The Scanning Electron Microscope (SEM) has played an important role for many years for research and development of advanced materials in the leading edge of many technologies.

Hitachi High-Technologies Corporation has developed the SU6600 Schottky Field Emission Analytical SEM to meet the increased demand for analytical, high resolution microscopy. It utilizes advanced Variable Pressure (VP) technology and an improved Schottky field emission electron source that provides exceptional imaging and high probe current with great stability. It allows accommodation of EDX, WDX and EBSP systems for versatile material analyses in addition to high resolution imaging and materials characterization. The VP mode allows the operator to change vacuum conditions in the sample chamber from high vacuum ($\leq 10^{-4}$Pa) to low vacuum (10–300Pa) operation with a single click of the mouse. The SU6600 provides unparalleled imaging and EDX and EBSP analysis of challenging samples without the need for sample preparations such as metal coating or special grounding techniques.

The SU6600 is a new and versatile Field Emission SEM for a diversified range of applications including observations and analyses of advanced materials which have become increasingly important for modern science and engineering.

### SU6600 Features

- **Maximum probe current of 200nA** for analytical applications including EDX, WDX and EBSP.
- **Increased analytical sensitivity and throughput**
- **Advanced Variable Pressure** mode allows observation and analysis of non-conductive samples. The high vacuum mode and the VP mode are selectable at a click of the mouse on the operation panel. An unique automated differential aperture system (ADAPT) selects and inserts the optimum aperture size for each vacuum mode and application.
- **An improved signal detection system includes a highly efficient Everhart-Thornley Secondary Electron Detector (SED) for high resolution imaging and a new low impedance solid state Backscattered Electron Detector (BSED) with clear, sharp TV rate observation.** An optional Environmental Secondary Electron Detector (ESED-II) permits collection of secondary electron in the VP mode providing surface observation even at long sample working distances.
- **A large analytical specimen chamber with a standard specimen exchange airlock system** is standard on the SU6600. Simultaneous accommodation of EDX, WDX and EBSP optimizes workflow and user convenience without sacrificing performance. The sample exchange system allows a maximum of 150mm diameter x 40mm thick sample with a pumpdown time of approximately 30 seconds and vent time of 13 seconds.
- **A large, 5-axis, computer eucentric, motor-drive stage is a standard feature on the SU6600.**

### Vacuum control

The Variable Pressure (VP) mode has been developed for observation of wet, oily or dirty samples as well as non-conductive materials without the need of sample preparation. The chamber pressure is continuously variable within a range of 10-300Pa to help control sample dehydration and to eliminate charging and sample drift. In the VP mode, a differential aperture separates the high vacuum from low vacuum allowing the highly focus beam of electrons into the sample chamber yet maintains vacuum integrity in the gun and column optics. In the VP mode of operation, the beam current is reduced due to the small size of the differential aperture. An automated differential aperture system (ADAPT) was developed to robotically insert the differential aperture assembly when required for the VP mode and removing the assembly when high current, high vacuum applications are required. This system eliminated the need for the operator to physically change the differential aperture assembly as needed for each application requirement, reducing the potential for damage or contamination of the aperture assembly.

### Vacuum mode change (ADAPT function)*

**- Automated Differential Aperture –**

A small differential pumping aperture can be inserted in the pole piece or retracted out of the beam path by a click of the mouse. The right picture shows how the differential pumping aperture is inserted automatically step by step.

### Sample exchange

The specimen exchange chamber can quickly and easily allow a maximum sample size of 150mm diameter x 40mm thick through the airlock. The typical exchange time is 30 seconds for pre-pumping and 13 seconds for venting the airlock. It also allows direct loading of wet samples by maintaining the same vacuum level in the specimen exchange chamber as selected for the specimen chamber.

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*EDX : Energy Dispersive X-ray Spectrometer  
WDX : Wavelength Dispersive X-ray Spectrometer  
EBSP : Electron Back-Scatter Patterns  
SED : Secondary Electron Detector  
SE : Scanning Electron  
Primary electrons   
M : Molecule  
+ : + ion   
= : gas   
A : residual gas  
X-ray   
Objektive   
Lens   
EDX   
WDX   
Sample  
EDX   
WDX  
Residual gas molecule x ion  
Differential pumping aperture  
Sample chamber pressure: $\leq 10^{-4}$Pa  
Probe current: 20nA (maximum)  
This is sufficient for WDX operation.  
Sample chamber pressure: 10–300Pa  
Probe current: 200nA (maximum)  
This probe current is available with a small differential pumping aperture. It allows EBSP operation in the VP-mode.
**Signal Detection**

**Imaging performance**

- **SE Image (Vac: 30kV  Mag: 300kX  Vacuum: High)**
  Sample: Catalyst, courtesy of Prof. Y. Takasu, Dept. of Fine Material Engineering, Shinshu University, Japan

- **SE Image (Vac: 20kV  Mag: 80kX  Vacuum: High Probe current: 5nA)**
  Sample: Au particle on carbon

- **SE Image (Vac: 1kV  Mag: 10kX  Vacuum: High)**
  Sample: Helicobacter cinaedi (non coated), Courtesy of Infectious Disease Surveillance Center, Japan

- **SE Image (Vac: 5kV  Mag: 50kX  Vacuum: High)**
  Sample: Pneumococcus (non coated), Courtesy of Infectious Disease Surveillance Center, Japan

**High sensitivity BSE detector**

BSE images provide high contrast, compositional information of the sample due to the atomic number differences within the material. The SU6600 has a new 5 segment solid state type BSE detector that allows observation of topographic information of a sample at 4-orientations without the need to rotate the sample. It also provides 3D-observation at a click of a button. Due to the thin, compact and high sensitivity design of the detector, high resolution imaging at a shorter working distance improves image performance. TV rate observation facilitates searching for the area of interest due to the TV rate observation mode possible by the unique design of this detector.

- **Composite BSE Image**
  - Sample: foreign material on electrical component

- **Topographic BSE Image**
  - Sample: Helicobacter cinaedi (non coated), Courtesy of Infectious Disease Surveillance Center, Japan

- **3D BSE Image**
  - Sample: foreign material on electrical component
**ESED-II Secondary electron detector for VP mode (Optional)**

In the VP mode of operation, secondary electrons generated from a sample surface interact and ionize gas molecules in the specimen chamber. Hitachi has developed an optional Environmental Secondary Electron Detector (ESED-II) which collects these ions that carry secondary electron information. The ESED-II detector has improved collection efficiency and permits secondary electron images at high and low accelerating voltage with excellent signal to noise.

**EBSP analysis at VP mode**

The SU6600 includes the Variable Pressure (VP) mode in its standard configuration. It allows EBSP analyses of non-conductive samples such as ceramics without the need for sample preparation such as metal coating. It permits quick crystal analyses and mapping without deterioration of the diffraction pattern.

**Analytical specimen chamber**

The sample chamber of the SU6600 has many accessory ports for simultaneous accommodation of EDX, WDX and EBSP systems without sacrificing performance. In addition, accommodation of a Cryotransfer system, CL detector and other analytical accessories are possible.

**Features of 5-axis motor stage**

- **Basic stage control**
  Trackball control is standard (joystick is optional). Both stage control types can be selected through the GUI when the option joystick is ordered.

- **Stage history**
  Observation points or user-defined points on a sample can be saved and graphically displayed. It is easy to return to any stored points of interest for future observation and analysis or for repeatability from sample to sample.

- **Focus-linked Z control**
  Image focus is automatically adjusted with the Z stage axis keeping the sample in focus.

- **Eucentric tilting and eucentric rotation**
  The computer eucentric stage design allows sample tilt or rotation while maintaining the field of interest in view and in focus.

- **X-Y step movement**
  Allows the X and Y stage motion to be programmed to move in user-defined steps per click of the mouse. This feature facilitates observation of repeating patterns and distances.

- **Graphic display of relation between objective lens and sample**
  The positions of a sample and objective lens are graphically displayed in the stage operation menu panel. This helps the operator to see the sample position with respect to the objective lens.

**Image navigation**

The image navigation system can capture low magnification SEM images, import optical or reference documents such as schematics. A single click on the reference image will drive the sample to the chosen location.

**Motor stage operation with virtual joystick**

Computer-controlled stage movement offers flexibility and user-friendliness. In addition to using a trackball, joystick (optional) or GUI stage control, a virtual joystick graphical user interface can be superimposed on the sample image. This provides interactive control of the sample movement using the computer mouse.
Multiple viewing screens available

Images can be displayed in full frame, small frame and dual frames to simultaneously display two images with two different signal inputs. Split screen and dual magnification images can also be selected. Image magnification is calculated based on the traditional, industry standard 4" × 5" Polaroid format, not on viewing monitor size.

Full frame display mode
(1,280 × 960 pixels)

Small frame display mode
(640 × 480 pixels)

Dual frame display mode
(640 × 480 pixels × 2)

Image adjustment by mouse operation

The mouse control design allows operators to manipulate image focus, stigmation, contrast, and brightness by viewing the image on the monitor. There is a separate control panel provided for traditional knob adjustments.

Personalized user log-in

The operators may input their individual names in a log-in user list. Operating conditions of the SU6600 are stored in memory by the user’s name. When the operator’s name is input in the login menu, personal operating conditions are recalled and the SU6600 is set accordingly. This design allows operators to make their personal operating environments. Examples of these personal setup include:

- Operation panel layout on GUI
- Accelerating voltage, electron optical parameters and other conditions
- Image display (Choice of full screen, reduced area, simultaneous two images) / Image store / File format / Scan speed select button layout

SEM Data manager

The SEM Data Manager is a useful software program standard for Hitachi PC-SEMs. It allows the automatic registration of stored images from the database by the user’s name. It also allows a sequential selection of images of interest by dates, operating conditions, image sizes, key words, folders, etc. These images may be printed after the contrast and brightness adjustments or other image processing layout if required.

*Note: This function is available as an option outside of the microscope room such as an office room using a separate PC.

CD Measurement

The CD measurement function allows dimensional and angle measurement of a specific point of interest on the SEM image. The measurement is available in manual or automatic measurements, continuous measurements and simultaneous measurements of width and pitch. Operators may choose any one of these measurements for their specific purposes.
### Standard specifications

**Secondary electron image resolution**
- 1.2mm (Vacc: 30kV, WD = 5mm, Mag: 180kX)
- 3.0mm (Vacc: 1kV, WD = 4mm, Mag: 80kX)
- 4.5mm (Vacc: 30kV, WD = 5mm, Mag: 50kX, 150Pa)

**Magnification**
- 10 – 600,000X (at displayed image size is 127 x 96mm)

**Electron optics**
- Electron gun: ZrO/W Schottky emission electron source
- Prove current: 1pA ~ 200nA
- Voltage: 0.5 – 30kV (0.1kV step)
- Lens system: Octopole electromagnetic system (X, Y)
- Objective lens: Movable aperture: [heating type, 4 openings selectable from outside of vacuum with fine adjustment mechanism, 200-100-50-30μm]
- Stigmator coil: Octopole electromagnetic system (X, Y)
- Scanning coil: 2-stage electromagnetic deflection
- Beam blanking: Electromagnetic type (for image freezing)

**Specimen stage**
- Stage control: 5-axis computer eucentric motor drive
- Movable range:
  - X: 0 – 110mm
  - Y: 0 – 110mm
  - Z: 4 – 40mm
  - T: -5° ~ +70°
  - R: 360°
- Sample size (maximum):
  - 150mm diameter x 40mm height

**Electrical image shift**
- ±50μm (WD= 15 mm)

**Detector**
- Secondary electron detector
- Backscattered electron detector

**Personal computer**
- Windows® Desktop PC
  - OS: Windows®XP Professional

### Image display mode
- Full screen display: 1,280 x 960 pixels
- Reduced area display: 640 x 480 pixels
- Reduced area display: 320 x 240 pixels
- Dual image display: 640 x 480 pixels x 2

**Scanning speed**
- TV scan: (640 x 480 pixel display: 25/30*1 frame/s)
- Fast scan: (full screen display: 6.25/7.5*1 frame/s)
- Slow scan: (full screen display: 1/20/40/80s/frame)

**Image data saving**
- 640 x 480 pixels, 1,280 x 960 pixels, 2,560 x 1,920 pixels, 5,120 x 3,840 pixels

**Image data printing**
- Free layout print function provided

**Exterional device connection port**
- USB interface (2ports)
- Network interface (Ethernet*)

**Evacuation system**
- Auto evacuation: Fully automatic pneumatic valve control system
- Ultimate vacuum: Electron gun chamber: x1 x 10⁻¹⁰ Pa
  - Specimen chamber: x7 x 10⁻¹⁰ Pa
- Vacuum pumps:
  - Ion pump: 40L/s x 2
  - Turbo molecular pump: 260L/s x 1
  - Oil rotary pump: 135/162 L/min x 2
- Vacuum gauges: Penning gauge: 1
  - Pirani gauge: 4
  - N2 purger: Port for N2 purge (1/4 taper nut)
  - (Supply pressure: 10 – 20kPa)

**Protection functions**
- Protection against power and vacuum failures

### Optional accessories

**Detectors**
- ESEDA (optional SE detector for VP mode)
- EBIC image observation device
- STEM detector
- Faraday cup
- Energy dispersive X-ray detector
- Wavelength dispersive X-ray detector
- EBSP detector
- Cathodoluminescence detector

**Specimen stage/specimen holder**
- Cryogenic stage
- Cool stage
- Cross-section specimen holder
- Cross-section mounting holder
- Cross-section specimen stub (90, 75, 60)
- Wafer holder (2”, 3”, 4”, 5”, 6”)
- EBIC holder

**Software**
- CD measurement function
- CD measurement function for SEM Data Manager
- SEM Data Manager for external PC
- H-Mouse
- DBC interface

**Utilities**
- Ion pump backup power supply N2 gas leak port

**Others**
- RS232C Communication interface
- Electrostatic blanking plate
- Signal selector
- Microscope
- Chamberoscope
- Anti-contamination trap

### Dimension & Weight

<table>
<thead>
<tr>
<th>Main unit</th>
<th>Width × Depth × Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>840 x 966 x 1,660mm</td>
<td>670kg</td>
</tr>
<tr>
<td>Display unit</td>
<td>1,000 x 1,005 x 1,200mm</td>
<td>205kg</td>
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<tr>
<td>High-voltage unit</td>
<td>326 x 394 x 775mm</td>
<td>128kg</td>
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<tr>
<td>Oil rotary pump</td>
<td>526 x 233 x 306mm</td>
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<tr>
<td>Air compressor</td>
<td>400 x 230 x 550mm</td>
<td>18kg</td>
</tr>
<tr>
<td>Weight</td>
<td>200 x 180 x 160mm</td>
<td>40kg</td>
</tr>
</tbody>
</table>

### Utility requirements

**Temperature**
- 15 ~ 25°C

**Humidity**
- 60%RH or less

**Power**
- AC100–240V ±10%, 4kVA, 50/60Hz

**Grounding**
- 100Ω or less

### Suggested layout

![Suggested layout diagram](image-url)
Schottky Emission VP FE-SEM

Analytical Variable Pressure Scanning Electron Microscope

SU6600

NOTICE: For proper 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.

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