

SEM Mill

Tabletop precision preparation for producing high-quality SEM samples for a wide variety of applications





MODEL 1061 SEM Mill

A state-of-the-art ion milling and polishing system. It is compact, precise, and consistently produces high-quality scanning electron microscopy (SEM) samples in the shortest amount of time for a wide variety of applications.

- **Two independently adjustable TrueFocus ion sources**
- **High energy operation for rapid milling; low energy operation for sample polishing**
- **Ion source maintains its small beam diameter over a wide range of operating energies (100 eV to 10 keV)**
- **Faraday cups for the direct measurement of beam current from each ion source**
- **Adjustable 10-inch touch screen with a user-friendly interface for simple setup of milling parameters**
- **Create pristine cross-section samples with the Cross-section station (optional)**
- **Independent ion source gas control**
- **Adjustable milling angle range of 0 to +10°**
- **In situ viewing and image capture during milling**
- **Sample rocking or rotation with ion beam sequencing**
- **Automatic termination by time or temperature**
- **Liquid nitrogen-cooled sample stage (optional)**
- **Vacuum or inert gas transfer capsule (optional)**

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 rapidly studying material structure and properties. Fischione Model 1061 SEM Mill is an excellent tool for creating the sample surface characteristics needed for SEM imaging and analysis.

Accepts large sample sizes

The SEM Mill accepts the following sample sizes:

- **Cross section***
Maximum:
 0.39 x 0.39 x 0.157 in. (10 x 10 x 4 mm)
Minimum:
 0.12 x 0.12 x 0.028 in. (3 x 3 x 0.7 mm)
- **Planar**
 1.25 in. diameter x 1 in. height (32 x 25 mm)

Automatic sample thickness sensing maximizes throughput, while magnetic encoding provides absolute positioning accuracy.

Cross-section station (optional)

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

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, 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 fixing 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.

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.

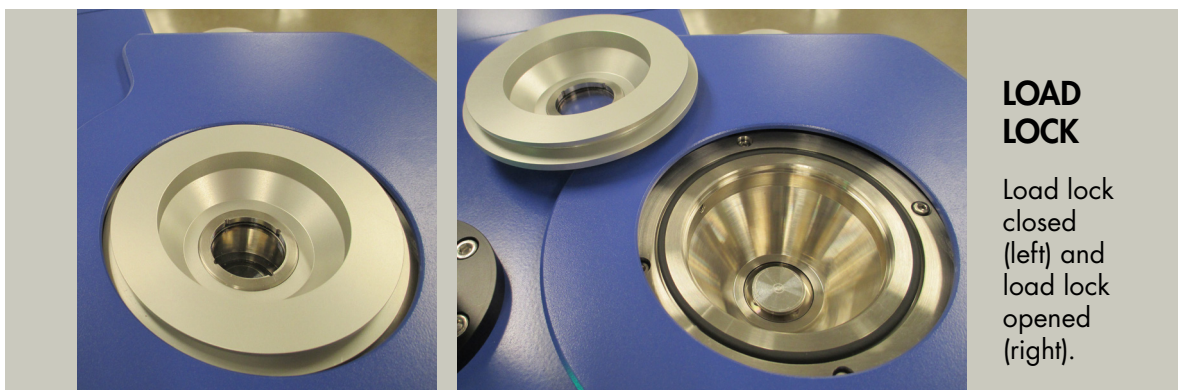
*Standard size; other sizes available upon request.



CROSS-SECTION SAMPLES MADE EASY

Fischione Instruments' Cross-section station (top) is an optional tool for the fast creation of pristine cross-section samples. The station allows precise positioning of the area of interest (middle) – x , y , and θ . The resulting cross-section sample (bottom) is ready for ion milling in the Model 1061 SEM Mill.

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Quick sample transfer

The SEM Mill features a vacuum load lock for rapid sample exchange. The load lock is ergonomically designed; simply lift the load lock cover to load the sample holder onto the stage.

Replace the cover and evacuation of the load lock occurs within a few seconds. The vacuum secures the load lock cover in place during ion milling. An electronically controlled elevator then moves the sample into the milling position.

At the conclusion of the milling process, the sample holder returns to the load lock, but remains under vacuum until vented by the user. Venting takes only a few seconds.

Vacuum or inert gas transfer capsule (optional)

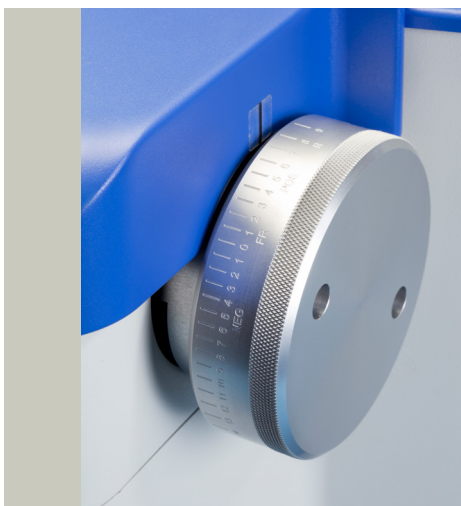
An optional vacuum capsule allows transfer of the sample to the SEM under vacuum or in an inert gas.

Chamber

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

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°. The ion



MILLING ANGLE ADJUSTMENT

The base Model 1061 SEM Mill is equipped with manually adjustable milling angle controls for both ion sources. The milling angle of each ion source is independently adjustable. Automated milling angle adjustment, which is controlled through the SEM Mill's touch screen, is optional.

source angles are adjusted using the left and right ion source controls.

You may choose to use one or both of the TrueFocus ion sources. If you are using both ion sources, you can adjust the beam angles independently.

When both ion beams are directed to one of the sample's surfaces, milling rates are doubled; 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 (optional)

Automated milling angle adjustment using the touch screen is an available option for the SEM Mill. Adding this capability enables you to create multi-step milling sequences that include the automatic adjustment of milling angles throughout the milling process.

Programmable sample motion

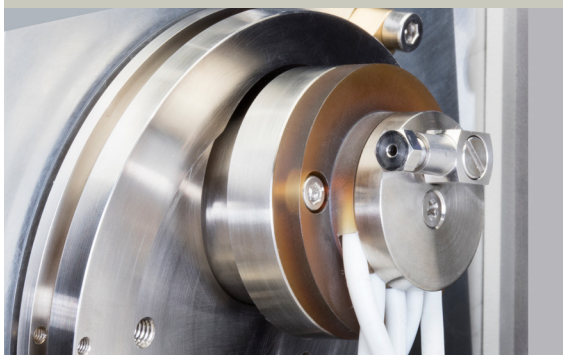
Sample rotation is 360° with variable rotation speed and a sample rocking feature. The instrument automatically senses the sample thickness and establishes the milling plane, which maximizes throughput. A magnetic encoder provides absolute positioning accuracy.

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 SEM Mill'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. Two dewar options are available: a standard dewar for applications that require 3 to 5 hours of cooling during ion milling, or an extended dewar for

NEW HIGH-PERFORMANCE TRUEFOCUS ION SOURCES



Fischione's history of innovation continues with the introduction of the next generation of ion source technology. Our patented TrueFocus ion sources are now 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 1061 SEM Mill.

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.

TRUEFOCUS QUICK FACTS

- Near 100% ionization efficiency
- Consistent beam current
- Each ion source independently controlled
- Adjustable energy range from 100 eV to 10 kV
- Ion beam spot size range from 300 µm to 5 mm
- Beam current density up to 10 mA/cm²
- Milling rates in excess of 500 µm/hour
- Easily accessible for routine maintenance



OPTIONAL INTEGRATED STAGE COOLING

The SEM Mill's liquid nitrogen system features a dewar located within the enclosure that is fully integrated. The dewar is positioned near the operator for easy access. Two dewar options are available: a standard dewar or an extended dewar. Temperature is both programmable and continuously displayed on the touch screen.

applications that require 18+ hours of operation under cryogenic conditions. Temperature is continuously displayed on the touch screen.

Programmable temperature

The SEM Mill 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.

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.

In situ sample viewing

The ion milling process can be monitored in situ in the milling position when using either the optional stereo or the high-magnification microscope.

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

Stereo microscope (optional)

A stereo microscope (7 to 45 X) enhances sample viewing. The microscope's long working distance allows the sample to be observed in situ while milling.

High-magnification (525X) microscope (optional)

The SEM Mill can be configured with a 525X high-magnification microscope coupled to a CMOS (complementary metal oxide semiconductor) camera and video monitor to view samples and

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capture images in situ during milling. This system is ideal for preparing site-specific samples.

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

The SEM Mill can be configured with a 1,960X high-magnification microscope coupled to a CMOS camera and video monitor to view samples and capture images in situ during milling. This system is ideal for preparing site-specific samples.

Sample illumination

Both the high-magnification and stereo 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

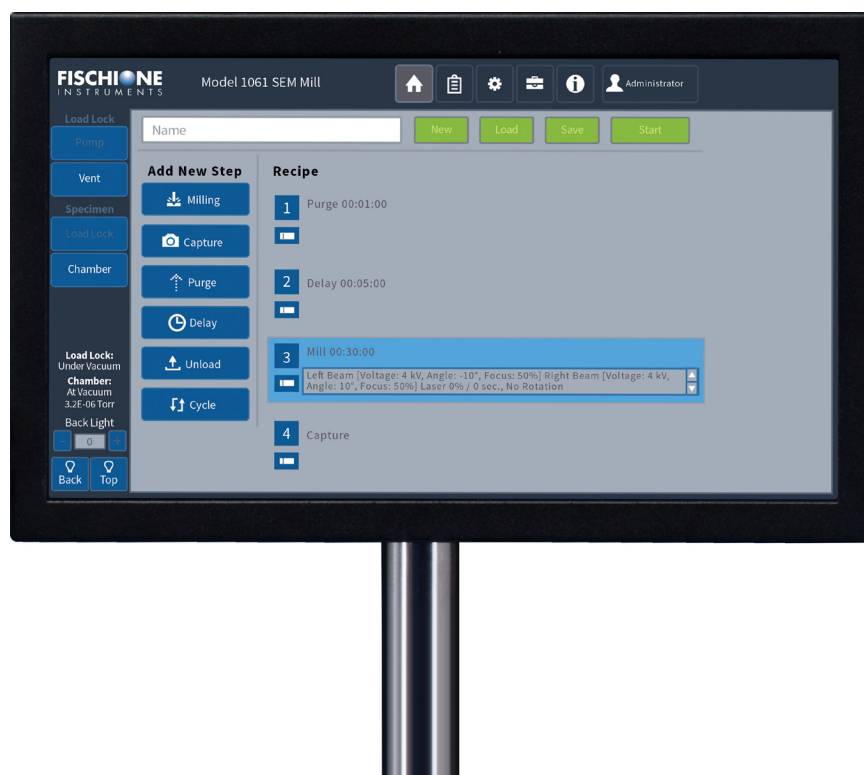
of instrument parameters, such as ion beam energy, milling angle, sample motion, sample position, and process termination.

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 tools for managing sample data, maintenance and log files, and image storage, as well as remote access, which allows you to oversee milling operations via a remote computer if the SEM Mill is networked with your facility's intranet.

Access to instrument configuration, administrative and diagnostic tools, and



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.

maintenance and log files, is controlled through privileges granted to the various user levels and require login credentials.

Stack light system status indicator (optional)

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

Automatic gas control

Two mass flow controllers provide independent and automatic regulation of process gas for the ion sources. The gas control algorithm produces stable ion beams over a wide variety of ion source milling parameters. The process gas is ultra-high purity (99.999%) argon.

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.

Because the gas requirements of the TrueFocus ion source are small, the 70 lps turbomolecular drag pump produces an operating system vacuum of approximately 5×10^{-4} mbar. 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 the 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 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 SEM Mill has remote diagnostics capabilities built in. When connected to the Internet, the SEM Mill can be accessed remotely by Fischione Global Service for rapid troubleshooting and diagnostics support.

Service and preventive maintenance

To learn more about Fischione Global Service's comprehensive service and preventive maintenance programs, contact service@fischione.com.



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