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TrionMill

Large scale milling of planar and cross-section samples; creates the largest and most uniform flat area achievable by ion milling. Provides the ultimate workflow for environmentally sensitive materials.





MODEL 1062 TrionMill

A fully automated tabletop argon ion mill that features highly flexible milling parameter adjustment. The instrument offers large-scale milling of planar and cross-section samples. Samples of up to 50 mm diameter are effectively processed with three ion sources, which creates the largest and most uniform flat area achievable by ion milling. Allows the direct transfer of environmentally sensitive materials to a SEM or FIB.

- **Three independently adjustable TrueFocus ion sources**
- **Planar sample sizes up to 50 mm diameter by 25 mm height**
- **High-energy operation for rapid milling; low-energy operation for sample polishing**
- **Controllable beam diameter over a wide range of operating energies (100 eV to 10 keV)**
- **Faraday cups for quantifying ion beam performance**
- **Low ion source maintenance**
- **Automatic height detection establishes the milling plane, which yields repeatable results**
- **Adjustable milling angle range of 0 to +10°**
- **Sample viewing and image acquisition during milling (optional)**
- **525X or 1,960X high-magnification microscope (optional)**
- **Automatic termination by time or temperature**
- **Liquid nitrogen-cooled sample stage (optional)**
- **Vacuum/inert gas/cryogenic transfer system protects environmentally sensitive samples (optional)**
- **Adjustable 10-inch touch screen with a user-friendly interface for the simple setup of milling parameters**

ION MILLING

Ion milling is used in the physical sciences to enhance the sample's surface characteristics.

Inert gas, typically argon, is ionized and then accelerated toward the sample surface. By means of momentum transfer, the impinging ions sputter material from the sample at a controlled rate.

Advanced sample preparation

For many of today's advanced materials, analysis by SEM is an ideal technique for studying material structure and properties. Fischione Instruments' Model 1062 TrionMill is an excellent tool for creating the sample surface characteristics needed for SEM imaging and analyses.

The TrionMill's three ion sources provide large-scale milling of planar and cross-section samples. High-energy operation allows rapid milling of large areas (up to 50 mm); low-energy operation allows gentle sample polishing.

Accepts large sample sizes

The TrionMill creates the largest and most uniform flat area achievable by ion milling. The instrument accepts the following sample sizes:

- **Planar**
Up to 50 mm diameter x 25 mm height
[1.968 x 0.787 in.]
- **Cross section**
Maximum: 10 x 10 x 4 mm
[0.39 x 0.39 x 0.157 in.]

Cross-section station (optional)

The Fischione Instruments' Cross-section station is a tool for creating pristine cross-section samples that are ready for ion milling in the TrionMill.

The station enables precise positioning of the area of interest and can be used with a wide variety of materials, including semiconductor devices, multilayers, ceramics, polymers, and hard/brittle materials. The prepared region of interest is flat and free from damage for subsequent SEM imaging and analysis.

High-quality cross-section samples can be produced quickly and easily by affixing a mask to a sample in the user-friendly loading station. This sample preparation method preserves the quality of the inner layers and allows imaging and analysis of the material in its native state.

HIGH-PERFORMANCE TRUEFOCUS ION SOURCES



Our patented TrueFocus ion sources are optimized to perform at near 100% ionization efficiency – the result is a highly efficient ion source that maintains a consistent beam current. This technology is built into the Model 1062 TrionMill.

TrueFocus ion sources maintain a small ion beam diameter, even at a low accelerating voltage, which means that the ions are directed only to the sample and that sputtered material is not redeposited from the sample holder or chamber onto the sample.

Accelerating voltages are programmable and can be continuously varied from as high as 10 keV for rapid milling to as low as 100 eV for final sample polishing. Beam current density is adjustable up to 10 mA/cm². The ion sources are physically small and require minimal gas, but deliver a wide range of ion beam energies.

When operated in the upper energy range, milling is rapid, even at low angles. When operated at low energy, material is gradually sputtered from the sample without inducing artifacts.

TrueFocus ion sources are easily accessible for routine maintenance.

The station is designed to accommodate a wide range of sample sizes; the alignment of the mask and the sample is done both laterally and angularly.

Quick sample transfer

The front-loading load lock with pneumatic vacuum gate valve enables high sample



CROSS-SECTION SAMPLES MADE EASY

The optional cross-section station is a tool for the fast creation of pristine cross-section samples. The station allows precise positioning of the area of interest – x , y , and θ .

throughput. The bayonet sample holder's quick release functionality speeds sample transfer.

Precise angle adjustment

The ion sources are tilted to provide the desired milling angle. The continuously adjustable ion source tilt angles range from 0 to +10°. You may choose to use one, two, or three of the TrueFocus ion sources. Each ion source beam angle moves in unison.

When three ion beams are directed to the sample surface, milling rates are tripled; this capability is useful for applications such as planar polishing of samples. Faraday cups allow for the direct measurement of beam current from

each ion source, which enables optimization and adjustment of the ion source parameters for specific applications.

Automated milling angle adjustment

Automated milling angle adjustment using the touch screen enables you to create multi-step milling sequences that include the automatic adjustment of milling angles throughout the milling process.

Programmable sample motion

Sample rotation is 360° continuous rotation with variable rotation speed and a sample rocking feature. Automatic height detection establishes the milling plane, which yields repeatable results.

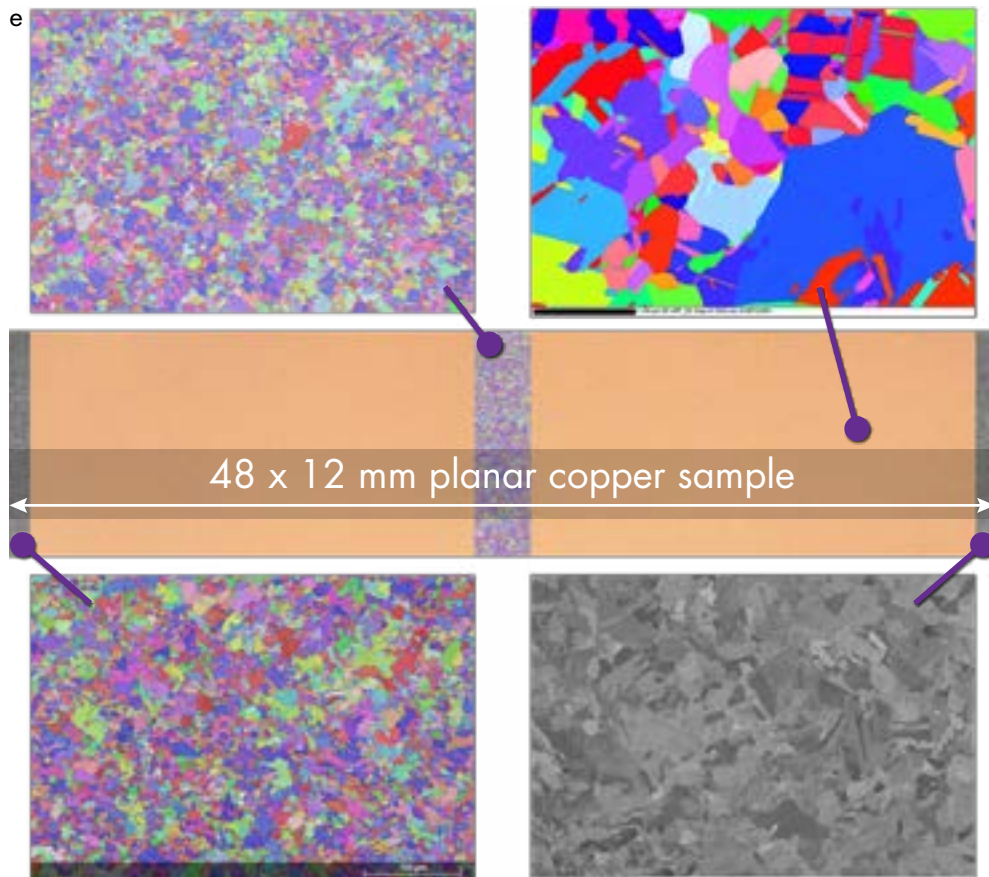
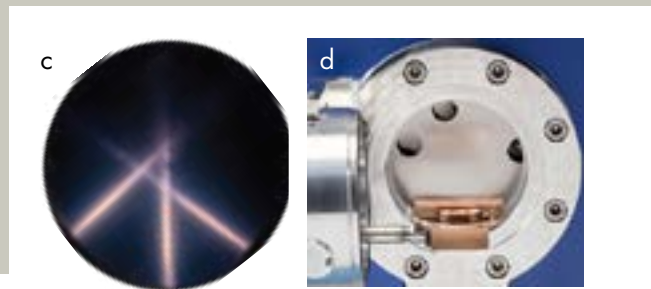
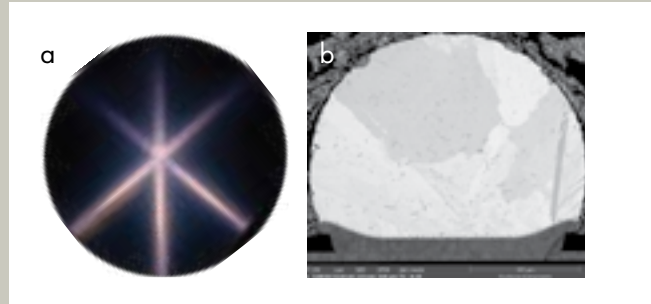


QUICK SAMPLE TRANSFER

The front-loading load lock with pneumatic vacuum gate valve enables high sample throughput. The bayonet sample holder's quick release functionality speeds sample transfer.

ADJUSTABLE BEAM POSITION

The position of each of the three ion sources is independently adjustable; different beam positions enable different milling characteristics. For example, aligning the ion beams in the default position (a) was ideal for preparing a 4.5 mm semiconductor solder bump cross-section sample for SEM analyses (b). However, the large planar milling beam positioning (c) was optimal for preparing a 50 mm copper sample (d) for SEM and electron backscatter diffraction (EBSD) analyses (e) of the (clockwise from left) center top, right middle, right bottom, and left bottom areas of the sample.





INTEGRATED STAGE COOLING

The TrionMill's optional liquid nitrogen system features a dewar located within the enclosure that is fully integrated. The dewar is positioned near the operator for easy access.

Chamber

The TrionMill's vacuum chamber remains under continuous vacuum during operation. A load lock isolates the high chamber vacuum from ambient during sample exchange, which ensures optimal vacuum conditions.

Integrated stage cooling (optional)

Although milling at low angles with low ion beam energies reduces sample heating, temperature-sensitive samples may require further cooling. Liquid nitrogen cooling of the sample stage is very effective in eliminating heat-induced artifacts.

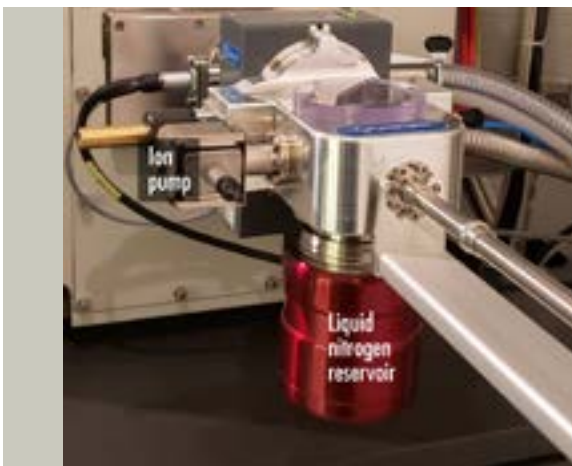
The TrionMill's liquid nitrogen system features a dewar located within the enclosure that is fully integrated and interlocked. The dewar is positioned

near the operator for easy access. Temperature is continuously displayed on the touch screen. The stage cooling functionality provides up to 18 hours of cryo conditions.

Programmable temperature

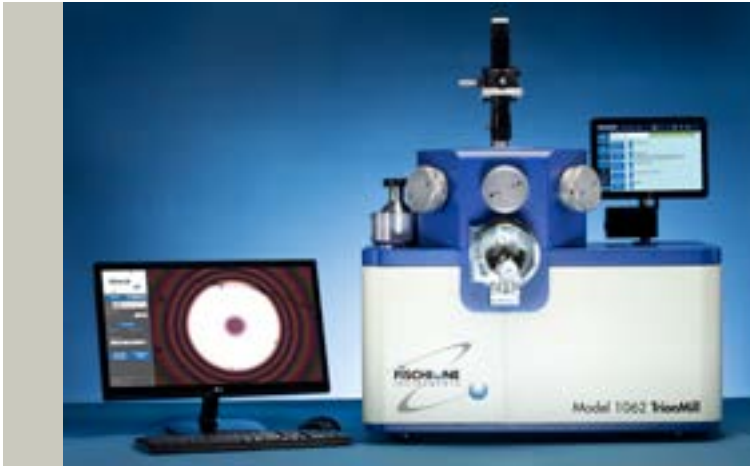
The TrionMill offers the ability to program and maintain a specific temperature between ambient and cryogenic.

At the conclusion of milling at cryogenic temperatures, the stage temperature is automatically increased to ambient before venting to avoid sample frost and contamination. A thermal safeguard can be programmed to a specific stage temperature threshold at which the ion sources will be deactivated if the liquid nitrogen in the dewar becomes depleted.



VACUUM/INERT GAS/ CRYOGENIC TRANSFER SYSTEM

Allows direct transfer of sample at vacuum, in inert gas, or at cryogenic temperature to SEM or FIB. Transfer system shown mounted on a Quorum PP3004 Airlock on a Thermo Fisher Scientific Scios focused ion beam system.



SAMPLE IMAGE ACQUISITION

The TrionMill's optional sample image acquisition system includes a CMOS (complementary metal oxide semiconductor) camera, a secondary monitor, an imaging computer, a keyboard, and a mouse.

Vacuum/inert gas/cryogenic transfer system (optional)

This system allows for the direct transfer of a sample at vacuum, in inert gas, or at a cryogenic temperature to SEM or FIB. The transfer system is a collaboration with Quorum Technologies Ltd.

Sample viewing (optional)

The ion milling process can be monitored in situ in the milling position when using either of the optional high-magnification microscopes.

- High-magnification (525X) microscope
- High-magnification (1,960X) microscope

The viewing window is protected by a shutter, which prevents buildup of sputtered material that can interfere with sample observation.

Sample image acquisition (optional)

The sample image acquisition option employs a CMOS (complementary metal oxide semiconductor) camera and monitor to view samples and capture images in situ during milling. This system is useful for monitoring the delayering process. The image acquisition system includes:

- CMOS camera
- Secondary monitor
- Imaging computer
- Keyboard
- Mouse

Images can be saved to the imaging computer or transferred to another computer.

Sample illumination

Both high-magnification microscopes have light sources that provide top-down, user adjustable, reflected sample illumination.

Touch screen control

Milling parameters are entered via a 10-inch touch screen, which can be physically positioned to your preferred height and viewing angle. From the touch screen, you can control a broad variety of instrument parameters, such as ion beam energy, milling angle, sample motion, sample position, and process termination.

For automated, unattended operation, you can program a series of milling sequences. A typical approach is to begin with rapid milling to remove larger amounts of sample material; then, as the sample thins, a lower milling rate to polish the sample. These milling sequences can be easily stored and recalled for future use.

During milling operations, milling sequence progress and instrument status are displayed in real time on the touch screen.

Advanced functionality includes instrument configuration, administrative and diagnostic tools, and maintenance and log files. Access to



ERGONOMICALLY DESIGNED TOUCH SCREEN

Milling parameters are entered via a 10-inch touch screen. The touch screen can be physically positioned to your preferred height, as well as tilted or pivoted to your preferred viewing angle.

this advanced functionality is controlled through privileges granted to the various user levels and require login credentials.

Remote operation (optional)

Remote operation allows you to oversee milling operations via a remote computer if the TrionMill is networked with your facility's intranet. Tasks that may be accomplished remotely include:

- Recipe programming
- Start, pause, stop, and restart
- Sample viewing
- Sample image acquisition
- Operating parameters monitoring
- Service diagnostics

Stack light indicator (optional)

An optional stack light allows you to view the system status from across the room.

Automatic termination

The ion milling process can be automatically terminated by elapsed time or by temperature.

Time

A timer allows milling to continue for a predetermined time and then turns off the energy to the ion sources when the time has elapsed. The sample remains under vacuum until the load lock is vented.

Temperature

The thermal safeguard associated with the sample cooling system will stop the process if the sample stage reaches a preset temperature.

Automatic gas control

Two mass flow controllers provide independent and automatic regulation of process gas (argon, 99.995% or better) for the ion sources. The gas control algorithm produces stable ion beams over a wide variety of ion source milling parameters.

Fully integrated dry vacuum system

The integrated vacuum system includes a turbomolecular drag pump backed by a multi-stage diaphragm pump. This oil-free system assures a clean environment for sample processing. The vacuum level is measured with a cold cathode, full-range gauge and is continuously displayed on the touch screen.

Minimal maintenance

Due to the efficiency of ionization, maintenance of a TrueFocus ion source is minimal and the components have an extremely long life. Material sputtered from the ion source is negligible, minimizing both sample contamination and component maintenance. Automated shuttering prevents the buildup of sputtered material on

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the viewing window. All system components are easily accessible for routine cleaning.

Remote diagnostics

Fischione Instruments is committed to support maximum instrument uptime. To that end, the TrionMill has the capability of remote diagnostics. When connected to the Internet, the TrionMill can be accessed by Fischione

Instruments Service for rapid troubleshooting and diagnostics support.

Service and preventive maintenance

To learn more about Fischione Instruments comprehensive service and preventive maintenance programs, contact service@fischione.com.



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