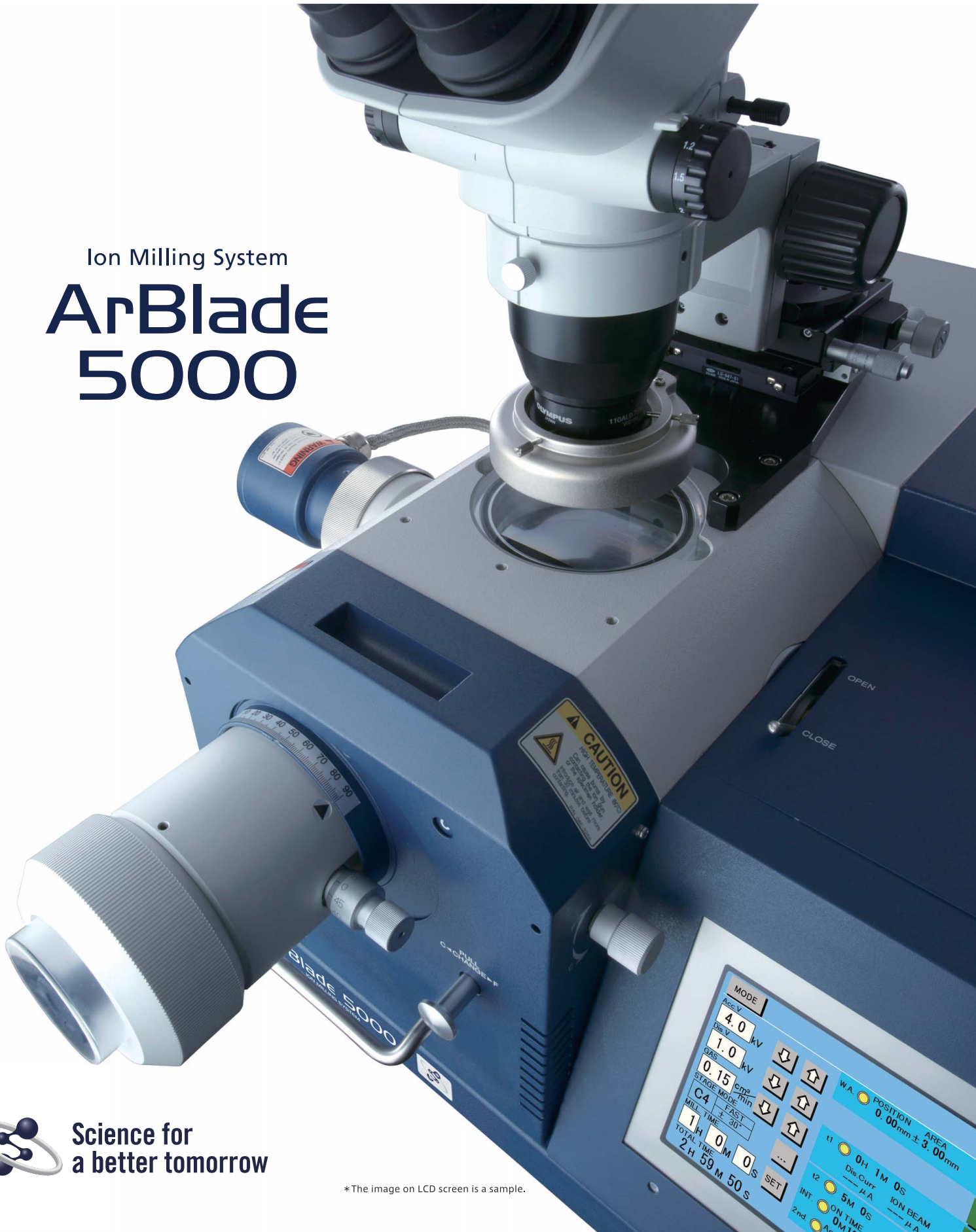
Ion milling system
ArBlade 5000

HITACHI
Inspire the Next

Ion Milling System

ArBlade 5000



Science for
a better tomorrow

*The image on LCD screen is a sample.

This is the top-end model of all Hitachi Ion Milling Systems.

Since our first ion milling system was released in 1985,
we have been improving its performance and function for over thirty years.
Our latest model, ArBlade 5000, is equipped with the most advanced functions
that satisfy various needs for sample preparation.

＊Options are included in the image of exterior view.
＊The image on the LCD screen is a sample.

Ion Milling System

ArBlade 5000

1 High milling rate

- Improved cross-section milling rate by PLUS-II ion gun.
- Wider-area fabrication can be achieved in a short time by combining with wide-area cross-section milling

2 Hybrid milling

- Hybrid model with cross-section milling and flat milling
- Cooling temperature control for reducing damage from the beam

3 Wide-area cross-section milling

- Flat and smooth surface with the width customizable in millimeter that cannot be achieved by conventional cross-section milling.
- Up to 8 mm of width can be processed by wide-area cross-section milling.

4 Easy to operate

- Simplified operation using LCD touch screen
- Second milling and stand-by functions can reduce operational burden on users

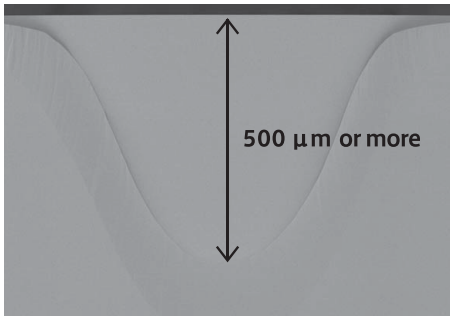
Ion gun with high milling rate (PLUS-II)

Newly-developed PLUS-II ion gun with higher accelerating voltage and increased current density of the ion beam enables to achieve the milling rate of 1 mm/h or more*, which is twice as fast as the milling rate of our IM4000PLUS (manufactured in 2014). This allows to prepare a cross-section sample in a shorter time for hard materials such as metals that conventionally require a long processing time.

*1: Maximum depth processed for 1 hour when Si is protruded 100 µm from the mask edge.

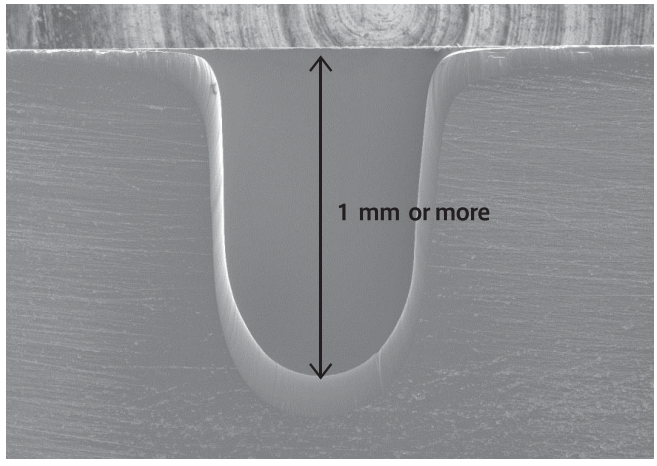
PLUS-II ion gun

IM4000PLUS



(accelerating voltage: 6 kV)

ArBlade 5000

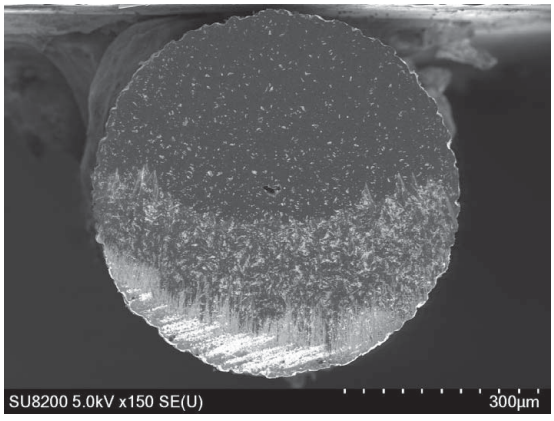


(accelerating voltage: 8 kV)

Specimen: Si wafer (2 mm thick)
Milling time: 1 hour

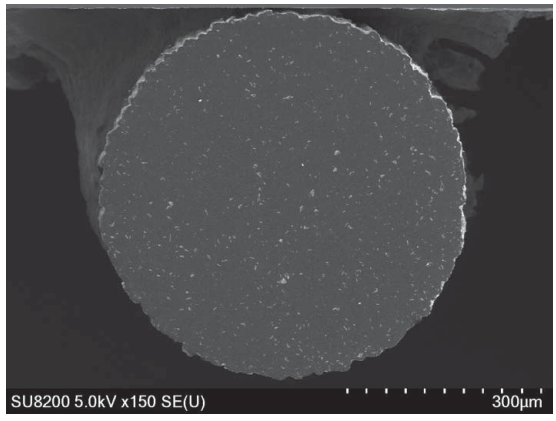
The main component of mechanical pencil lead is graphite carbon which is difficult to slice by the ion milling. The images shown here are the results of processing a mechanical pencil lead by two different machines for the same processing time: The image on the left was processed by IM4000Plus, and another on the right was processed by ArBlade 5000. The entire lead was equally processed by ArBlade 5000 while only the upper half of the lead was processed by IM4000Plus.

IM4000PLUS



(accelerating voltage: 6 kV)

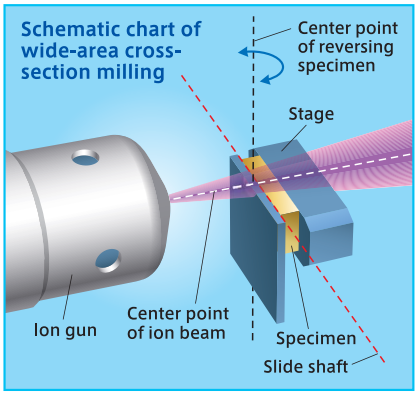
ArBlade 5000



(accelerating voltage: 8 kV)

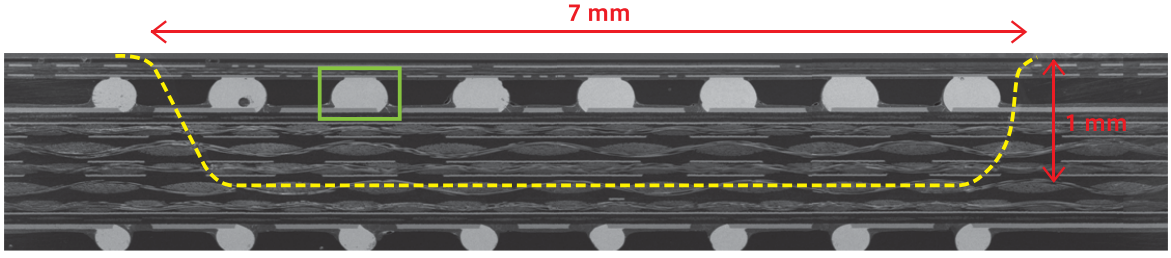
Specimen: mechanical pencil lead (hardness of 4H)
Milling time: 1.5 hours

wide-area cross-section milling



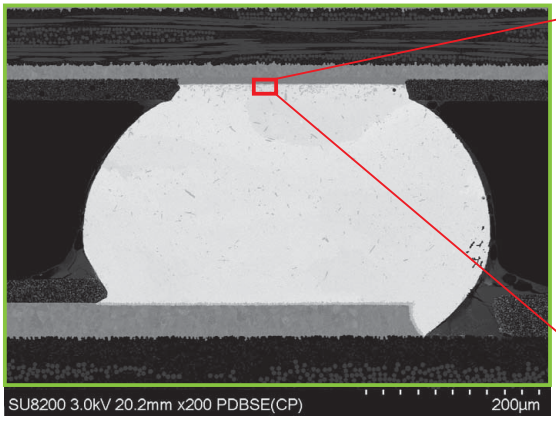
Wide machined surface can be achieved by inverting (or swinging) the cross-section milling holder and sliding the holder at the same time. The width of the specimen can be adjusted according to the purpose in the range of ±5 mm. This is particularly useful for electronic and metallic parts that require wide-area processing.

The result of processing an electronic substrate by the wide-area cross-section milling system is shown here. The area enclosed by dotted line is the processed area, with the width of 7 mm and depth of 1 mm. 5 hours were spent completing the process. PLUS-II ion gun enables wide-area cross-section milling in a short time.

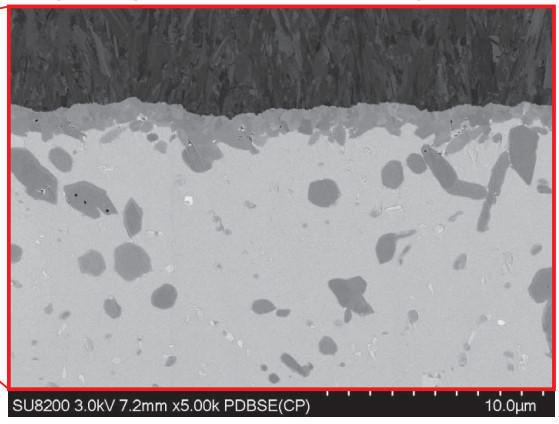


Overall image of wide-area cross-section milling

Enlarged image of the area marked above



Enlarged image of the area marked in the figure on the left



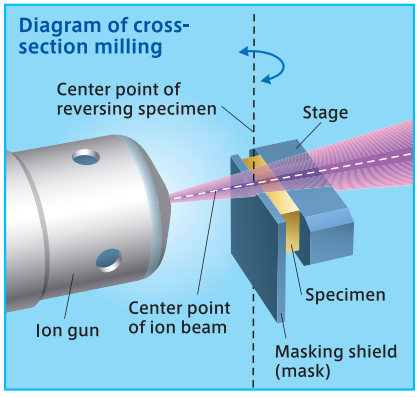
Specimen: electronic substrate
Milling time: 5 hours

Hybrid milling

Milling system that can deal with various specimens

This is a hybrid model of the ion milling system that has an established reputation since it was used on IM4000PLUS.
Various sample preparations for various purposes are available by replacing holders of cross-section milling and flat milling.

Cross-section milling

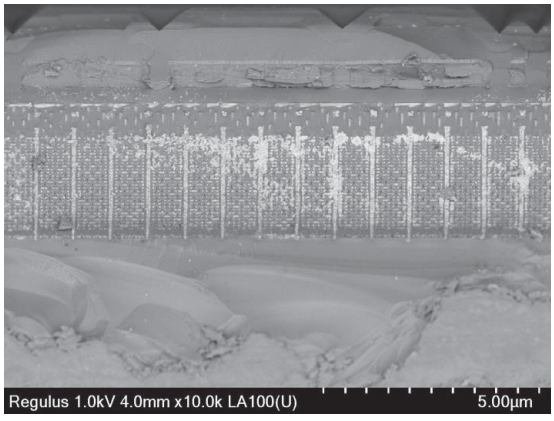


A flat surface can be achieved as protruding parts (parts of the specimen) from the mask edge are sputtered along the edge. By irradiating the ion beam parallel to the processed surface of the specimen, flat and smooth milling is available even with composite materials which include different composition in terms of hardness or milling rate.

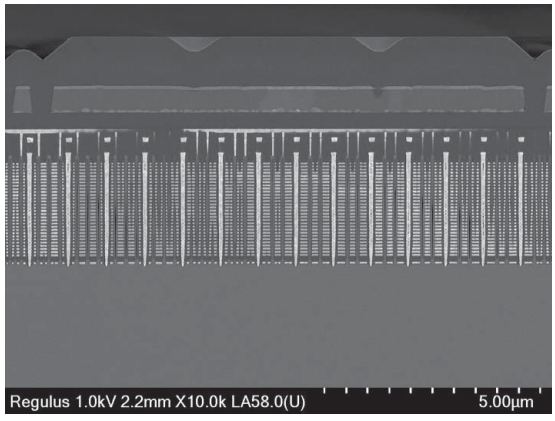
Main use

- Preparation of cross-section sample in a particular area
- Preparation of cross-section sample that is difficult to polish by machines (composite materials, multi-layer interface, papers/films etc.)
- Preprocessing for EBSD (electron backscatter diffraction)

After a sample was cut by ultrasonic cutter



After cross-section milling

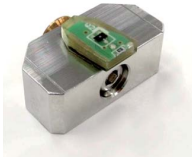


Specimen: 3D NAND flash memory

Linkage with Hitachi SEM (scanning electron microscope)

SEM observation can be done without removing specimen from the stage as cross-section and flat milling holders are linked with Hitachi SEM. With the draw-out style Hitachi SEM, observation can be done with the specimen holder (SEM option is required).

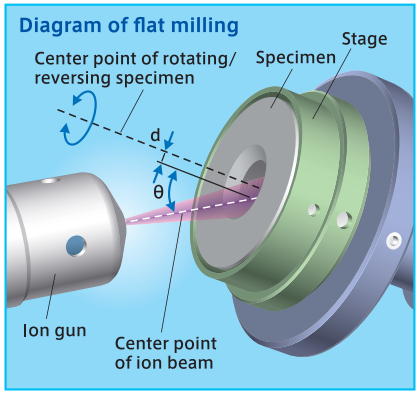
Hitachi FESEM
(field emission scanning electron microscope)



Stage

∗The image on LCD screen is a sample.

Flat Milling

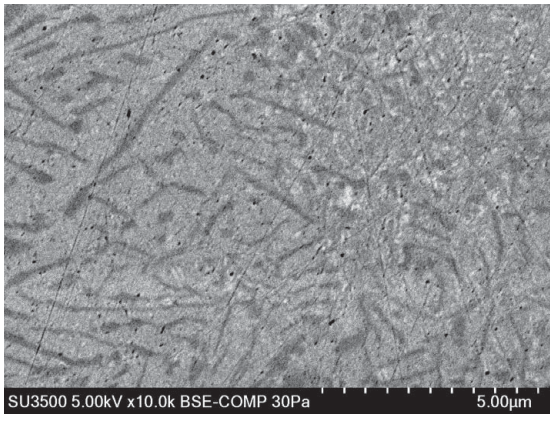


In flat milling, a wider area can be processed than in cross-section milling by eccentricity of center points of ion beam and of rotating specimen. It is also possible to emphasize or reduce irregularities by changing the irradiation angle of ion beam in order to use crystal orientation and/or compositional difference in etching rate.

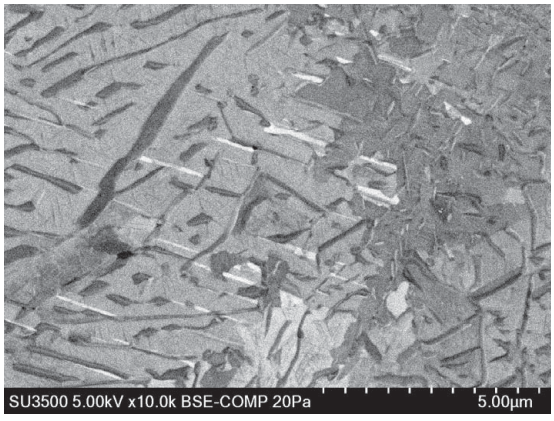
Main use

- Removing polishing flaws and sags of specimen from machine polishing (maximum diameter of 50 mm x thickness of 25 mm)
- Removing the surface of multilayer film
- Discriminating layers of the cross-section of multilayer film (emphasizing irregularities)
- Preprocessing for EBSD (reducing irregularities)

After being machine-polished



After being machine-polished and flat milling



Specimen: gold-silver-copper palladium alloy

Flat milling holder

Cross-milling holder

Draw-out style Hitachi SEM

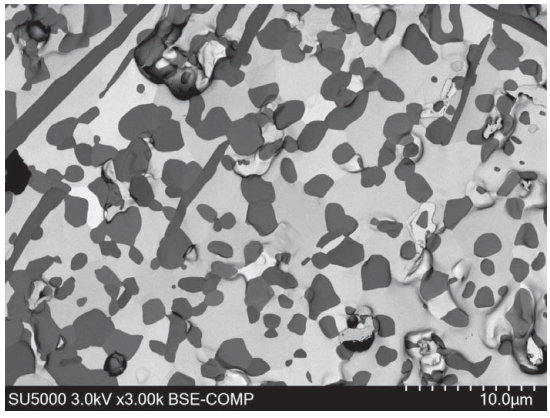
Cooling temperature control*

Specimen vicinity is cooled with liquid nitrogen filled in dewar. When the specimen contains resin and rubber, the temperature will go below glass transition temperature even by indirect cooling. Therefore, cooling temperature control that can control the temperature between 0℃ and -100℃ is loaded in order to prevent overcooling.

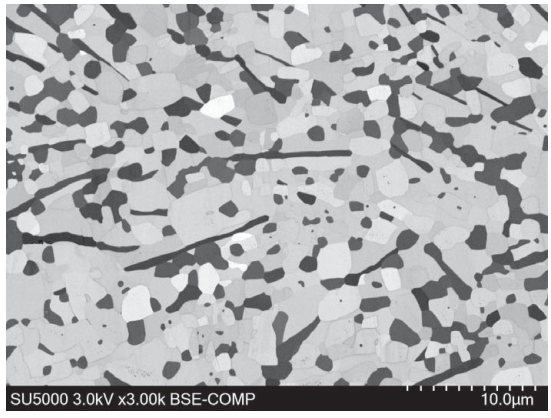
＊Option to deliver with the main unit.
＊The image on LCD display is a sample.

ArBlade 5000 with cooling temperature control

Room temperature milling



Cooling milling



Specimen: wood alloy

Higher beam tolerance mask

Various masks are available for cross-section milling which have twice as high tolerance for ion beam as the standard masks. These masks are suitable for milling hard materials which require long processing time. Higher beam tolerance mask is made of cobalt-free tungsten carbide.

Stereo microscope unit for process observation

This is a stereo microscope unit for observing the specimen during milling at the maximum of 100-fold magnification.
Monitor observation is available on the trinocular type on which CCD camera* can be mounted. In addition to the trinocular type shown in the right figure, the binocular type is also available.

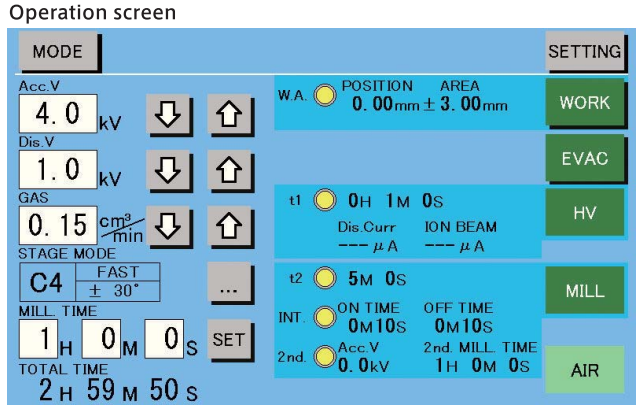
＊CCD camera and monitor are not included.
Please purchase separately.
＊The image on LCD display is a sample.

Stereo microscope unit for process observation (trinocular type)

Touch panel

Setup of milling conditions can be done via LCD touch panel. Various settings can be selected according to the purpose including the time to switch ON/OFF during intermittent milling. After milling with higher accelerating voltage, as shown by the image of ceramic capacitor, clear grain contrast of $BaTiO_3$ can be obtained by milling with lower accelerating voltage.

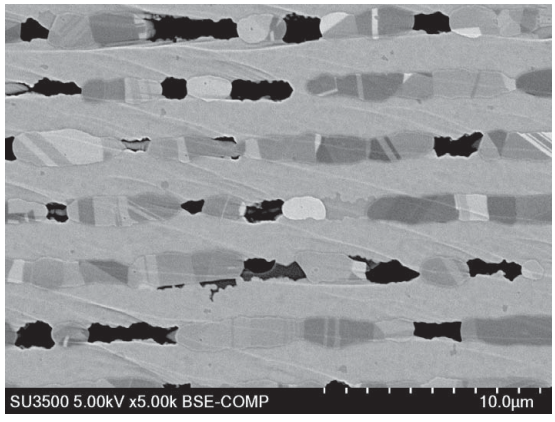
Operation screen



Second milling function

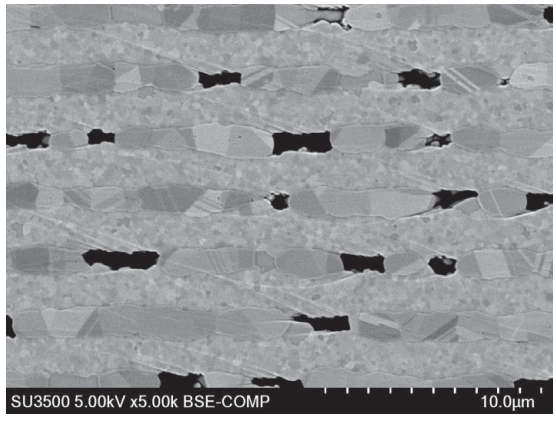
This is a function to process the same area in two different milling conditions successively.
The process is automatically carried out until the second milling condition is completed.

Cross-section milling with accelerating voltage of 8kV



Automatic execution

Cross-section milling with accelerating voltage of 2kV

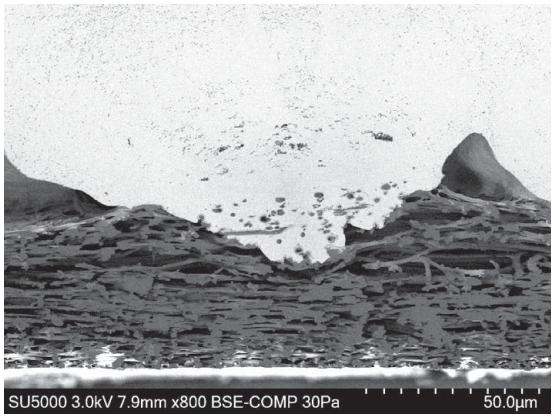


Specimen: ceramic capacitor

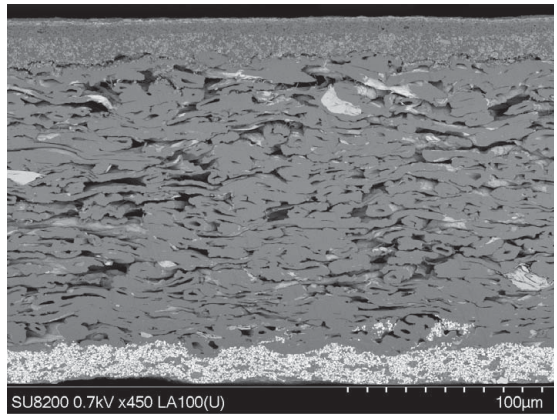
Stand-by function

This is a function to automatically turn on accelerating voltage to start processing after completion of vacuuming.
Stand-by time after vacuuming can be set arbitrarily so that process completion time is also adjustable.

Cross-section milling enables to expose cross-section of specimen, including ones on which machine polishing or razor cutting cannot be used, without damaging its structure. For specimen that may be damaged by irradiating argon ion beam, milling with low accelerating voltage can be used.

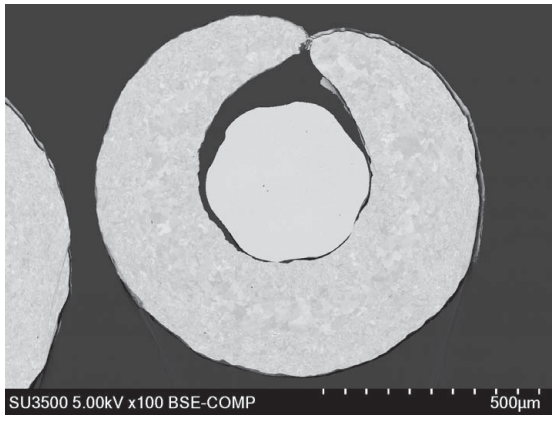


Specimen: eggshell

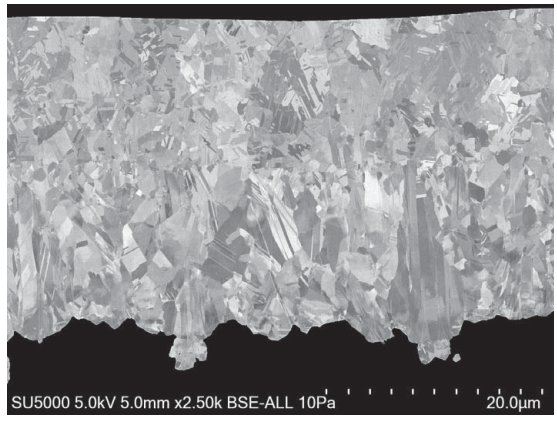


Specimen: ticket

This is an example of cross-section milling of a metallic material. Ion milling can process the sample without having external stress, enabling metallographic observation of the specimen.

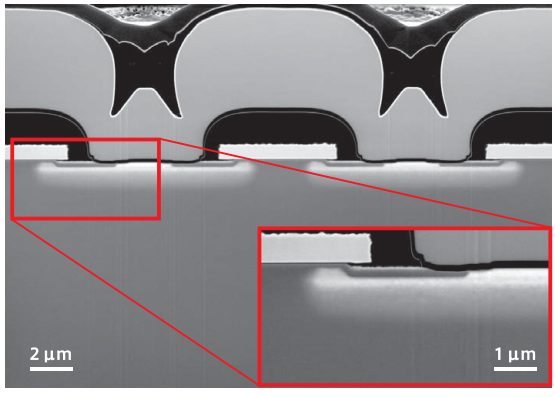


Specimen: maraging steel

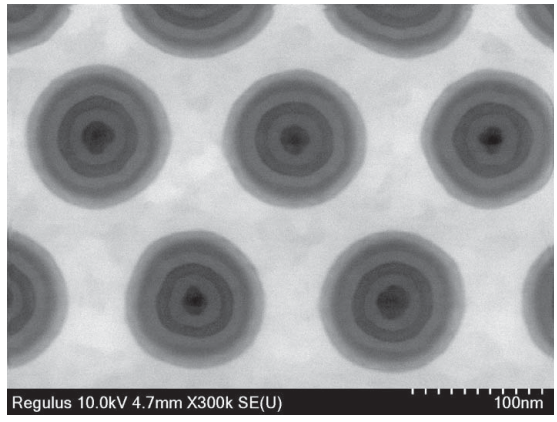


Specimen: copper foil in flexible film

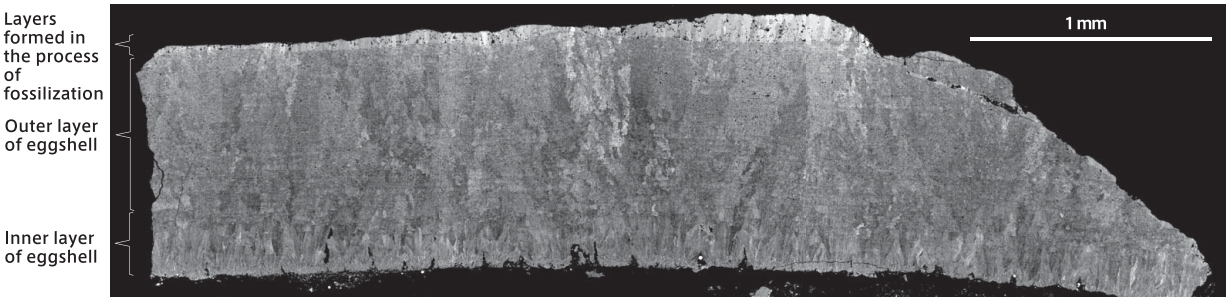
This is an example of using flat milling for post-processing of FIB or machine polishing. Milling for high resolution, high contrast observation of semiconductor devices that are further miniaturized is also available.



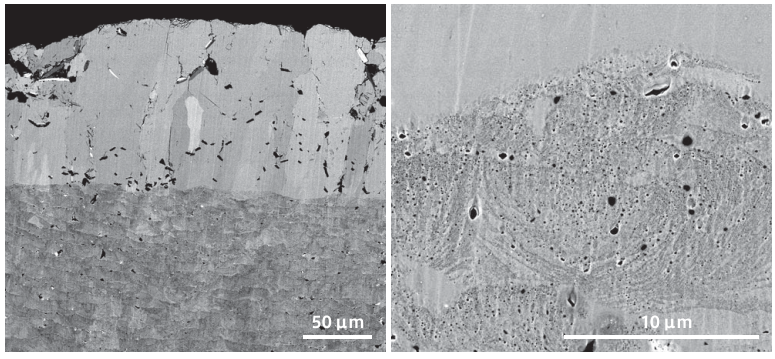
Specimen: silicon carbide (SiC) power device



Specimen: 3D NAND flash memory



Specimen: Fossil (eggshell of a dinosaur egg)

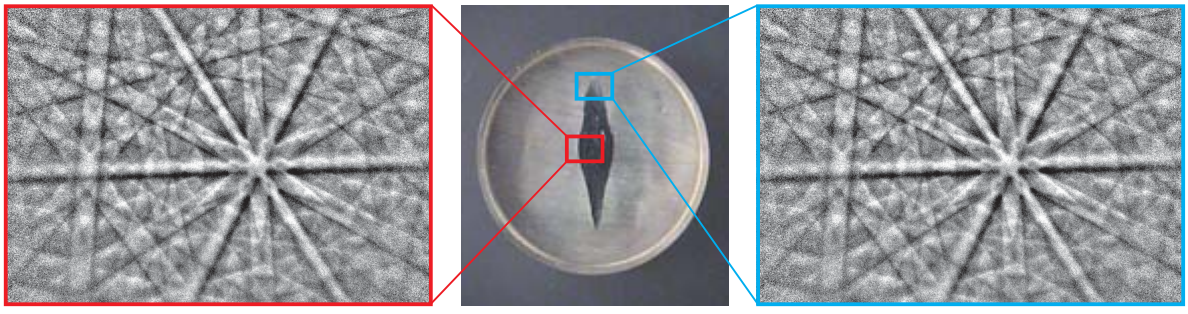


A flat and smooth milling surface approximately 5.5 mm(W) x1.5 mm(D) was obtained from a fragile specimen. Three layers of different compositions can be observed by these grain contrast. You can also see countless pores on the eggshell by enlarging a part.

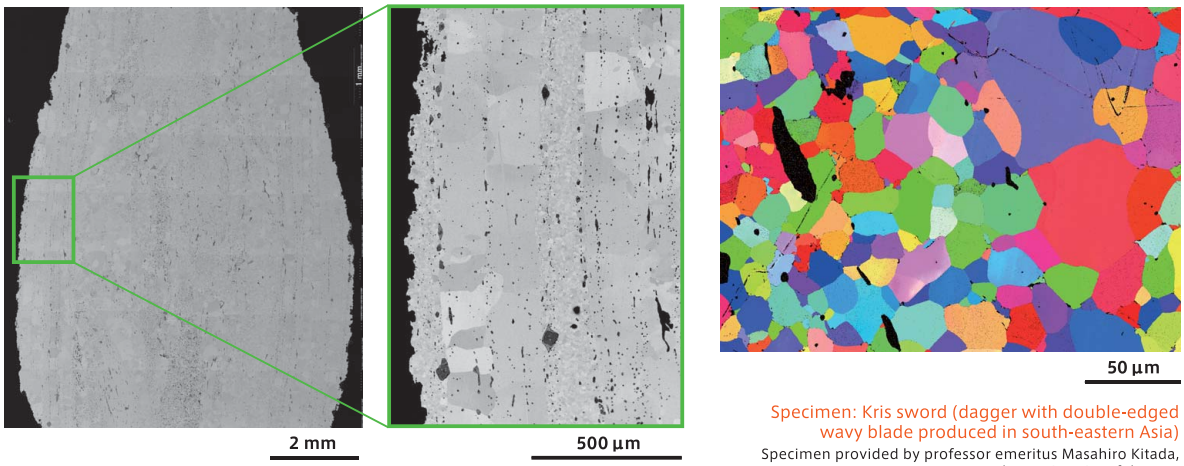
Specimen provided by Yasuhisa Nakajima, Atmosphere and Ocean Research Institute, The University of Tokyo

Flat milling was used to final polish after machine polishing. Clear EBSPs were obtained at the center and tip of the specimen, and a stripe structure with small phases and large phases of grains can be observed in the SEM and EBSD map. Flat milling enables to cover a wider area that cross-section milling cannot.

EBSP at the center part (area enclosed by red line) | Kris sword after machine polishing | EBSP at the tip (area enclosed by blue line)



SEM image of the center part | Enlarged image of the area marked in the figure on the left | IPF Map (X) of the center part (stripe vicinity)



Specimen: Kris sword (dagger with double-edged wavy blade produced in south-eastern Asia)
Specimen provided by professor emeritus Masahiro Kitada, Tokyo University of the Arts

Specifications of ArBlade 5000

General

Items	Descriptions
Gas used	Ar (argon) gas
Ar gas flow control system	Massflow controller
Accelerating voltage	0 to 8 kV
Evacuation system	Turbo-molecular pump (35 L/S) + Rotary pump (135 L/min (50 Hz), 162 L/min (60 Hz))
Size	620 (W) × 725 (D) × 312 (H) mm
Mass	Main unit: 52 kg + Rotary pump: 29.5 kg

Cross-section milling

Maximum milling rate (Material: Si)	1 mm/hr*1 or more
Maximum sample size	20 (W) × 12 (D) ×7 (H) mm
Sample moving range	X: ±7 mm, Y: 0 to +3 mm
Ion beam intermittent irradiation	Standard function
Swing angle	±15°, ±30°, ±40°
Wide-area cross-section milling*2	Standard function, processing width of 8 mm

Flat milling (optional)

Milling area	ϕ32 mm
Maximum sample size	ϕ50 × 25 (H) mm
Sample moving range	X: 0 to +5 mm
Ion beam intermittent irradiation	Standard function
Rotation/swing speed	1 r/m, 25 r/m
Tilt	0 to 90°

*1: The maximum depth when Si protrudes 100 µm from the mask edge and is processed for one hour.
*2: Sample moving range of X is ±5 mm. Other specifications are the same as the cross-section milling holder.

Accessories

Items	Descriptions
Cooling temperature control*3	Indirectly cooling by LN2, Range of set temperature: 0 to -100 °C
Higher beam tolerance mask	Twice as high tolerance against the beam as the standard mask (Cobalt-free)
Stereo microscope unit for monitoring the process	15 to 100 magnifications, Binocular type, Trinocular type (correspond to CCD camera)

*3: Option to deliver with the main unit. Functions are partly restricted during the use of cooling temperature control.

Installation requirements ■Installation conditions

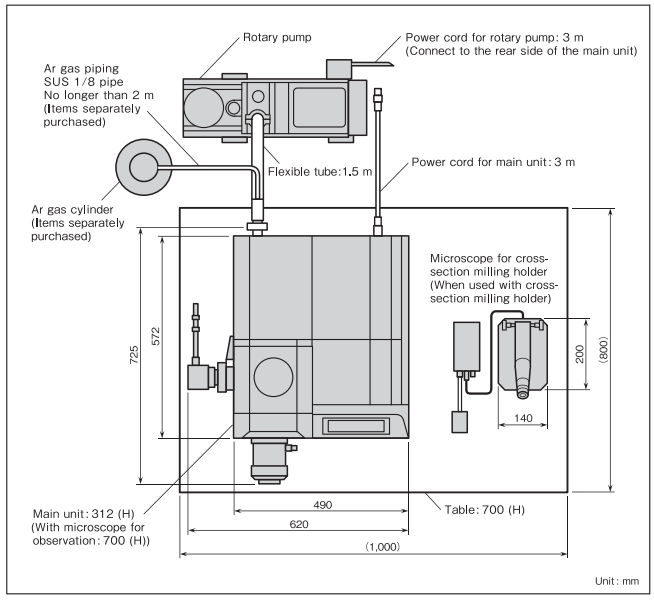
Items	Descriptions
Room temperature	15 to 30 ℃ (Temperature range during the process is below ±5 ℃/hour)
Humidity	Below 70% RH, Condensation should be avoided
Power source	AC 110 V~240 V (±10%), 50/60 Hz, 1.5 kVA, 3P high tension cord
Earth connection	Type D (below 100 Ω)

Items separately purchased

Items	Descriptions
Ar gas	Purity of 99.99%
Ar gas pressure	0.03 to 0.05 Mpa
Ar gas introduction pipe*4	1/8 inch SUS pipe (correspond to 1/8 Swagelok), pressure governor
Oxygen meter*5	Oxygen level of 19% or more should be measurable
Recommended table	1,000 (W) × 800 (D) ×700 (H) mm or larger Load capacity of 70 kg or more (The minimum value for installing ArBlade 5000 only)

*4: Piping to connect Ar gas supply equipment (Ar gas cylinder) and the unit. Pressure governor for supply equipment (Ar gas cylinder) should be purchased together.
*5: An oxygen meter and a ventilation facility are required in the installation area to avoid danger of suffocation by Ar gas.

Example of installation layout



Science for a better tomorrow

The Science Ring demonstrates our desire to contribute to the betterment of society through Hitachi's innovative scientific instruments and expertise.

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Notice: For correct operation, follow the instruction manual when using the instrument.

Specifications in this catalog are subject to change with or without notice, as Hitachi High-Technologies Corporation continues to develop the latest technologies and products for our customers.

Hitachi High-Technologies Corporation

Tokyo, Japan
http://www.hitachi-hitec.com/global/em/
24-14, Nishi-shimbashi,1-chome, Minato-ku Tokyo,105-8717, Japan

For technical consultation before purchase, please contact:contact@nst.hitachi-hitec.com

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