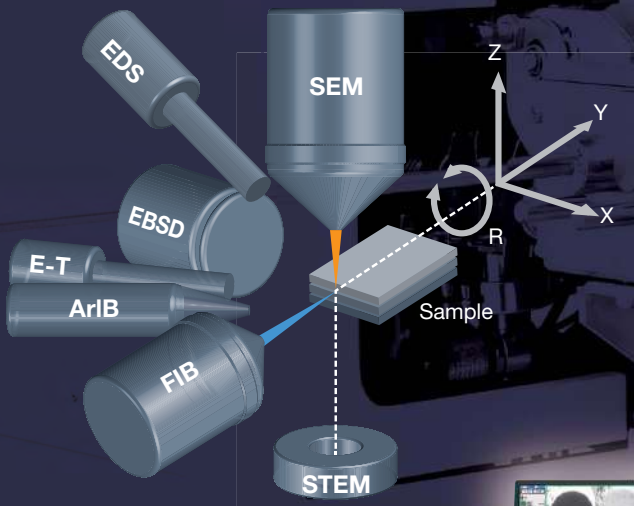
Real-time 3D analytical FIB-SEM

HITACHI
Inspire the Next

FIB-SEM System for True 3D Structural Analysis

The analysis of internal structures are important for a comprehensive evaluation of advanced materials and devices. The combined Scanning Electron Microscope (SEM) and Focused Ion Beam (FIB) system enables site-specific cross sectioning and lamella preparation, which have become indispensable for SEM observation and Transmission Electron Microscope (TEM) analysis.

The newly developed FIB-SEM system from Hitachi, the NX9000 incorporates an optimized layout for true high resolution serial sectioning to tackle the latest demands in 3D structural analysis and for TEM analysis.
The NX9000 FIB-SEM system allows the highest precision in material processing for a wide range of areas relating to advanced materials, electronic devices, biological tissues and a multitude of other applications.



Hitachi patents:
US6118122, US6538254, US6828566, US7138628, US7345289, US7397050, US7397051, US7442942, US7525108, US7550750, US8198603, US8569719, US8642958, US8664598, and other patents, as of Jun., 2015

Real-time 3D analytical FIB-SEM NX9000

Features

SEM column and FIB column are orthogonally arranged to optimize column layout for 3D structural analysis.

Combination of high brightness cold field emission electron source and high sensitivity optics support analysis of a wide range of materials from magnetic materials to biological tissues.

Micro-sampling system and Triple Beam system allow high quality sample preparation for TEM and atom probe applications.

Applications

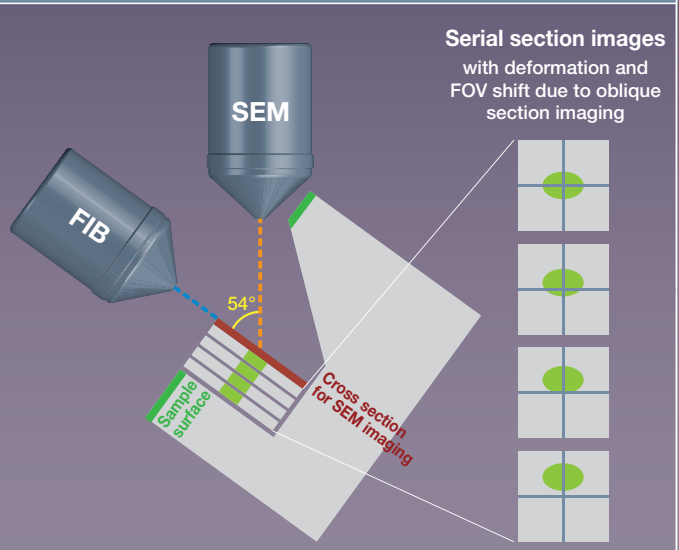
(1) Energy Dispersive x-ray Spectroscopy, option
(2) Electron BackScatter Diffraction, option

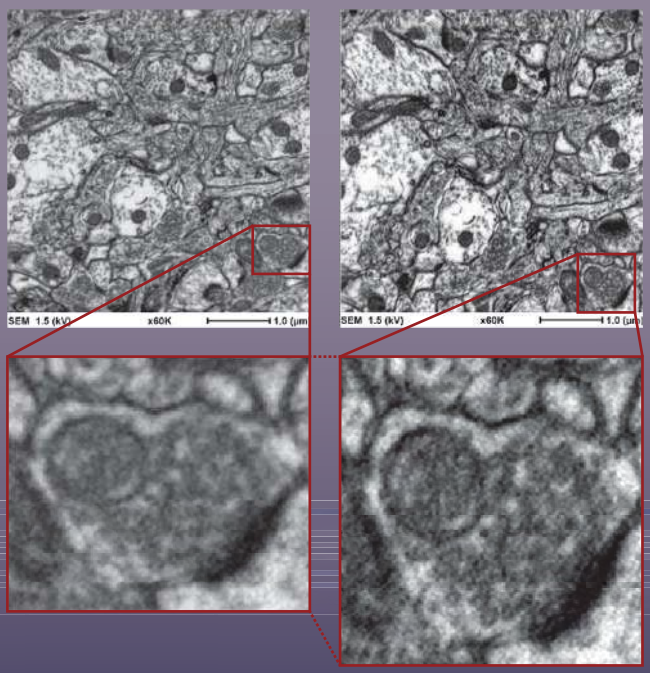
*Option

Ion milling and observation at normal incidence in real-time for true analytical imaging

The SEM column and FIB column are orthogonally arranged to realize normal incident SEM imaging of FIB cross sections. Orthogonal column arrangement eliminates aspect deformation, foreshortening of cross sectional images and shift of FOV (Field Of View) during serial section imaging, which cannot be avoided by conventional FIB-SEM systems. The NX9000 images produced enable highly accurate 3D structural analysis. Optical correlative microscopy can be applied easily due to the benefit of surface planar EM imaging.

Conventional FIB-SEM

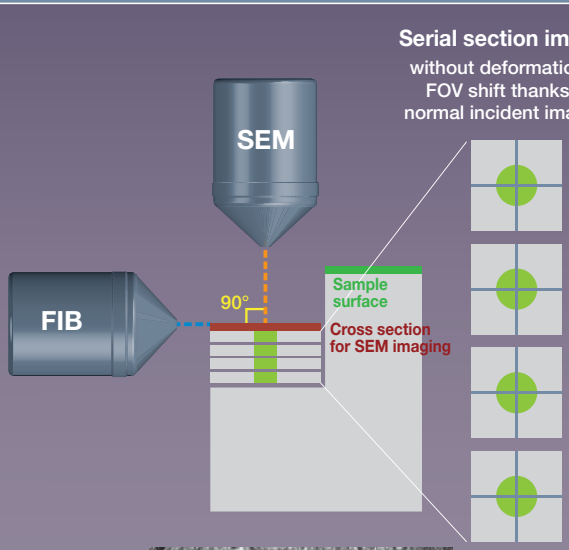


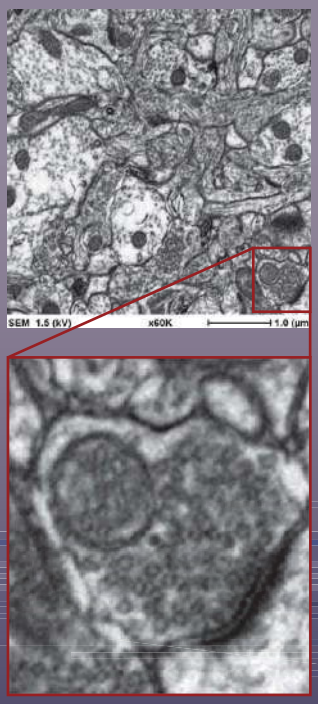


SEM incident angle: 54°
Deformed aspect ratio
due to oblique section imaging

SEM incident angle: 54°
After aspect ratio correction

Orthogonally arranged FIB-SEM





SEM incident angle: 90°
No deformation thanks to
normal incident SEM imaging

Sample : Mouse brain neuron
Sample courtesy of Yoshiyuki Kubota, Ph.D.,
Neural Information Processing Systems (NIPS)

Real-time 3D analytical FIB-SEM **NX9000**

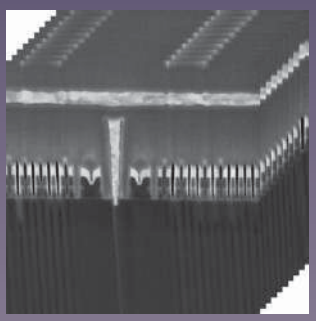
Cut & See・3D-EDS*・3D-EBSD* available for a wide variety of materials

Cut & See

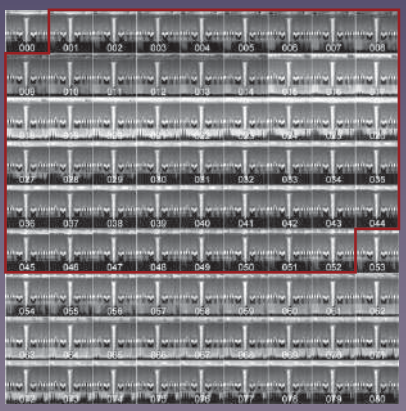
Cut & See supports high resolution, high contrast imaging of biological tissues, semiconductors, and magnetic materials such as steel and nickel at low accelerating voltage.
Serial section images can be collected with high throughput due to the proper geometry of the ion and electron column.

Sample : NAND flash memory
SEM accelerating voltage : 1 kV
Cutting interval : 1 nm
Number of cut : 300

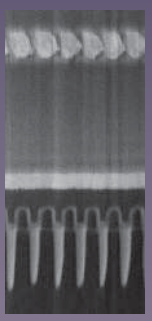
1 nm step Cut & See



Serial section images



Reconstructed XZ plane

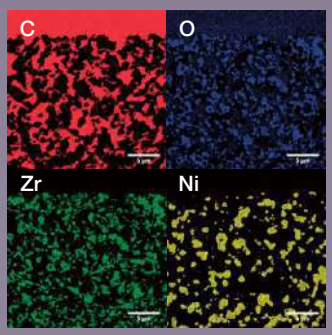


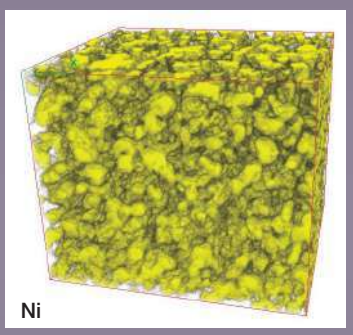
3D-EDS*

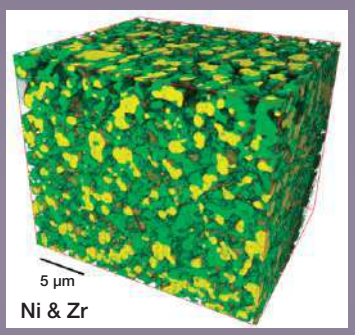
Serial section SEM images and serial section elemental maps can be collected using 3D-EDS.
Large area silicon drift detector reduces acquisition time and enables elemental mapping at low accelerating voltage.

Sample : Fuel cell electrode
SEM accelerating voltage : 5 kV
Cutting interval : 100 nm
Number of cut : 212

Sample courtesy of Prof. Naoki Shikazono, University of Tokyo

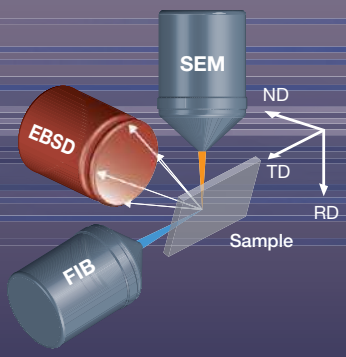




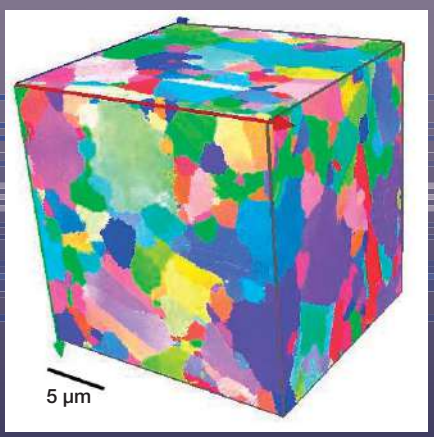


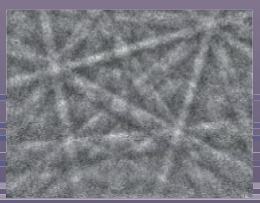
3D-EBSD*

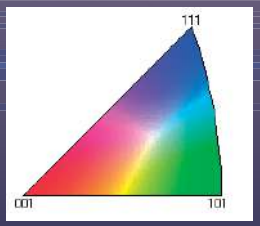
Simultaneous SEM, FIB and EBSD signals are obtained for 3D-EBSD without moving the stage during FIB sectioning and EBSD analysis. Accuracy and throughput of 3D crystal orientation analysis and segmentation yield high quality and less post-processing correction.



Sample : Ni
SEM accelerating voltage : 20 kV
Cutting interval : 150 nm
Number of cut : 150





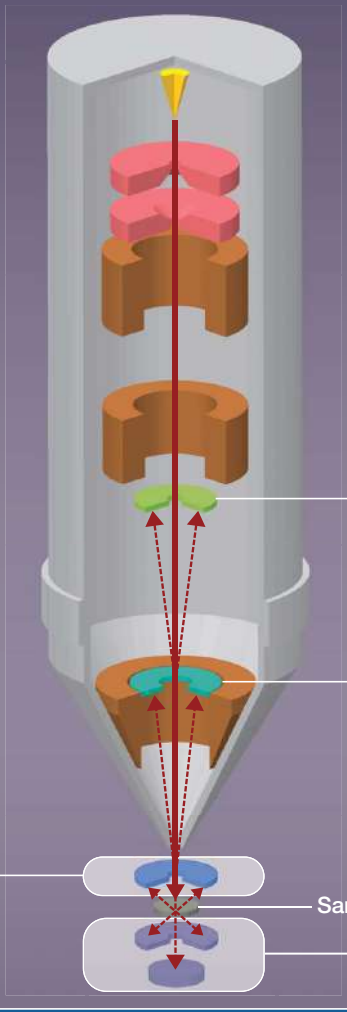


*Option

High resolution, high contrast SEM column

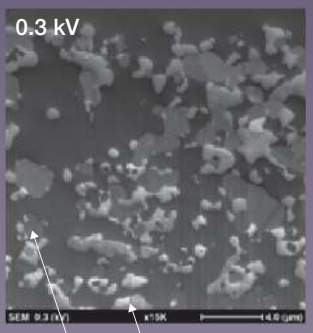
by high brightness cold cathode field emission electron source and high sensitivity optics

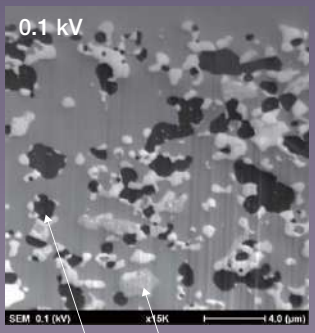
Small source size and low energy spread of cold cathode field emission electron source allow high resolution imaging even at low accelerating voltage. In-column SED, In-column BSED, Retractable BSED*, and STEM(3) detectors* are placed at optimal positions to support a diverse range of samples and analytical purposes. Each signal can be simultaneously acquired at beam coincident point. For STEM imaging, bright field STEM detector* and dark field STEM detector* are available. FIB prepared sample for TEM and atom probe can be examined rapidly without taking sample out of the chamber.



In-column SED (Secondary Electron Detector)

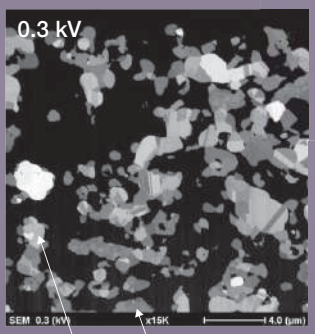
Fuel cell electrode



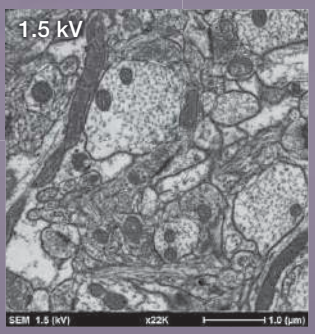


In-column BSED (Backscattered Electron Detector)

Fuel cell electrode

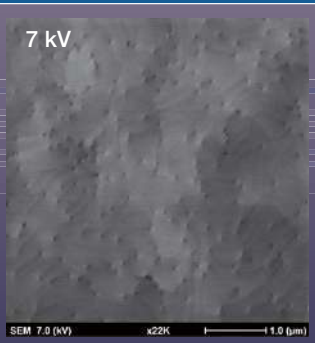


Mouse brain neuron tissue



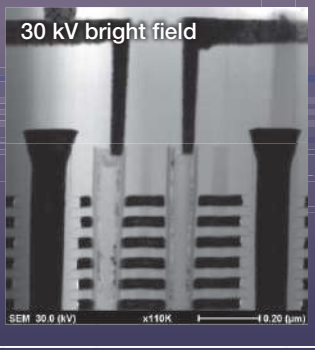
Retractable BSED*

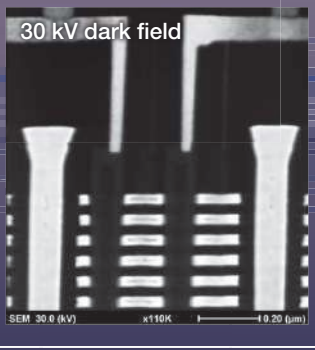
Gallium nitride (GaN)



STEM detector*

3D NAND flash memory





(3) Scanning Transmission Electron Microscope, option

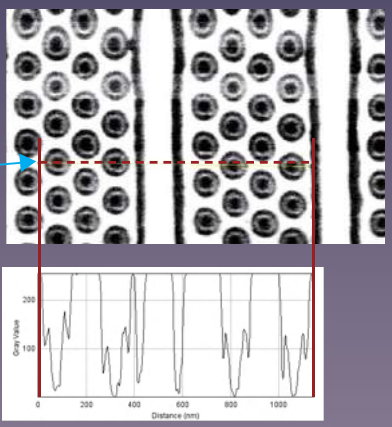
Sample courtesy of Prof. Naoki Shikazono, University of Tokyo (Fuel cell electrode), Yoshiyuki Kubota, Ph.D., Neural Information Processing Systems (Mouse brain neuron) and Prof. Takashi Egawa, Nagoya Institute of Technology (Gallium nitride)

Real-time 3D analytical FIB-SEM NX9000

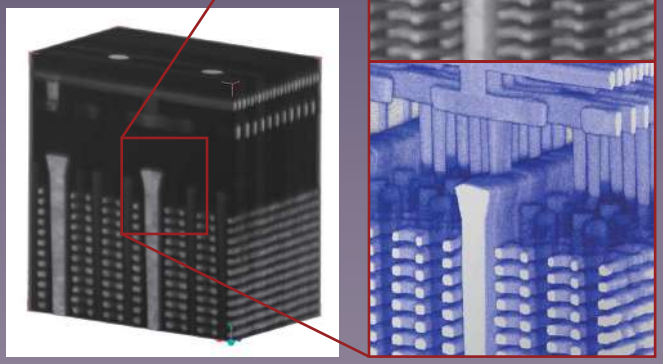
High resolution 3D structural analysis enabled by highly stable, high precision sample stage

Optimized sample stage and sample holder significantly reduce drift for lengthy acquisition sessions.
Together with stable ion source and optics, high precision serial FIB slicing is achieved to support high resolution 3D structural analysis at nanometer scale.

Poly Si layer measurement



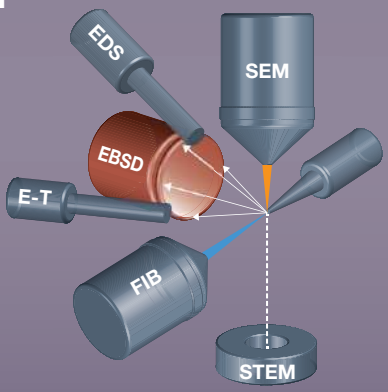
3D reconstruction

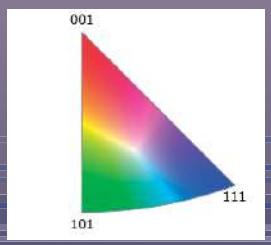


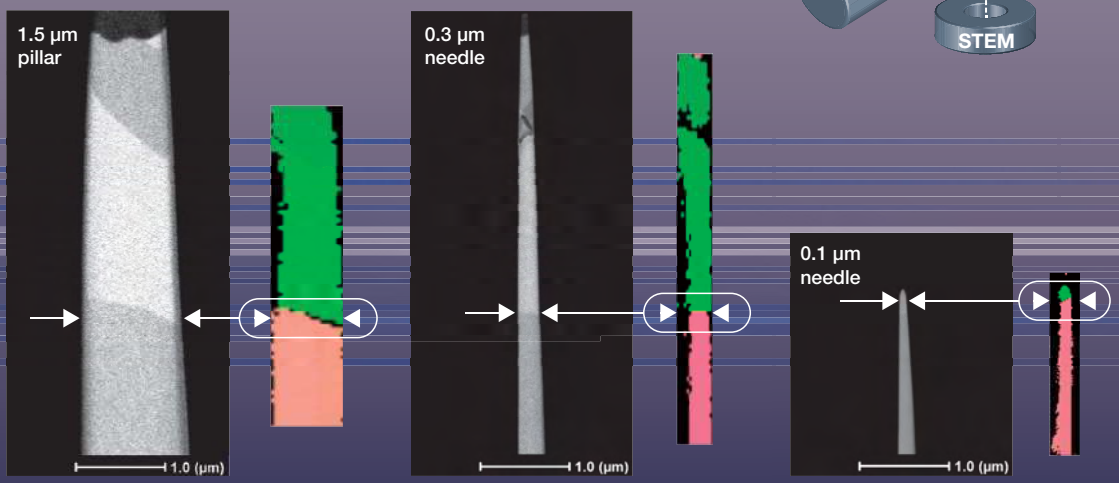
Sample : 3D NAND flash memory
SEM accelerating voltage : 1 kV
Cutting interval : 2 nm
Number of cut : 498

High quality TEM･atom probe sample preparation using Micro-sampling* and Triple Beam* system

Micro-sampling system* enables site-specific extraction of micro sample inside the chamber while Triple Beam system* drastically reduces FIB-induced damage using Ar ion beam.
For atom probe sample preparation, EBSD* signal can be utilized for end point detection simultaneously. Needle shape sample can be prepared with specific grain boundary preserved which is difficult to identify by SEM.







Sample : Metal material
SEM accelerating voltage :
1 kV for imaging
20 kV for EBSD analysis

*Option

Specifications

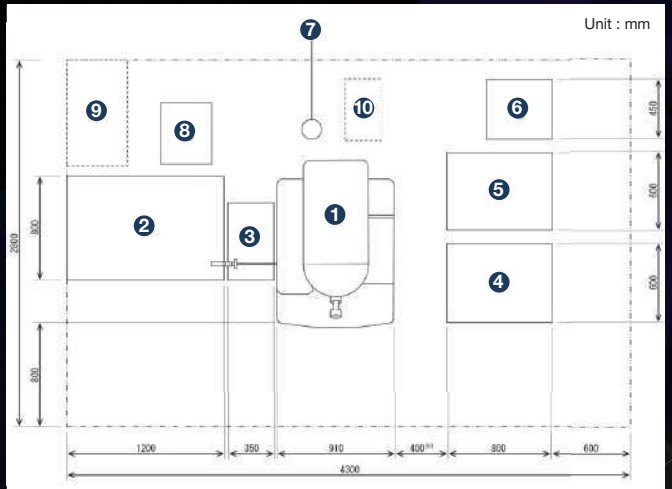
		NX9000
SEM	Electron source	Cold cathode field emission source
	Accelerating voltage	0.1 - 30 kV
	Resolution	2.1 nm@1 kV
		1.6 nm@15 kV
FIB	Ion source	Ga liquid metal ion source
	Accelerating voltage	0.5 - 30 kV
	Resolution	4.0 nm@30 kV
	Maximum probe current	100 nA
Standard detector		In-column SED / In-column BSED / Chamber SED
Stage	X	0 - 20 mm*1
	Y	0 - 20 mm*1
	Z	0 - 20 mm*1
	θ	0 - 360°*1
	τ	–25 - 45°*1
Maximum sample size		6 mm x 6 mm, 2 mm thick

*1 Stroke is limited by each sample holder.

Options

Ar ion 3rd column	For low energy Ar ion beam polishing with real-time SEM end point detection functions.
Micro-sampling system	For micro sample extraction from bulk sample.
Multi gas injection system ●Carbon deposition gas ●Tungsten deposition gas ●Platinum deposition gas	For deposition of multiple gases. Gas needs to be specified.
Retractable BSED	For low angle BSE detection. Retractable STEM detector cannot be mounted simultaneously.
STEM detector (STEM Type Ⅰ)	For bright field STEM imaging.
Retractable STEM detector (STEM Type Ⅱ)	For dark field STEM imaging. Retractable BSED cannot be mounted simultaneously.
Cold trap	Effective for reducing contamination.
Air protection sample transfer	Sample environment protection during transfer.
Side entry auto stage	TEM holder stage for direct transfer. Occupies EBSD port.
Air protection cooling holder	Side entry auto stage required.
Sample rotation holder	Side entry auto stage required.
Plasma cleaner	For reduction of hydrocarbon in SC chamber.
EDS	For X-ray Dispersive Spectroscopy.
EBSD	For crystal orientation analysis and mapping. Side entry auto stage cannot be mounted simultaneously.
A-TEM	For automatic TEM sample preparation.
Vector scan	For customised patterning by vector scan.
3D-EDS software	EDS system required.
3D-EBSD software	EBSD system required.
Chiller	For SEM lens system cooling.

Layout



1,000 mm when side entry auto stage is mounted.

Unit	Width x length x height, mm	Weight, kg
❶ Main unit	910 x 1,280 x 2,020	1,430
❷ Operation table	1,200 x 800 x 720	85
❸ Sub table	350 x 600 x 720	20
❹ SEM control cabinet	600 x 800 x 2,000	320
❺ FIB control cabinet	600 x 800 x 2,000	340
❻ Transformer	550 x 500 x 750	140
❼ Weight	Φ150 x 120	20
❽ Scroll dry pump (recommended model)	500 x 460 x 340	35
❾ Chiller (recommended model) *2	457 x 800 x 620	65
❿ Argon cabinet *2	300 x 470 x 830	70

The values listed in the table are rounded (approximate value).
The values such as dimensions, weights differ depending on the product configuration (options and such).
The values listed in the table are reference values.
*2 Option

Utilities

Room temperature	Set value	22°C±3°C
	Tolerance	Set value ±1°C
	Fluctuation	0.5°C/h or less
Humidity	Tolerance	35 - 60% no condensation
Power	Single phase AC200/208/220/230 V±10% 30 A (50/60 Hz)	
Grounding	D-class	100 Ω or less
Cooling water	Flow	0.6 - 0.7 L/min or less
	Pressure	50 - 100 kPa
	Temperature	15 - 25°C
	Temperature fluctuation	±0.5°C or less/10 min
N_2 gas	Purity	99.95% or higher
	Pressure	0.5 - 0.7 MPa

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-Tech Corporation continues to develop the latest technologies and products for our customers.

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