

CleanMill Broad Ion Beam System

Enabling high-quality sample preparation for SEM imaging and characterization

High-quality observation and characterization of materials often requires an artifact-free surface, which can be difficult to achieve with traditional polishing techniques like grinding or mechanical polishing.

The Thermo Scientific™ CleanMill™ Broad Ion Beam System is a complete ion polishing solution for SEM applications in materials science, enabling optimal imaging and analysis of materials where a pristine surface is required, including beam and air sensitive materials.

The CleanMill Broad Ion Beam System is a cross-polisher (BIB-CP) solution developed for applications where sample preparation is as critical as the final result. The CleanMill System is designed with throughput and quality in mind, and comes standard with an ultra-high-energy ion source (with a maximum accelerating voltage of 16 kV), enabling fast ion milling without sacrificing surface quality. When ultra-fine surface polishing is required, the CleanMill System can be configured with an ultra-low-energy ion source to achieve the best surface polish possible.

Materials scientists and engineers often require preparation of “scratch-free” pristine surfaces and planar cross-sections for accurate analytical SEM techniques such as EBSD (electron backscattered diffraction) or EDS (elemental dispersive spectroscopy). Protecting these high-quality polished surfaces from oxidation or nitridization can also be crucial for accurate characterization. That is why the CleanMill System is also fully compatible with the Thermo Scientific™ CleanConnect™ Sample Transfer System, which enables the Thermo Scientific IGST (inert gas sample transfer) workflow. The CleanConnect System provides an integrated, cost-effective solution for fast, easy automatic transfer of samples from the CleanMill System to the microscope chamber. This process minimizes sample handling after sample preparation, minimizes time to results, and enables the observation of materials in their native states.

Key features

Ultra-high-energy ion source for rapid milling and polishing

Cross-section sample preparation by slope cutting at a 90° angle using dedicated sample holders

Automated parameter setting and operation with sample rotation and oscillation

CleanConnect System compatibility for air sensitive samples, enabling a complete inert gas sample transfer workflow

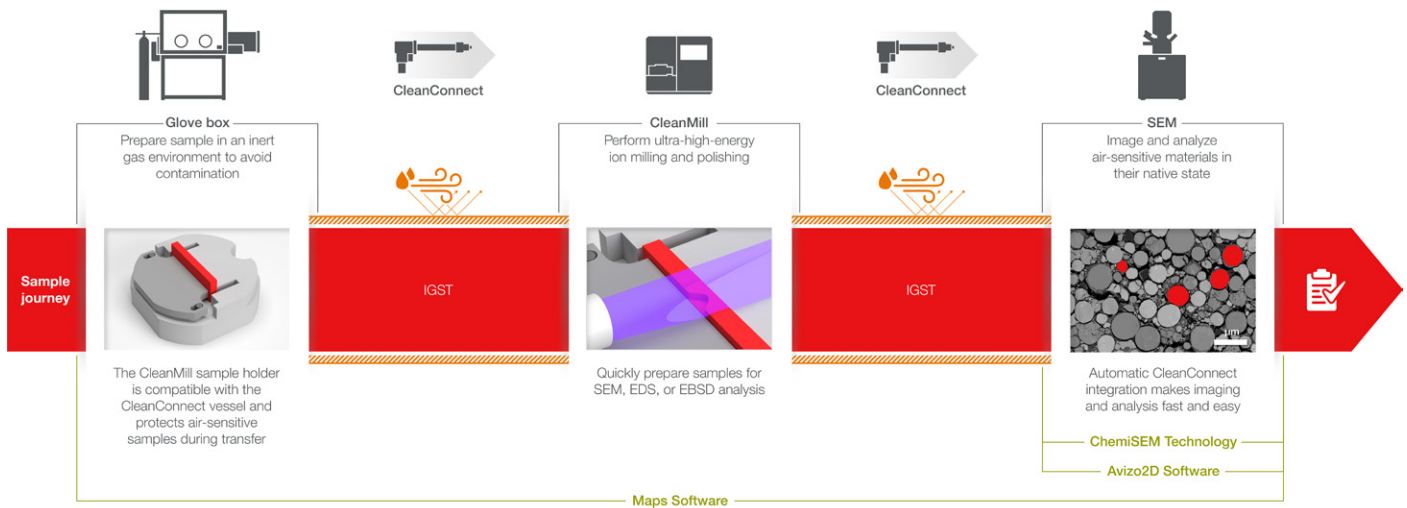
Real-time monitoring of processes using the integrated touch screen and high-resolution camera

Optional low-energy ion source for final polishing of sample surfaces

Optional cryo-stage with automated refill when cryogenic milling is required for extremely beam sensitive materials



CleanMill Broad Ion Beam System.



The CleanMill Broad Ion Beam System is fully compatible with the Thermo Scientific IGST workflow and CleanConnect IGST for air sensitive samples.

Essential specifications

Ion optics

Ultra-high-energy ion source with continuously and independently adjustable milling energy

- 2–16 kV
- Ion beam current range: 20 to 500 μA
- Maximum sputter rate: $>500 \mu\text{m/hr}$

Optional low-energy source

- 0.1 to 2 kV
- Ion beam current range: 10 to 80 μA
- Automated ion source setup

Imaging system

High-resolution CMOS camera with fixed 10x optical zoom and continuously adjustable digital zoom up to 120x magnification

Sample stage

- Sample tilt range: 0 to 180° in 0.1° steps
- Sample rotation: 360°, in-plane rotation
- Sample oscillation: $\pm 1^\circ$ to $\pm 180^\circ$ in 1° steps

Sample holders and maximum sample size

Standard surface polishing sample holder

- 30 mm (diameter) x 15 mm (height)

CleanConnect System compatible sample holders

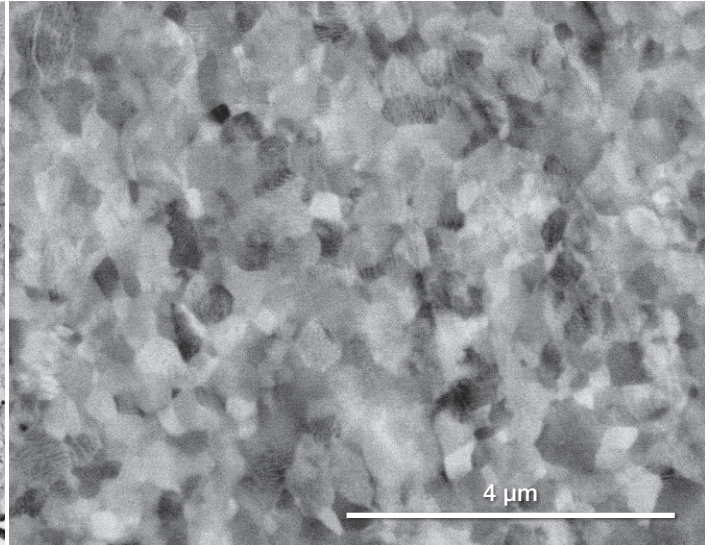
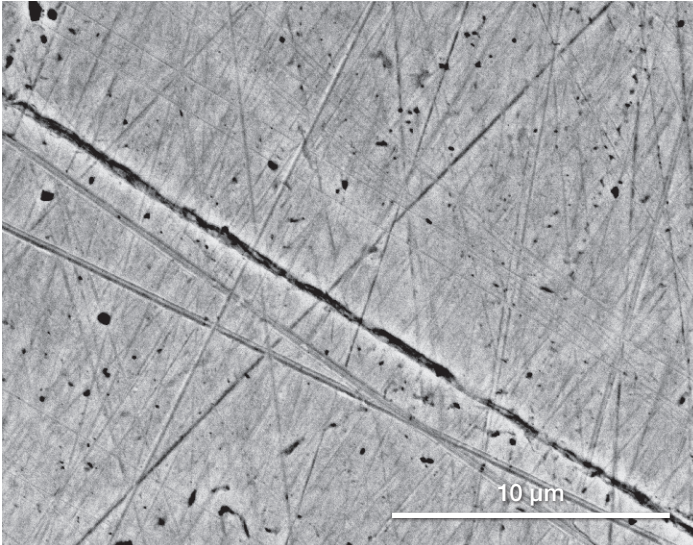
- Surface polishing
 - 28 mm (diameter) x 3 mm (height)
 - Interchangeable holder to allow: 20.5 mm (diameter) x 8.5 mm (height)
- Cross-section polishing
 - 90° slope: 10 mm x 10 mm x 3 mm

Vacuum system

- Oil-free diaphragm and turbomolecular pumps with Pirani and Penning vacuum gauges
- Gas supply: high purity argon with high-precision gas flow control

Computer control

- Easy-to-use touchscreen graphical user interface (GUI)
 - System setup
 - Milling parameter setting
 - Operation control
- Touch GUI with Microsoft Windows 11



Left) A mechanically polished copper sample. Right) The same sample after ion polishing with the CleanMill Broad Ion Beam System.

Optional accessories

- Liquid nitrogen stage cooling with automated refilling for uninterrupted cooling while milling/polishing
- Optional sample adjustment station
- Optional spare part and consumable kit
- Optional CleanConnect glovebox port for compatible gloveboxes
- Optional venting with dry nitrogen

Warranty and training

- 1 year warranty
- Simple design minimizes training
- User manual with instructions included

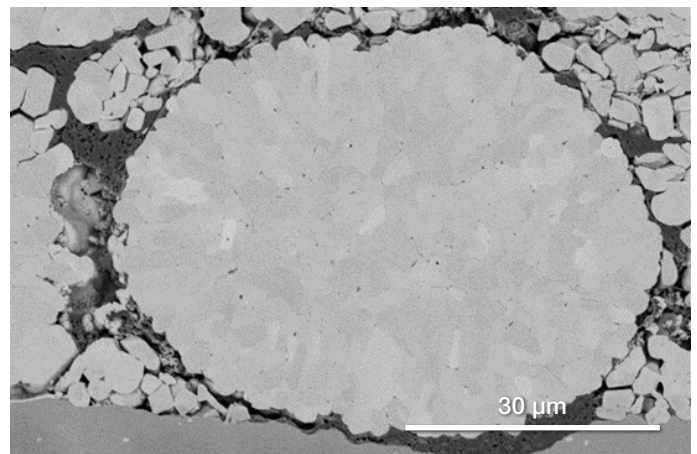
Installation requirements

- Port must be free for CleanConnect installation onto the SEM chamber (i.e., no other accessories can share the port)
- Environment: same requirements as standard microscope, as indicated in the pre-install manual
- Clearance must be available on the right side of the instrument to accommodate use of the transfer rod
- System dimensions: 70 cm (width) x 70 cm (depth) x 61 cm (height)

Battery materials analysis

Advanced battery development and manufacturing is increasingly reliant on SEM analysis for high-resolution insights into battery materials and structures. Many times, these observations require special sample preparation that is more precise than traditional techniques like grinding or mechanical polishing. The CleanMill Broad Ion Beam System is an ideally suited ion polishing solution for battery SEM applications, producing pristine surfaces for optimized imaging and analytical characterization.

Battery materials are also frequently beam and air sensitive. With the IGST workflow, battery samples can be processed for imaging and subsequently transferred directly to the Thermo Scientific SEM under inert gas conditions, preserving these sensitive materials and ensuring surface integrity.



Polished cross-section of a battery cathode showing a nickel-manganese-cobalt (NMC) particle.

Learn more at thermofisher.com/cleanmill