Cryo-SEM & Cryo-FIB/SEM Preparation

TECHNIQUES & APPLICATIONS

featuring the PP3010T Cryo-SEM Preparation System

www.emsdiasum.com
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 90% of some animal and plant tissues it represents a most formidable specimen problem to most Microscopists. Cryo-SEM is a quick, reliable and effective way to overcome 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 other) by using a series of time resolved samples. Naturally the advent of various "high 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 has a number of 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" specimens (eg re-fracture and coat)

Cryo-SEM — the advantages
Quick Overview
The PP3010T 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 PP3010T 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 sublimation and specimen coating. The specimen can then be transferred 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
- Large "recipe" driven touch screen interface
- Easy to use — extensive automation, on-screen help, videos, data logging and diagnostics
- Column-mounted preparation chamber — essential for frost-free transfer and ease of use
- Cold stage temperature down to -190°C, plus comprehensive cold trapping (not possible with conduction cooling)
- Turbo pumping system mounted off-column — less mass on the SEM
- Unsurpassed specimen visibility — large front window, top viewing ports, multiple LED chamber lighting
- Cameras in the preparation chamber and SEM — cumbersome binocular not needed
- Automated start up, sublimation, and coating
- Fully compatible with SEM beam deceleration/stage bias modes up to 5kV
- Vacuum storage of the cryo transfer device
- Typical vacuum when cold: 10^-6 mbar or better — specimen transfer into the SEM always high vacuum to vacuum
- Twin liquid nitrogen slushing and specimen handling system for pre-frozen specimens
- Fracturing/specimen manipulation device
- Prepdek™ workstation — self contained work area, extra bench space not required
- Specialized support backed up with a three-year warranty

Product Description
The PP3010T is a great leap forward in cryo-SEM technology. It combines the highest quality results with unparalleled ease of use.

The PP3010T is a column-mounted, gas-cooled cryo preparation system suitable for use with SEM, FE-SEM and FIB/SEM instruments. Control is via a large and intuitive touch screen mounted on the spacious Prepdek™ workstation, giving the operator instant access to, and control of, all the key operating parameters.

Visibility is a key feature throughout the whole system. CCD camera images from the preparation chamber and the SEM are displayed on the control screen — the image can be expanded to full screen when required. Five preparation chamber viewing windows give unsurpassed visibility of the specimen and chamber interior.

On-column preparation chamber with off-column cooling and pumping
The PP3010T conveniently combines the advantages of what are often referred to as “on-column” and “off-column” cryo preparation systems. The preparation chamber is directly attached to the SEM, but with the turbomolecular pumping and advanced SEM cooling system mounted remotely from the SEM. In this way, the mass and volume attached directly to SEM is kept to a minimum.

There are significant advantages of having the preparation chamber attached directly to the SEM. In particular, specimen transfer is always from high vacuum to high vacuum, which greatly reduces the risk of specimen contamination (frosting). In addition, it makes the system easier to use and allows the operator a more flexible approach to specimen preparation and observation. This is because during a single processing run it may be useful to move the specimen between the preparation chamber and the SEM cold stage — and vice versa — on a number of occasions.
Handling and transferring specimens

The PP3010T Prepdek™ workstation is fitted with a slushy nitrogen freezing station, connected to the pumping system. Rapid freezing reduces ice crystal damage, which results in improved ultra-structural preservation. For handling pre-frozen material, the Prepdek™ is also fitted with the Advanced Specimen Handling System, which allows specimens that have been frozen by alternative freezing methods (or stored field specimens) to be manipulated in liquid nitrogen and then transferred under vacuum into the PP3010T preparation chamber for subsequent processing and observation.

The vacuum transfer device is compact, vacuum-tight and has a convenient bayonet connection to the specimen shuttle to ensure rapid transfer. In line with the automatic design of the PP3010T, when the vacuum transfer device is located on the preparation chamber, the airlock is automatically pumped.

The PP3010T is supplied with universal 10mm specimen stubs with surface slots, holes and a flat area — useful for most specimen types, because the holes and slots can be used for liquids and to hold solid material for cross-section fracturing. Blank stubs are also included. A range of optional holders are available, including shuttles for large specimens and top-loading holders for high pressure freezing rivets and planchettes.

Cryo preparation chamber

The PP3010T preparation chamber is connected directly to the SEM and includes facilities for preparing all types of 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.

The stage has a dovetail fitting to accept a cryo shuttle and specimen and can be precisely controlled over a temperature range down to -190°C or lower. Large gas cooled cold traps located above and below the specimen stage ensure clean, high vacuum conditions in the chamber.
High visibility
The PP3010T has superb chamber visibility. In addition to the large front window there are additional top windows. The specimen stage is lit by three LEDs.

A CCD camera allows the specimen stage to be viewed on the control touch screen. Twin manipulators (actively cooled) are available and allow a range of specimen types to be fractured.

The PP33010T is fitted as standard with a front-mounted fracturing/manipulation device. The ball-jointed mount offers flexible movement of the blade and allows the scalpel to be used both as a surface pick (probe) and a fracturing knife.

An optional micrometer advanced fracturing tool (12145) is available (in addition to the standard side-mounted tool).

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

Automatic sublimation and sputtering
Sublimation and sputtering are fully automatic. The high resolution sputter coater is specifically designed for cryo applications and will give fine grain films that are essential for FE-SEM applications. A platinum (Pt) target is fitted as standard; other metals include gold (Au), gold/palladium (Au/Pd), chromium (Cr) and iridium (Ir). An optional carbon fiber evaporation head can be fitted.

An optional terminating film thickness monitor (FTM) is available. The system is fully integrated – no external control boxes.

Cryo preparation chamber pumping
The preparation chamber is pumped by a remotely-positioned 70L/s turbomolecular pumping system. Typical preparation chamber vacuums during operation are in the region of 10^-6 mbar or better. Positioning the turbomolecular pump away from the SEM ensures total elimination of mechanical vibration and significantly reduces the cryo system mass that is connected to the SEM. A vacuum buffer tank allows the rotary pump to be automatically switched off for most of the time. The pumping system is connected to the preparation chamber by flexible stainless-steel bellows.

A 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.

SEM cold stage, cold trap and cooling system
A highly stable, thermally isolated, liquid 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 down to -190°C. 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 — a cold stage temperature of -175°C and a cold trap temperature of -190°C.

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

Off-column cooling
The cold nitrogen gas-cooling dewar for the SEM stage and cold trap is remotely positioned (typically on the floor behind the SEM). The system will run for up to 24 hours between fills.
PP3010T Cryo-SEM Preparation System

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

### 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
  - Fully automatic sputtering
  - Quick, easy overview of system status
  - User-definable "recipes" can be stored
  - Quick access to videos outlining preparation techniques and system maintenance
- Twin liquid nitrogen flushing 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 and Stubs (Others available — see Ordering Information)
- (2) AL200077B specimen shuttles (to hold 10mm diameter cryo stubs) per pack of 10
- E7449-5 multi-stubs 7mm high (with holes and slots) — pack of 5
- 11541 multi-stubs 5mm high (with 10mm dia. X 7mm high) — pack of 5
- 20529 Dovetail holder shuttle
- 328116510 Brass rivets for fracturing liquids — pack of 100
- E7406 Copper (Cu) stub with 3mm x 3mm slot — pack of 5
- E7407 Copper (Cu) stub with 1mm x 3mm slot — pack of 5

### 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 LN₂ 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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### Ordering Information

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

**PP3010T** Cryo-SEM Preparation System for SEM, FE-SEM and FIB/SEM applications.

**Options and Accessories**

- **SEM Cooling Dewar, SEM Cold Stage and Cold Trap (anticontaminator)**
  - Pressurized dewar (60L) for LN₂ storage and venting gas supply: each
- **Carbon fiber evaporation head including 1m high purity carbon fiber**
  - 12434 Specimen shuttle without 10mm hole (flat surface 22mm x 13mm) for large specimens: each
- **Shuttle for clamping hard, flat specimens**
  - 15244 Screw down stub for thin hard specimens (x1) each
  - 11541 Universal specimen stub with holes and slots (pack of 5), one packet included as standard each
- ** preparation chamber with off-column turbo pumping system. SEM**
  - 12147 Film thickness monitor (FTM): each
  - 12145 Micrometer controlled fracturing device with tool steel blade. Note: the standard ball-point mounted fracturing tool is fitted as standard. The 12145 can be fitted in addition: each
- **Top loading freeze-facture “Balzers” planchette holder shuttle**
  - 10245 Top loading specimen holder shuttle (similar to AL200077B but stub clamping mechanism is located on the top for handling pre-frozen specimens mounted on a stub), one included as standard: each
- **Rivet holder stub, screw down style (for use with 10246)**
  - 14006 Rivet holder stub, screw down style: each
- **Special shuttle for cryo-FIB/SEM of TEM Autogrid™**
  - 328116510 Brass rivets for fracturing liquids (pack of 100), one packet included as standard: each

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**Specimen Stubs (10mm diameter)**

- **Universal specimen stub with holes and slots (pack of 5)**
  - E7449-5 (10mm dia. X 7mm high), two packs included as standard: each
- **Universal specimen stub with holes and slots (pack of 5)**
  - E7402 Aluminium (Al) stubs (pack of 10), one pack included as standard: each
- **Copper (Cu) stubs (pack of 10)**
  - E7403 Copper (Cu) stubs (pack of 10): each
- **Copper (Cu) stubs (pack of 10)**
  - E7405 Copper (Cu) stubs (pack of 5) each
- **Copper (Cu) stubs (pack of 10)**
  - E7407 Copper (Cu) stubs (with 1mm x 3mm deep slot) each
- **Brass rivets for fracturing liquids (pack of 100)**
  - 328116510 Brass rivets for fracturing liquids: each

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**Sputter Targets and Carbon Fiber**

- **Gold (Au) target 0.2mm thick**
  - E7400-314A Gold (Au) target 0.2mm thick: each
- **Gold/palladium target 0.2mm thick**
  - E7400-314C Gold/palladium target 0.2mm thick: each
- **Platinum (Pt) target 0.2mm thick**
  - E7400-314R Platinum (Pt) target 0.2mm thick: each
- **Iridium (Ir) target 0.3mm thick**
  - E7400-314IrIridium (Ir) target 0.3mm thick: each
- **Carbon fiber stubs**
  - 35421 Carbon fiber stubs for use with optional 11920 carbon attachment: each
  - 35421-10 Carbon fiber stubs for use with optional 11920 carbon attachment: each
Techniques and Applications

Examples of 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**
- Pipette liquid sample into hole in sample stub
- Place metal rivet or small piece of plastic tubing on top of hole (containing liquid sample)
  - Note: Small drop of “Super Glue” can be used to hold tube to stub.
- Freeze & transfer onto preparation chamber cold stage
- Pipette liquid sample into tube

**Result: clean surface fracture**

Cryo-SEM Micrographs

- 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

**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

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

Building on the success of the PP3010T cryo-SEM/FIB/SEM preparation system, we are pleased to announce three new related products for ambient and cryo temperature transfer...

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

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).

QuickLok specimen stage and adaptor to SEM

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
Specimen Transfer Systems

PP3005 SEMCool (continued)

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).

PP3005 SEMCool

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 PP3010T, 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

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.

PP3006 installation example
Specimen Transfer Systems

PP3006 CoolLok (continued)

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 PP3010T – a full cryo preparation system.

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.

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

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).
Specimen Transfer Systems

Specifications for PP3004, PP3005, PP3006

<table>
<thead>
<tr>
<th>Specification</th>
<th>PP3004</th>
<th>PP3005</th>
<th>PP3006</th>
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<tbody>
<tr>
<td>Temperature</td>
<td>Ambient</td>
<td>RT to -190°C</td>
<td>RT to -190°C</td>
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<td>Cooling Runtime</td>
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<td>Pumping Requirements</td>
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<td>Nitrogen Gas</td>
<td>For venting and valve operation</td>
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<td>Power Requirements (excluding pump)</td>
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<td>Maximum Specimen Size</td>
<td>Flat specimens up to 23 x 26 mm. For taller specimens the maximum height will reduce from a mid-point of 9 mm. Contact us for more details.</td>
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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, gate 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 10 mm diameter specimen stub), blank 10 mm stubs – packet of 10.

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.
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.

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.

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.

Sircal in-line gas dryer. Helps to reduce water content of nitrogen gas supply each.

24426 Pfeiffer HiCube 80 turbomolecular and diaphragm pumping system each.
13034 Pfeiffer Duo 6 — 5 m³/hr rotary vacuum pump with oil mist filter each.
PP7450 Pressurized (60 L) LN₂ dewar. Boil-off nitrogen gas is used for cooling the stage and cold trap (PP3005 and PP3006 only) each.
13296 Pumping station, liquid nitrogen gas for cooling the stage and cold trap (PP3005 and PP3006 only) each.
24426 Pfeiffer HiCube 80 turbomolecular and diaphragm pumping system each.
13034 Pfeiffer Duo 6 — 5 m³/hr rotary vacuum pump with oil mist filter each.
13296 Pumping station, liquid nitrogen gas for cooling the stage and cold trap (PP3005 and PP3006 only) each.

Carbon fiber cord — high purity — 5m each.

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

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.

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.

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.

CONTACT US FOR MORE INFORMATION...

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