



Model 1060

SEM Mill

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



EXCELLENCE...MAGNIFIED

Model 1060 SEM Mill

- *Modular design for basic instrument operation or fully automated control.*
- *Two independently adjustable TrueFocus (patent pending) ion sources.*
- *High energy operation for rapid milling.*
- *Low energy operation for sample polishing.*
- *The TrueFocus ion source allows adjustable beam diameters.*
- *Simple setup of milling parameters.*
- *Individual, automatic ion source gas control.*
- *Oil-free vacuum system.*
- *Continuously adjustable milling angle range of 0° to 10°.*
- *Sample rocking or rotation.*
- *Stereo microscope for direct sample observation.*
- *High-magnification microscope and CCD camera.*

Model 1060 SEM Mill is a state-of-the-art ion milling and polishing system. It is compact, precise, and consistently produces high-quality SEM samples for a wide variety of applications. Shown fully equipped



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.

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Advanced sample preparation

For many of today's advanced materials, analysis by scanning electron microscopy (SEM) is an ideal technique for rapidly studying material structure and properties. Fischione Model 1060 SEM Mill is an excellent tool for creating the sample surface characteristics needed for SEM imaging and analysis.

Two ion sources

Two TrueFocus ion sources direct controlled-diameter ion beams to the surface of the sample. Beam diameter is user adjustable. Both sources are concentrated on the sample surface for high milling rates. The ion sources are physically small and require minimal gas but deliver a large 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.

The unique design of the TrueFocus ion source allows for a controlled ion beam diameter, which means the ions are directed only to the sample and sputtered material is not redeposited from the sample holder and/or chamber onto the sample surface.

Ion accelerating voltages are programmable and can be continuously varied from as high as 6.0keV for rapid milling to as low as 100eV for final sample polishing. Ion beam currents can be established from hundreds of nA to tens of μ A.

The Model 1060 is equipped with Faraday cups for measuring ion beam current.

The ion sources are visually aligned from outside the vacuum using a luminescent target.

Minimal maintenance

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 and maintenance.

When connected to the Internet, the Model 1060 can be accessed remotely for diagnostic purposes.

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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.

Fully integrated dry vacuum system

The fully 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 70lps turbomolecular drag pump produces an operating system vacuum of approximately 5×10^{-4} mbar. The vacuum level is measured with a Pirani gauge and is continuously indicated.

Sample mounting and positioning

The Model 1060 accommodates a wide range of sample sizes and configurations for applications such as bulk milling, electron backscatter diffraction (EBSD), semiconductor preparation, as well as traditional slope cutting and cross sectional polishing.

A series of sample holders are available for a multitude of applications. Loading stations further facilitate the sample handling process.



Various sample holders

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Chamber

The Model 1060'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. The small chamber size makes it easy to clean during periodic maintenance.

Quick sample transfer

The Model 1060 features a vacuum load lock for extremely rapid sample exchange. Once the sample is placed onto the stage, evacuation of the load lock occurs within a few seconds.

Before milling, an automatic height sensing system provides feedback to a mechanical elevator so that the sample's top surface is properly aligned with respect to the ion beams.

At the conclusion of the milling process, the sample returns to the load lock but remains under vacuum until vented by the user. Venting takes only a few seconds. The main chamber remains under a continuous vacuum during the sample exchange.

After venting, the sample can be rapidly transferred to the SEM, thus reducing contamination from the ambient.



Load lock closed



Load lock open

Cold trap (optional)

The Model 1060 is available with an optional cold trap that is highly effective in removing hydrocarbons and water vapor therefore improving the chamber vacuum quality.

The cold trap features a dewar located within the enclosure.

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Precise angle adjustment

With the sample stage fixed in position, the ion sources are tilted to provide the desired milling angle. Tilt angles are continuously adjustable in the range from 0° to +10°.

Ion beam impingement angles are independently adjustable for each ion source.

Ion milling with low angles of incidence (less than 10°), combined with low-energy ion source operation, minimizes irradiation damage and sample heating. Since it facilitates the uniform thinning of dissimilar materials, low angle milling is highly beneficial when preparing layered or composite materials as well as cross-sectional SEM samples.

Programmable sample motion

Sample rotation is in-plane and continuous throughout 360°.

The Model 1060 is ideally suited to preparing cross-sectional samples from heterogeneous or layered materials. Sample holders are indexed to the sample stage for repeatable orientation. Sample motion control in relation to the ion beam minimizes preferential milling, which can occur when a glue bond line exists in cross sectional samples or when lower atomic number (Z) materials are contained in layered composite samples.

In addition, the sample can be rocked in relation to the ion beam so that interfaces or glue lines are never parallel to the direction of the ion beam. Rocking angles ranging from 40° to 60° are typically employed.

Automatic termination

The ion milling process can be automatically terminated by elapsed time. A timer allows milling to continue for a predetermined time, and then de-energizes the ion sources while keeping the sample under vacuum until the user vents the load lock to extract the sample.

A sample can be serial sectioned by applying subsequent milling steps using the same parameters for the same time duration.

Sample viewing

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

A light source located above the sample surface is used for illumination.

Stereo microscope (optional) The Model 1060 SEM Mill accepts a stereo microscope to enhance sample viewing. The microscope's long working distance allows the sample to be observed in situ while milling.

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Sample viewing (continued)

High magnification microscope (optional) The Model 1060 can be configured with an imaging system including a high magnification microscope coupled to a CCD camera and video monitor to capture and display images. This system is ideal for preparing site-specific samples.

When the high magnification microscope and CCD camera are used, the sample is brought into the load lock for image capture and then returned to the milling position to continue the milling process.

Instrument operation

The Model 1060 SEM Mill features a universal control platform that manages total instrument operation. The basic version of the Model 1060 is for users who require only primary level instrumentation function. The premium version of the Model 1060 adds full computer control for setting, operating, and recording a broad variety of instrument parameters.

Feature	Basic version	Premium version
Touchscreen control	Yes	Yes
Computer control		Yes
Single-step recipe	Yes	Yes
Multiple-step recipe		Yes
Recipe storage and recall		Yes
Real-time milling conditions display	Yes	Yes
Automatic height sensing	Yes	Yes
Manual milling angle adjustment	Yes	
Automated milling angle adjustment		Yes
Independent ion source voltage control		Yes*
Unattended operation	Yes	Yes
Image capture		Yes*
Maintenance and log files		Yes
Remote access and process monitoring (single or multiple SEM Mills)		Yes*
Remote diagnostics		Yes

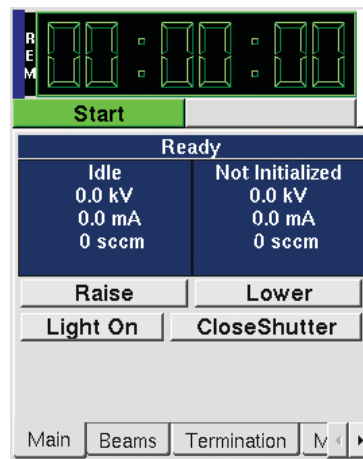
*Optional

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Basic version

The basic version is programmed via a touchscreen embedded module.

Initially, milling angles are established by manually positioning the ion sources to their desired orientations. A single-step recipe of parameters including ion beam energy, sample motion, sample position (load lock or milling), and process time is then readily programmed through the touchscreen. Once the user initiates the process, the instrument automatically executes the recipe and continuously displays the real-time milling conditions.



Touchscreen window

Premium version

The premium version is connected to a dedicated computer to provide enhanced programming capabilities and an expanded interface, thus minimizing the need for user intervention during the milling process.

The interface facilitates programming of ion beam energy, milling angle, sample motion, sample position, and process time.

For effective, unattended operation, a series of operational sequences can be established. Typical methodology starts with rapid milling; then a slower milling rate is employed to eliminate artifacts. Milling recipes can readily be stored and recalled.

Advanced functionality includes structured management of sample data, image acquisition and storage, maintenance and log files, as well as remote access and diagnostics.

The software allows secure access to the various instrument controls corresponding to levels of user expertise and needs for instrument operation. Administrative rights can be provided to qualified maintenance staff.

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Premium version (continued)

During operation, relevant parameters are displayed in real time on the computer monitor. When controlled by the computer, the touchscreen displays a Pause button so that, if necessary, instrument operation can be quickly suspended.



SEM Mill program window

The premium version has the optional capability of remote monitoring via a network connection. This allows the instrument to be both monitored and paused remotely. Multiple Model 1060 SEM Mills can be networked.

Applications

The Model 1060 is an excellent tool for removing surface artifacts from SEM samples leading to improved imaging and analysis.

In many instances, SEM samples are prepared by metallographic polishing. Often, an unwanted topography remains, even when great care is taken during the preparation process. With today's advanced SEMs, even a minimal amount of damage may limit the ability to fully resolve or analyze the surface of a sample.

Sputtering material from the sample surface with inert gas ion beam milling is an ideal method to remove prior damage. This is the basis for the Model 1060.

Bulk

Virtually any type of inorganic SEM sample can benefit from treatment with the Model 1060. When the ion beams are directed at low incidence angles, the damaged layer is sputtered away, yielding a pristine surface for SEM imaging and analysis.

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Applications (continued)

EBSD

EBSD has become an extremely useful technique to obtain crystallographic information with an SEM because backscattered electrons form a pattern that represents the material's crystalline structure, orientation, and texture.

Since EBSD is a highly surface-sensitive technique, any type of damage limits the ability either to generate a pattern or to determine useful information from the pattern. Therefore, enhancing the surface with the Model 1060 is highly beneficial.

To take EBSD to the next level, the Model 1060 can be used to remove precise and repeatable amounts of material from the sample. This serial sectioning technique yields information that may not be clearly evident when using two-dimensional methods.

Cross sectional semiconductor

In many cases in the semiconductor industry, SEM allows information to be rapidly generated for applications such as failure analysis where it is essential to obtain useful data quickly. Frequently, the sample is prepared by cleaving or mechanical polishing which causes surface damage. Such damage is readily removed by ion milling with the Model 1060. Dedicated sample holders facilitate the process.

Selected access milling

When samples contain a highly variable surface morphology, SEM imaging and analysis can be difficult. In order to planarize such surfaces, a sputter-free mask is placed between the ion source and the sample. Depending on the placement and geometry of the mask, a flat surface with a defined angle is developed. This method, combined with the rapid material removal rate associated with the TrueFocus ion sources, quickly produces high-quality samples. This method is also beneficial for solder bump and similar samples.

Model 1060 specifications

Ion sources	Two TrueFocus ion sources Variable energy (100eV to 6.0keV) operation, continuously adjustable Beam current density up to 10mA/cm ² Choice of single or dual ion source operation Independent ion source energy control (optional on premium version)
Sample stage	Milling angle range of 0° to +10° Sample size of 1 inch diameter by 0.59 inch high (25mm diameter x 15mm high) Automatic height sensing 360° sample rotation Sample rocking
Vacuum system	Turbomolecular drag pump backed by an oil-free diaphragm pump Vacuum sensing with a Pirani gauge
Process gas	Argon, 99.999% purity Flow rate approximately 0.2scm/ion source, nominal 15psi delivery pressure required Automatic gas control using two mass flow controllers for unattended operation
Pneumatic supply	Ar, N ₂ , or dry air, nominal 40psi delivery pressure required
User interface (basic version)	Touchscreen embedded module for primary-level instrument functionality
User interface (premium version)	PC-based, fully programmable milling cycles with system status displayed Operation indicator stack light (red/amber/green) (optional)
Sample illumination	User selectable reflected lighting
Automatic termination	Automatic termination by timer
Microscope (optional)	Load lock window accommodates a 7-45X stereo microscope attachment for direct sample observation and a 2,000X high-magnification microscope and camera system for site specific image acquisition and display
Enclosure	Weight: 161 lb (73 kg) Dimensions: SEM Mill (basic): 26.7" (678mm) W x 14.6" (371mm) H (to top of cabinet) x 29.0" (737mm) H (to top of microscope) x 19.2" (488mm) D SEM Mill (premium): 42.0" (1,067mm) W including computer display x 14.6" (371mm) H (to top of cabinet) x 29.0" (737mm) H (to top of microscope) x 19.2" (488mm) D
Power requirements	100/120/220/240 VAC, 50/60 Hz, 720 Watts
Warranty	One year



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