittings (see: Pumping below).	
	Temperature and nitrogen gas flow controller mounted on the dewar trolley.	
	Specimen holders. 3 specimen shuttles (to hold 10 mm Ø cryo stubs), blank specimen shuttle, specimen shuttle with holding clips, blank 10 mm Ø stubs (packet of 10), 5 multi-purpose specimen stubs. Note: other holders available	
	Specimen mounting compounds (colloidal graphite and Tissue-Tek®)	each
PP3006	**CoolLok Cryo Transfer System Includes:**	
	Airlock assembly. Pump and vent and transfer controls, gate valve and fittings to the pumping system (see: Pumping below). Custom designed interface flange to the microscope vacuum chamber.	
	Cooling system. Nitrogen gas cooled cold stage with heater and sensor and cold trap with temperature sensor. Temperature controllable with a range down to -190°C, 21 L liquid nitrogen dewar with trolley, heat exchanger and LED chamber light.	
	Specimen transfer device	
	Specimen holders. 3 specimen shuttles (to hold 10 mm Ø cryo stubs), blank specimen shuttle, specimen shuttle with holding clips,blank 10 mm Ø stubs (packet of 10), 5 multi-purpose specimen stubs. Note: other holders available	
	Specimen mounting compounds (colloidal graphite and Tissue-Tek®), interlock cable and pump fittings	each

Pumping

The PP3004 QuickLok and PP3006 CoolLok require either a rotary pump or high vacuum turbomolecular pumping station (recommended). The PP3005 requires a rotary pump for evacuating the vacuum isolated gas lines.

13034	Pfeiffer Duo 6 — 5 m^3/hr rotary vacuum pump with oil mist filter	each
24426	Pfeiffer HiCube 80 turbomolecular and diaphragm pumping system	each

Options and Accessories

24429	Rapid cooling station (for PP3006 only) Consists of a floor-mounted trolley, liquid nitrogen freezing chamber mounted into the work surface which interfaces to the cryo transfer device, connections to vacuum pump (order separately)	each
PP7450	Pressurized (60 L) LN_2 dewar. Boil-off nitrogen gas is used for cooling the stage and cold trap (PP3005 and PP3006 only)	each
PP3050-RWT	CHE3010 Rapid Warming Tower	each
13296	Sircal in-line gas dryer. Helps to reduce water content of nitrogen gas supply	each

Specimen Holders

10245	Top-loading specimen shuttle for planchettes	each
10246	Top-loading specimen shuttle, to take a 10mm stub	each
10247	Top-loading specimen shuttle for rivets (vice style)	each
E7433	Rivet holder specimen stub, screw-down style (for use with 10246)	each
E7449-5	Universal specimen stub with surface holes and slots (5 pack)	each
E7401	Specimen stub shuttle (spare)	each
E7402	Aluminum (Al) stubs (10 pack)	each
E7403	Copper (Cu) stubs (10 pack)	each
E7405	Screw down stub for thin, hard specimens	each
E7406	Copper (Cu) stubs with 3 x 3mm slots (5 pack)	each
E7407	Copper (Cu) stubs with 1 x 3mm slot (5 pack)	each
32816510	Brass rivets for fracturing liquids (100 pack)	each

Sputter Targets and Carbon Fiber

E7400-314A	Gold (Au) target 0.008" thick	each
E7400-314B	Gold/palladium (Au/Pd) (80:20) target 0.2mm thick	each
E7400-314C	Platinum (Pt) target 0.008" thick	each
E7400-314IR	Iridium (Ir) target 0.008" thick	each
E7400-314CR	Chromium (Cr) target 0.3mm thick	each
91047-1	Carbon fiber cord — high purity — 1m	each
91047-5	Carbon fiber cord — high purity — 5m	each

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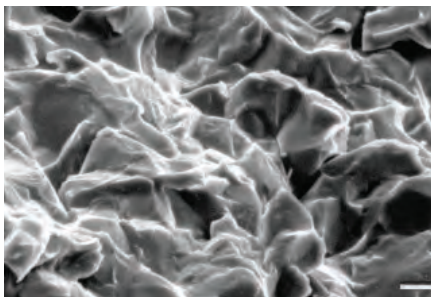
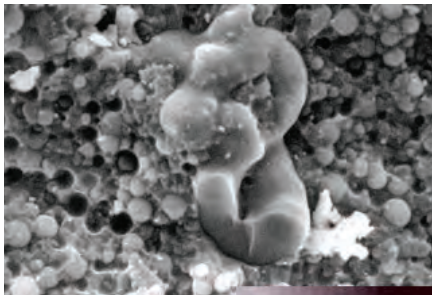


Wax crystals in gas oil

When cooled to a temperature below about 2°C, the waxes in fuel oils such as this tend to crystallize out. Wax crystal size and shape can be varied by altering the rate at which the oil is cooled.

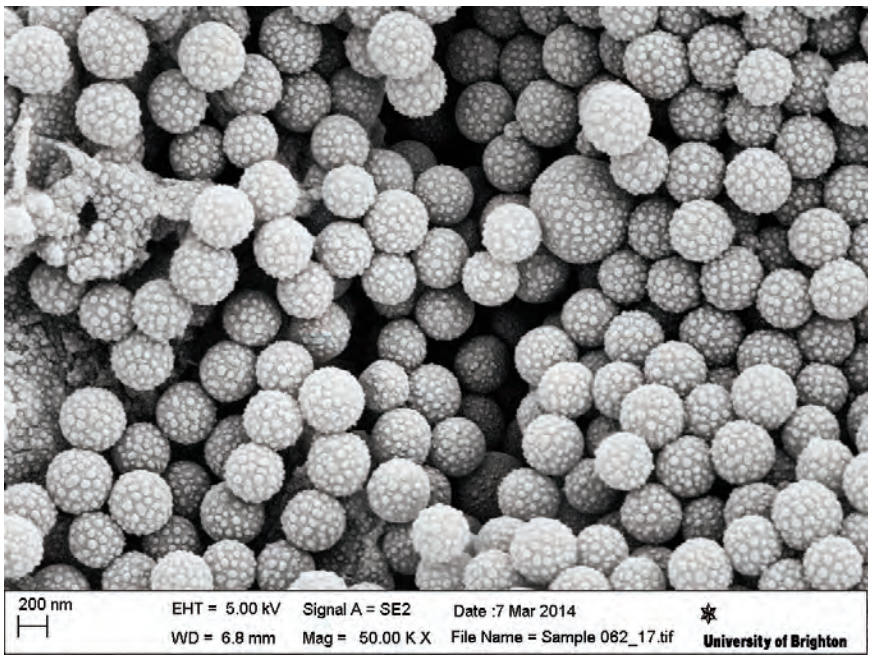


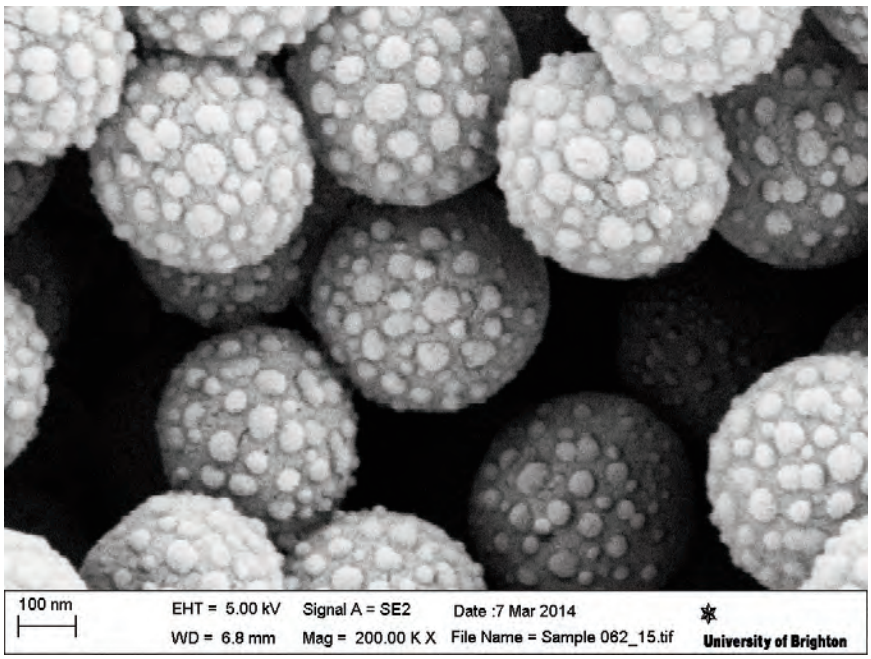
Stable emulsion of a hydrophobic polymer

This image illustrates a stable emulsion of a synthetic liquid polymer dispersed in an aqueous continuous phase.

Dendritic Ice Crystals

If it is cooled slowly, water forms dendritic ice crystals. These can have a variety of branching patterns — the complexity of which depends upon cooling rate. Arms extend from the main body of the crystal at an angle of 60°. Some, such as the one illustrated, resemble the arms of a snowflake. Bar: 2um





Latex

Latex particles are very electron beam sensitive, so cryo-SEM is an ideal method for their observation

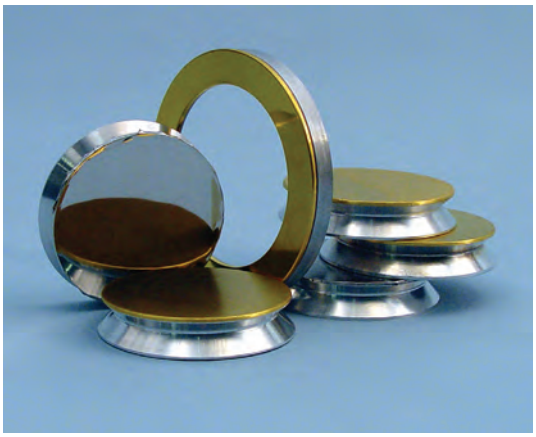
SPUTTER TARGETS

EMS precious metal sputtering targets are made from high purity metals, starting 99.99% with most standard disc sizes, for use on most sputtering units from many manufacturers: Emitech, Emscope, Bio-Rad, Polaron, Edwards, Balzers, Plasma Sciences, Technics Hummers, Denton, Cressington, and much more.

Our targets come in a standard thickness of 0.1 mm (100µm). Other thickness, ranging from 0.05 to 6 mm, are available upon request. Targets are available mounted or unmounted whichever you prefer. For mounting please always state the make and the model of the sputtering unit so we can tend to it for you. Targets in other materials such as Chromium, Iridium etc. are available upon request. We also can manufacture targets with diameters from 4 mm to 304.8 mm (12"). Call for pricing.

Ordering Information:

EMS strives to maintain accurate pricing. However, due to fluctuations in precious metal prices, pricing on products containing precious metals is not guaranteed. We will contact you if there is a discrepancy.



Target Diameter, mm	EMS Catalog Number								
	Gold (Au)	Platinum (Pt)	Palladium (Pd)	Au/Pd 60:40	Pt/Pd 80:20	Silver (Ag)	Nickel (Ni)	Iridium (Ir)	Copper (Cu)
20.0	91006-Au	91006-Pt	91006-Pd	91006-AP	91006-PP	91006-Ag	91006-Ni	91006-Ir	91006-Cu
20.4	91007-Au	91007-Pt	91007-Pd	91007-AP	91007-PP	91007-Ag	91007-Ni	91007-Ir	91007-Cu
32.0	91008-Au	91008-Pt	91008-Pd	91008-AP	91008-PP	91008-Ag	91008-Ni	91008-Ir	91008-Cu
39.0	91009-Au	91009-Pt	91009-Pd	91009-AP	91009-PP	91009-Ag	91009-Ni	91009-Ir	91009-Cu
42.0	91013-Au	91013-Pt	91013-Pd	91013-AP	91013-PP	91013-Ag	91013-Ni	91013-Ir	91013-Cu
50.0	91014-Au	91014-Pt	91014-Pd	91014-AP	91014-PP	91014-Ag	91014-Ni	91014-Ir	91014-Cu
50.8	91015-Au	91015-Pt	91015-Pd	91015-AP	91015-PP	91015-Ag	91015-Ni	91015-Ir	91015-Cu
54.0	91016-Au	91016-Pt	91016-Pd	91016-AP	91016-PP	91016-Ag	91016-Ni	91016-Ir	91016-Cu
57.0	91017-Au	91017-Pt	91017-Pd	91017-AP	91017-PP	91917-Ag	91917-Ni	91917-Ir	91917-Cu
60.0	91010	91012	91010-Pd	91011	91010-PP	91010-Ag	91010-Ni	91010-Ir	91010-Cu
63.5	91018-Au	91018-Pt	91018-Pd	91018-AP	91018-PP	91018-Ag	91018-Ni	91018-Ir	91018-Cu
75.0	91019-Au	91019-Pt	91019-Pd	91019-AP	91019-PP	91019-Ag	91019-Ni	91019-Ir	91019-Cu
76.0	91020-Au	91020-Pt	91020-Pd	91020-AP	91020-PP	91020-Ag	91020-Ni	91020-Ir	91020-Cu
Annular Targets (Outside Diameter x Inside Diameter, mm)									
1170D x 89 ID	91030-Au	91030-Pt	91030-Pd	91030-AP	91030-PP	91030-Ag	91030-Ni	91030-Ir	91030-Cu
87 OD x 57 ID	91031-Au	91031-Pt	91031-Pd	91031-AP	91031-PP	91031-Ag	91031-Ni	91031-Ir	91031-Cu
59 OD x 33 ID	91032-Au	91032-Pt	91032-Pd	91032-AP	91032-PP	91032-Ag	91032-Ni	91032-Ir	91032-Cu
57 OD x 40 ID	91033-Au	91033-Pt	91033-Pd	91033-AP	91033-PP	91033-Ag	91033-Ni	91033-Ir	91033-Cu

Target Diameter, mm	EMS Catalog Number								
	Chromium (Cr)	Tungsten (W)	Carbon (C)	Titanium (Ti)	Iron (Fe)	Cobalt (Co)	Molybdenum (Mo)	Magnesium (Mg)	Tantalum (Ta)
20.0	91006-Cr	91006-W	91006-C	91006-Ti	91006-Fe	91006-Co	91006-Mo	91006-Mg	91006-Ta
20.4	91007-Cr	91007-W	91007-C	91007-Ti	91007-Fe	91007-Co	91007-Mo	91007-Mg	91007-Ta
32.0	91008-Cr	91008-W	91008-C	91008-Ti	91008-Fe	91008-Co	91008-Mo	91008-Mg	91008-Ta
39.0	91009-Cr	91009-W	91009-C	91009-Ti	91009-Fe	91009-Co	91009-Mo	91009-Mg	91009-Ta
42.0	91013-Cr	91013-W	91013-C	91013-Ti	91013-Fe	91013-Co	91013-Mo	91013-Mg	91013-Ta
50.0	91014-Cr	91014-W	91014-C	91014-Ti	91014-Fe	91014-Co	91014-Mo	91014-Mg	91014-Ta
50.8	91015-Cr	91015-W	91015-C	91015-Ti	91015-Fe	91015-Co	91015-Mo	91015-Mg	91015-Ta
54.0	91016-Cr	91016-W	91016-C	91016-Ti	91016-Fe	91016-Co	91016-Mo	91016-Mg	91016-Ta
57.0	91017-Cr	91017-W	91017-C	91017-Ti	91017-Fe	91917-Co	91917-Mo	91917-Mg	91917-Ta
60.0	91010-Cr	91010-W	91010-C	91010-Ti	91010-Fe	91010-Co	91010-Mo	91010-Mg	91010-Ta
63.5	91018-Cr	91018-W	91018-C	91018-Ti	91018-Fe	91018-Co	91018-Mo	91018-Mg	91018-Ta
75.0	91019-Cr	91019-W	91019-C	91019-Ti	91019-Fe	91019-Co	91019-Mo	91019-Mg	91019-Ta
76.0	91020-Cr	91020-W	91020-C	91020-Ti	91020-Fe	91020-Co	91020-Mo	91020-Mg	91020-Ta
Annular Targets (Outside Diameter x Inside Diameter, mm)									
1170D x 89 ID	91030-Cr	91030-W	91030-C	91030-Ti	91030-Fe	91030-Co	91030-Mo	91030-Mg	91030-Ta
87 OD x 57 ID	91031-Cr	91031-W	91031-C	91031-Ti	91031-Fe	91031-Co	91031-Mo	91031-Mg	91031-Ta
59 OD x 33 ID	91032-Cr	91032-W	91032-C	91032-Ti	91032-Fe	91032-Co	91032-Mo	91032-Mg	91032-Ta
57 OD x 40 ID	91033-Cr	91033-W	91033-C	91033-Ti	91033-Fe	91033-Co	91033-Mo	91033-Mg	91033-Ta

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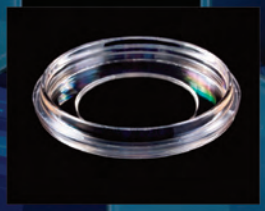

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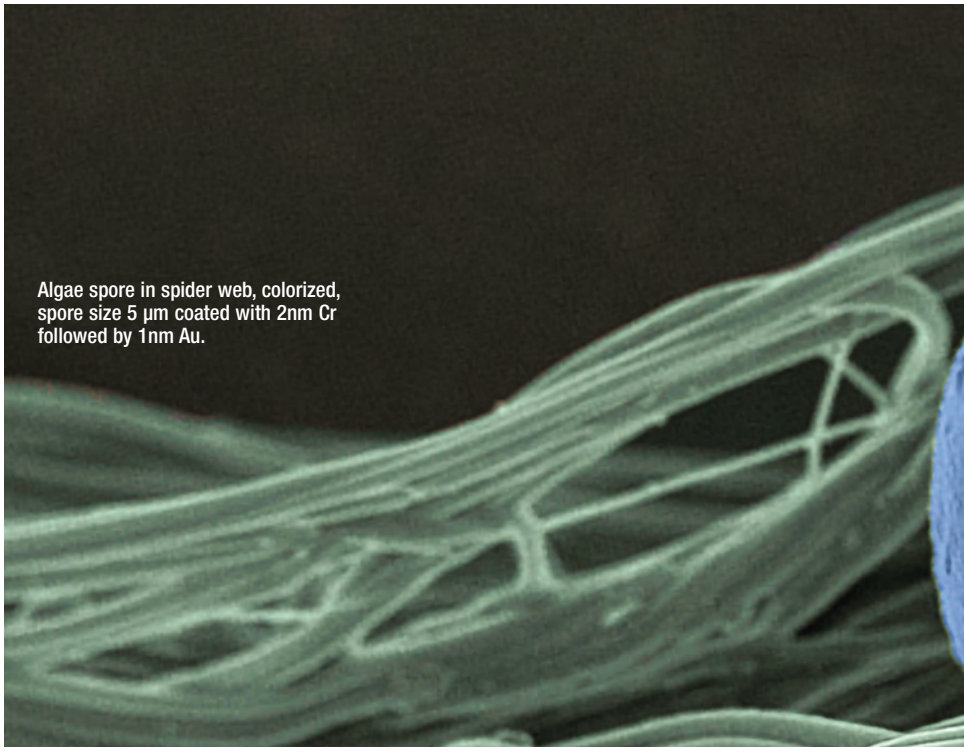
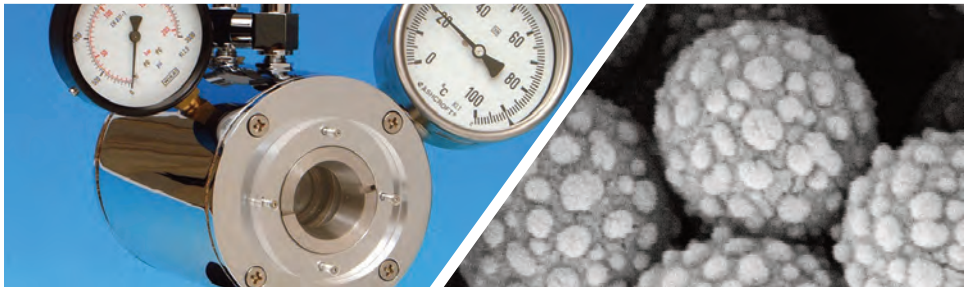


Algae spore in spider web, colorized, spore size 5 µm coated with 2nm Cr followed by 1nm Au.



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