

JEOL JSM-840A LaB₆ FILAMENT OPERATION

(See JEOL 840A Manual for Details)

IMPORTANT: Make sure you are aware of whether the filament currently installed is a tungsten or LaB₆.

I. PRESETS

- A. System lights should be on. **ACCEL VOLTAGE** should be off.
- B. Low vacuum thermocouple gauge < 50 mTorr and high vacuum Penning gauge < 1x 10⁻⁶ Torr. Ion pump should be reading < 400 μ A with the knob set to the 2 MA scale.
- C. **DISPLAY MODE**
 - 1. **D-MAG** and **NORM** lights on.
 - 2. **CONT** and **BRIGHT** fully CCW.
- D. **MAGNIFICATION:** 300,000x.
- E. **SCAN MODE:** **RDC** and **PIC** lights on.
- F. **SCAN SPEED:** **SLOW 1** light on.
- G. **EOS MODE:** **SEM** light on.
- H. **COARSE PROBE CURRENT:** 6 x 10⁻¹¹ A.
- I. **FINE PROBE CURRENT:** 11:00 position
- J. **FILAMENT:** Set to 180 μ A. Knob should be set to roughly the 11:30 position
- D. Log onto the microscope in the logbook.
- E. Check to make sure the EDS detector is fully withdrawn.

II. OPERATING THE SEM

A. Sample Insertion

- 1. While wearing gloves, mount samples on one of the 840 sample stages available and screw this stage onto the specimen transfer arm located under the laminar flow hood.
- 2. Make sure the red light on the specimen load lock pre-evac button is on and insure that the sample stage parameters are set properly to load the sample. Adjust the stage controls to Y = 35.0 mm, X = 25.0 mm, R = 000, and T = 000. The coarse Z working distance knob should be set to 48 mm (for the 32 mm diameter sample holder) or 39 mm (for the smaller sample holder).
- 3. Inspect the plastic sealing surface on the transfer arm for any debris as well as the o-ring around the transfer stage. Make sure the specimen holder sits back close to the plastic sealing surface. Place the specimen transfer arm into the specimen load lock area and apply slight pressure to insure a good seal between the o-ring and the plastic sealing surface. Press the load lock pre-evac button to begin roughing out the load lock chamber.
- 4. Monitor the low vacuum thermocouple gauge to insure a vacuum is being pulled. When the red light on the load lock pre-evac button turns off, the samples are ready to be transferred to the SEM sample stage.
- 5. Turn the knob on the specimen load lock gate valve CCW so the word OPEN is facing you and pull the knob out to open the gate valve. Monitor the high

- vacuum Penning gauge. The pressure will rise but shouldn't go above about 10^{-3} Torr and/or stay there. If this is the case, close the valve.
6. Push the sample transfer arm in to bring the samples into the SEM chamber. There is a little bit of play up and down and side to side on the transfer arm. You shouldn't be able to freely rotate the transfer arm if the specimen holder is seated well onto the SEM specimen stage.
 7. At this point you can rotate the transfer arm CCW to release the specimen holder. Pull the transfer arm back out beyond the gate valve into the load lock chamber.
 8. Close the gate valve by pushing the gate valve knob in and lock it by rotating the knob clockwise so that the word OPEN is facing up.
 9. Push the pre-evac button while holding onto the transfer arm to vent the load lock chamber. Place the transfer arm onto the holder under the laminar flow hood.

B. Obtaining an Image

1. Adjust room lights to comfortable level. Adjust as needed while operating. Also turn on the PANEL LIGHT switch on the SEM console.
2. Open up the EDS 2008 application from the desktop if it is not already open. If EDS 2008 is not available on the desktop, the lithography computer may be showing on the screen. Hit select on the monitor input unit to change between computers.
3. Select an appropriate aperture. Position 1 is the largest aperture while Position 4 is the smallest.
4. Release SCAN MODE RDC and go to EOS EMP mode, SCAN SPEED SLOW 2, DISPLAY MODE D-MAG and YZ-MOD with AMPL fully CW. Adjust DISPLAY MODE BRIGHT knob to the 3 o'clock position and set the CONT knob to the 2 o'clock position. Make sure the FINE PROBE CURRENT knob is in the 11:00 position and adjust SE IMAGE BRIGHT and CONT until a dim sweep can be observed.
5. Select an appropriate accelerating voltage using the ACCEL VOLTAGE selection controls. Turn on the high voltage by pressing the ACCEL VOLTAGE button on.
6. Slowly increase the FILAMENT current from 180 μA to 200 μA ($\sim 20 \mu\text{A}/20$ sec) and then wait 30 seconds. Next increase the current another 20 μA to 220 μA using the same rate ($20 \mu\text{A}/20$ sec) and wait 30 seconds. Continue this procedure until you are at saturation ($\sim 300 \mu\text{A}$ but depends on the age of the filament). Adjust SE IMAGE BRIGHT and CONT as necessary while viewing the emission pattern. At saturation, the pattern should be elliptical and increasing the filament current beyond this should have no effect.
7. Go to DISPLAY MODE NORM, EOS SEM mode, SCAN SPEED SR, and SCAN MODE LSP. Turn the BRIGHT knob all the way up on the DISPLAY MODE and set the CONT knob to the 2 o'clock position. Turn DISPLAY MODE D-MAG off and set the MAGNIFICATION to the lowest value.
8. At low probe currents ($\sim 6 \times 10^{-11} \text{A}$) adjust the GUN ALIGNMENT X and Y TILTS to maximize the line profile. At high probe currents ($\sim 2 \times 10^{-7} \text{A}$) adjust

- the GUN ALIGNMENT X and Y SHIFTS to maximize the line profile. Adjust the SE IMAGE BRIGHT and CONT as necessary.
9. Go to a medium probe current setting ($\sim 1 \times 10^{-9}$ - 6×10^{-10} A) and adjust the DISPLAY MODE BRIGHT knob to the 3 o'clock position. Go to SCAN MODE PIC at the lowest MAGNIFICATION and use the x and y stage controls to orient yourself. Adjust the coarse z knob to the desired working distance (8 mm gives the best resolution while 48 mm will give the best depth of focus). Find a feature of interest and adjust the COARSE and FINE FOCUS knobs to bring the image into focus. Continue to do this at successively higher magnifications.
 10. Adjust the X and Y STIGMATORS so that the image does not stretch in perpendicular directions as you go in and out of focus with the fine focus knob at high magnifications.
 11. Align the aperture by turning on the WOBB button and setting the AMPLITUDE control to a comfortable level. As the image goes in and out of focus, adjust the X and Y APERTURE DRIVES to eliminate any image sway. When finished release the WOBB button. The image should uniformly go in and out of focus with no image swaying (aperture) or perpendicular stretching (stigmators). For high resolution and high magnification imaging, these steps should be performed at as high a magnification as possible.
 12. Repeat steps 8-11 until satisfied that the microscope is aligned (maximum intensity with the gun tilts and shifts and no image sway or stretch when going through focus)
 13. Use the x, y, rotate, and tilt knobs to find the desired area of interest. When tilting the sample, consult the table on the SEM stage to find out the maximum tilt angle available based on the sample holder, working distance, *etc.* If at any point, the audible alarm sounds, stop the current action and adjust the stage controls in the opposite direction as this indicates that the sample stage has contacted something in the chamber.
 14. After finding a desired area, FOCUS and STIGMATE at a higher MAGNIFICATION than the desired image magnification.
 15. Go to WFM mode and turn the DISPLAY MODE BRIGHT knob all the way up. Adjust the SE IMAGE BRIGHT and CONT controls to expand the waveform to fit within the reference lines. When done, push the NORM button and turn the DISPLAY MODE BRIGHT knob back to the 3 o'clock position.

C. Recording an Image

1. Make sure the DVI KVM is selected to the JEOL 840A computer rather than the Nabity computer (position 1 - blue light on). If not, use the SELECT button to position 1 and log onto the user account 'JEOL840'.
2. See IXRF Manual for details.
 - a. If the EDS 2008 program is not open, open it from the desktop.
 - b. Open new image file (File; New; Image; OK).
 - c. Click on ACQUIRE button.
 - 1) Acquisition parameters plus Magnification Calibration and Color Palette can be adjusted under the Properties button.

- 2) The scale bar can be added or deleted from the image and its scale changed with the Edit; Annotations button.
- d. Image can be saved as an .imx file and exported in a number of other formats. Remember, .imx is a proprietary format (see IXRF Manual for details).

D. Removing/Exchanging samples

1. Slowly decrease the filament current to 180 μ A. Release the ACCEL VOLTAGE button.
2. Adjust the stage controls to the sample loading and unloading conditions: (Y = 35.0 mm, X = 25.0 mm, R = 000, and T = 000, coarse Z = 48 mm for the 32 mm diameter sample holder or 39 mm (for the smaller sample holder).
3. Inspect the plastic sealing surface on the transfer arm for any debris as well as the o-ring around the transfer stage. Place the specimen transfer arm into the specimen load lock area and apply slight pressure to insure a good seal between the o-ring and the plastic sealing surface. Press the load lock pre-evac button to begin roughing out the load lock chamber.
4. Monitor the low vacuum thermocouple gauge to insure a vacuum is being pulled. When the red light on the load lock pre-evac button turns off, the sample transfer stage is ready to be inserted into the chamber.
5. Turn the knob on the specimen load lock gate valve CCW so the word OPEN is facing you and pull the knob out to open the gate valve. Monitor the high vacuum Penning gauge. The pressure will rise but shouldn't go above about 10^{-3} Torr and/or stay there. If this is the case, close the valve.
6. Push the sample transfer arm in to the SEM sample stage and align the transfer arm with the threaded hole in the SEM stage. Screw the specimen transfer arm into the threaded hole by turn CCW.
7. Pull the transfer arm with the sample stage back out beyond the gate valve into the load lock chamber.
8. Close the gate valve by pushing the gate valve knob in and lock it by rotating the knob clockwise so that the word OPEN is facing up.
9. Push the pre-evac button while holding onto the transfer arm to vent the load lock chamber. Place the transfer arm onto the holder under the laminar flow hood and remove the samples.

E. Shut Down

1. Reestablish the preset conditions and turn the PANEL LIGHT switch off.
2. Fill out the logbook and also the excel file named 'JEOL-JSM-840A-Usage-Log.xls' on the computer desktop.

F. Checking Probe Current

1. Power on the Keithley 6485 PICOAMMETER
2. Press ZCHK to initialize and set to AUTO RANGE with the AUTO button on the right side.
3. On the PCD module, set the switch to INTERNAL.

4. Press the PCD button to insert the Faraday cup. The image will disappear and the beam current can be read off the Keithley PICOAMMETER. Push the PCD button as necessary to check the current or to remove the Faraday cup for imaging.
5. When finished, remove the Faraday cup (PCD button lit – Faraday cup is in, PCD button dim, Faraday cup is out).
6. Turn off the Keithley 6485 PICOAMMETER.