

HITACHI S-3400N

QUICK START GUIDE



Version 0.1
20 January 2015

1	TURNING THE S-3400N ON.....	3
2	LOADING A SPECIMEN	3
3	OBTAINING AN IMAGE	4
	<i>Problem 1: I CAN'T SEE AN IMAGE</i>	<i>5</i>
4	ALIGNMENT	6
5	IMAGING QUALITY	8
6	IMAGING USING THE SE DETECTOR	10

1 Turning the S-3400N on

In the case when the microscope has been switched off completely, e.g. over the weekend, check that power to the system is available and rotate the key switch on the SEM front panel to Start and then release the key. The SEM will now start.

The PC should start automatically, if not, press the start button on the front panel of the PC. Log in to the system and then log into SEM operating software.

2 Loading a Specimen

To load a specimen into the S-3400, firstly mount the sample onto an appropriately sized pin stub. The pin stub is then inserted into a brass carrier. For screw stubs, set up in a similar manner with an appropriate carrier.

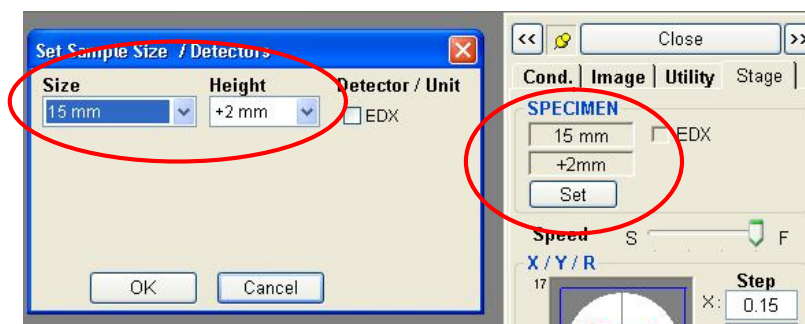
Using the sample height measurement tool supplied with the SEM, note the height of the specimen with respect to the standard height. Also, note the overall specimen size.

The specimen chamber needs to go to air to enable the loading of a specimen. To do this, either press AIR on the SEM front panel or AIR on the software control panel. To prevent any sample damage during loading, it is advised that the stage is at the Home Z65 position.



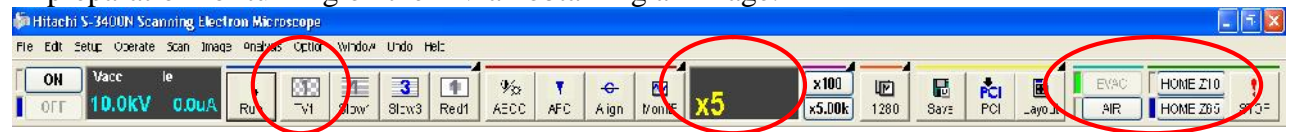
Once at air, open the chamber door, slide the sample and holder into the stage holder and close the chamber door. Press EVAC on either the SEM front panel or software control panel. The chamber will now return to vacuum.

As part of the loading procedure, the software will ask the user to confirm the sample size and height with respect to the standard height. The box shown below will be shown. If the sample size differs from that already loaded, change the values to appropriate ones and then click on ok. If at any point the user needs to refer to or change the sample size/height during operation, this window can be accessed from the Stage panel.



3 Obtaining an Image

In preparation for turning on the HV an obtaining an image:



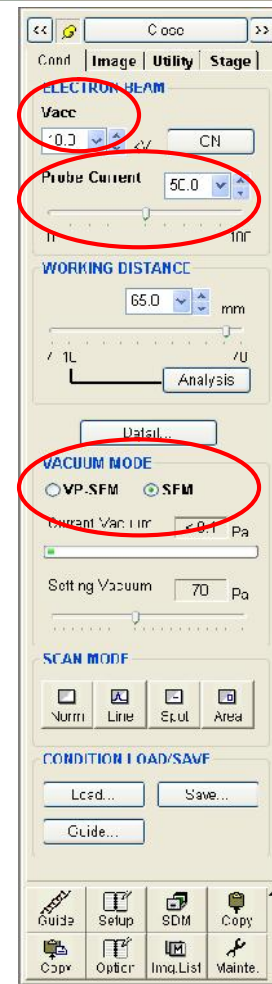
- Ensure the stage is at the HOME Z65 position
- Move to a low magnification
- Set the accelerating voltage (Vacc) to an appropriate value
- Set the spot size (Probe Current) to ~50
- Ensure the chamber is under high vacuum
- Set the Objective Aperture to position 0
- Check the detector selected in the Image panel is suitable; usually the SE detector is used.
- Set the refresh rate to TV1.

With the exception of the objective aperture setting, all the features can be found in the software control panel or the Condition panel.

Note: the beam conditions can also be accessed from the Setup menu. This can be reached by either clicking on the Setup menu tab at the top of the software control panel and selecting Optics setup, the Detail button approximately half way down the Condition panel or the Setup button at the bottom of the panel.

Once the chamber is at high vacuum, turn the beam on using the ON button. This is located at the left hand end of the software control panel and at the right hand side of the acceleration voltage setting in the Condition panel.

It should now be possible to view an image on the screen.



Notes:

This procedure has been set up in such a way to easily observe an image immediately after the beam has been switched on.

- The long working distance, lack of Objective Aperture and low magnification increase the field of view and hence the likelihood of observing the sample.
- The accelerating voltage and spot size ensure that there is a bright enough beam to enable ease of observation.

Problem 1: I CAN'T SEE AN IMAGE

There are a number of reasons why a user may be unable to observe an image and a number of simple checks to help fix this:

- Is the HV on?
 - The small box directly to the left of the ON button on the software control panel should be coloured blue. If not, click ON.
- Is there any emission?
 - Check the Ie setting in the HV reading box of the software control panel. This should have a non-zero reading. If set at zero, check whether the HV is on.
 - If the HV is off, switch on.
 - If the HV is on, a filament change is required.
- Is the magnification appropriate?
 - If the magnification is too high, it can be difficult to observe an image, try lowering the magnification.
- Are the spot size (probe current) and accelerating voltage suitable.
 - A small spot size and low accelerating voltage can lead to imaging difficulties, try increasing to obtain the initial image – they can be reduced once the site of interest has been found.
- Is the working distance appropriate?
 - A short working distance reduces the field of view and can make initial imaging more difficult. Move to HOME Z65 to increase the field of view.
- What OA is being used?
 - There are four objective apertures, smaller OA's reduce the field of view and beam current on the specimen. This can make it harder to obtain an image, either remove the OA entirely or move to a larger OA. Also, check the alignment of the OA when performing the alignment.
- Does the focal length of the objective lens match the specimen height?
 - The objective lens focal length can be observed at the bottom of the Image Observation window. Cross check that this value matches that of the specimen height. If not, adjust the focus knob on the knob panel to a more suitable value is reached and the image comes into focus.
- Is there sufficient contrast?
 - Sometimes, the contrast and brightness levels are set up for previous users and may be inappropriate for the current use. Click on the ABC button on the software control panel for the SEM to automatically adjust the brightness and contrast or use the knob panel.
- Is the sample size correct?
 - Setting the sample size limits the stage drive so it may not be possible to drive to the correct location if the sample size is too small. This can be adjusted by clicking on the Set button in the Stage panel.

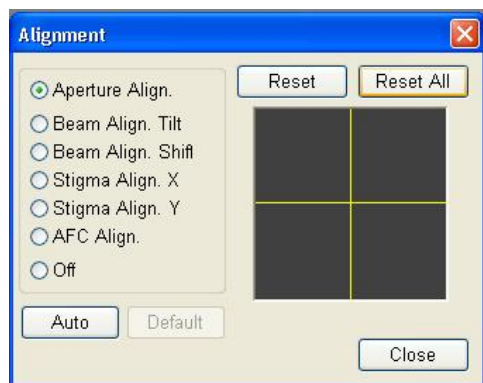
4 Alignment

This procedure is a full alignment of the S-3400, under normal operating conditions, the first two steps (setting the Gun Bias to zero and Auto Filament Saturation can be skipped).

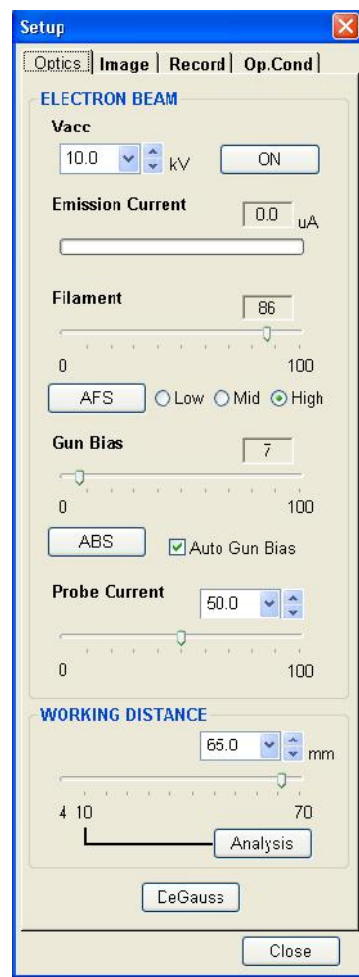
Move to the analytical working distance by clicking on HOME Z10 on the software control panel and focus the image. Set the magnification to a few hundred times. For a full alignment, the accelerating voltage should be set to 5 kV and spot size (probe current) 80. Also objective aperture should be set to 0.

The following procedure utilises the Auto alignment features of the SEM. It is still possible to manually align the beam by using the multifunction STIGMA/ALIGN knobs on the knob panel or moving the cross hairs in the Alignment window instead of clicking on Auto at each step.

- In the Setup (Optics) window, click on the Auto Gun Bias checkbox and ensure that the gun bias is set to zero.
- Run Auto Filament Saturation (AFS) to ensure optimum emission from the filament.
- Open the Alignment window through the Align button on the software control panel.



- Select Beam Align. Shift and click the Reset button. Click on Auto (or maximise the brightness if performing this manually).
- Select Beam Align. Tilt and click the Reset button. Click on Auto (or maximise the brightness if performing this manually).
- Move the Objective Aperture to position 1 and manually maximise the brightness using the two wheels on the Objective Aperture control stick. Repeat for Objective Apertures (OA) 2, 3 and 4.
- Return to OA 3 and click on Aperture Align on the Alignment panel. Click Reset button and using the two wheels on the OA control stick, minimise any lateral movement of the image on the screen.



- Return to the Setup window and restore Gun Bias (ensuring the value returns to the previous value).
- Move to a higher magnification (3 kX to 5 kX), switch on the Area Marker found in the Utility panel.
- Select Stigma Align. X, click the Reset button and then Auto (or minimise image movement if performing a fully manual alignment). Repeat for Stigma Align. Y.
- Click on Off and close the Alignment window.
- Focus the image and remove any astigmatism, this step will require repeating once the spot size has been changed to an appropriate size for the type of imaging required.

Notes:

This procedure has been set up so as to ensure a high quality and repeatable alignment of the column.

- Removing the Auto Gun Bias ensures a maximum current down the column hence maximising brightness and ease in observation.
- Saturating the filament maximises the emission from the electron gun without running the filament harder than required. This increases the tip lifetime.
- Aligning the Beam Shift and Tilt with no objective aperture or other limiting factors ensures that the beam is travelling straight down the optic axis. This ensures stability of the system when changing accelerating voltage and spot size.
- The mechanical alignment of the apertures centres the aperture with respect to the electron beam enabling the maximum current to pass through the aperture. It also ensures that as the focus is altered the image will not “swing” off of the imaging window.
- The alignment the Stigmator coils does not alter the stigmatism but corrects for any offset the coils may have had on the beam from the optic axis.
- Following this, the beam should be travelling down the entire length of the optic axis without deviation leading to improvements in focus, resolution and the ability to correctly stigmatise the image.

After a filament change, this entire alignment procedure requires repeating. After moving the alignment of one of the OA's (not just changing an aperture), the aperture will require realigned and all subsequent alignment steps completed. Following a change in the accelerating voltage and/or spot size (probe current), check the alignment of the OA and the Stigmator coils then focus and stigmatise.

5 Imaging Quality

There are a number of factors that require to be taken into imaging the specimen. Some of these are highlighted below. Note the tables can be found in section 3.10 of the manual.

When imaging a specimen the desired outcomes should be considered.

For example, a sample sensitive to charging with large features may benefit from a low accelerating voltage to reduce charging, a small to medium sized spot to improve resolution.

If resolution images on a similar specimen were required, changing to VP mode to minimise charging effects alongside a higher accelerating voltage and small spot size may be more suitable.

Experience with a variety of specimens assist in optimising observation conditions. The tables below highlight some of the effects of changing operating conditions. The following chapters/sections highlight some of these effects in the different imaging modes.

Accelerating Voltage and Image Quality

Acc. volt. (kV)	1	2	3	5	10	15	20	25	30
Resolution	Low ← → High								
Secondary electron signal	High ← → Low								
Surface information	Topmost surface info. ← → Surface info. (incl. internal info.)								
Influence of contamination ※1	High ← → Low								
Charge-up ※2	Low ← → High								
Non-deposition observation ※2	Easy ← →								
Specimen damage ※2	Low ← → High								
Influence of floating magnetic field	High ← → Low								
X-ray analysis	X-RAY								

※1: Under a low accelerating voltage, information is at the topmost surface. When there is contamination, that surface is observed, exerting significant impact on the image.

※2: The extent of this factor is subject to change depending on the type of specimen involved and the type of specimen pretreatment conducted.

Spot Size (Probe Current) and Image Quality

Probe Current Setting		0	50	100
Irradiation current (A)	Low			
Resolution	High			
Secondary electron signal	Low			
Image roughness	High			
Charge-up ※1	Low			

※1: For non-conducting specimens

Objective lens Aperture and Image Quality

Stop No.	1	2	3	4
Aperture diameter (μm)	150	80	50	30
Focal depth	Shallow			Deep
Probe current	High			Low
Resolution	Low			High
Application	X-ray analysis on low accelerating voltage	Observation and normal X-ray analysis		Observations requiring a great focal depth

WD influence

	Short		Long
Resolution	High		Low
Focal depth	Shallow		Deep
Specimen tilt angle	Small		Large

WD in low vac mode

Working Distance (mm)	10	50
Scattering of irradiation electrons	Low	High
Scattering of backscattered electrons	Low	High

6 Imaging using the SE detector

The images on this page show the effects of changing the accelerating voltage while maintaining all other aspects a constant.

The sample consists of tin evaporated onto a Carbon base. It forms a series of spheres that vary in size and shape.

Operating conditions:

Objective Aperture	3 (50 μ m)
Probe Current	20
Working Distance	7.1 mm
Accelerating Voltage	5 kV 10 kV 20 kV

In the first image, with an accelerating voltage of 5 kV, surface contamination on the largest sphere is easily observed. It is also possible to observe a range of sizes of smaller spheres surrounding the central one.

The second image, with the accelerating voltage increased to 10 kV, shows surface contamination as well. However, some features of the contamination are not as fully defined.

Once the accelerating voltage has been increased yet further to 20 kV, the image looks significantly different. Due to increased penetration of the beam into the material, the level of surface contamination appears significantly reduced. Also, the number and location of some of the smallest spheres is different to that in the first image, again this is due to increased beam penetration showing more of the carbon substrate below the surface.

This image series highlights the dependency of the accelerating voltage on the observed image.

