EBPG5200
Electron Beam Lithography (EBL) System

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Contacts

For problems, clarifications of procedures, or general information pertaining to this machine, please contact lab staff at staff-ndnf-list@nd.edu

In Case of Emergency, Please Contact Notre Dame Security at

911

Description

The Raith EBPG5200 is a high-end, state-of-the-art electron beam lithography system that can write to less than 8 nm in size on full 200 nm wafers or small sample pieces. The system uses a high current density thermal field emission gun for operation at 20, 50, and 100kV accelerating voltages. Rapid exposure is possible with up to 50 MHz write speeds and a 20-bit pattern generator. The system incorporates breakthroughs in enhanced resolution, noise reduction, and beam stability for the ultimate in nano-lithography.

Allowed Materials
Semiconductor-based materials, dielectrics, metal films, and resists.

Prohibited Materials
Magnetic materials, organics, epoxy, rubbers, and plastics. Substances that can outgas/sublime/evaporate in vacuum; hydrocarbons (oil, grease, fingerprints); organic materials; liquids of any kind.

Cleaning Procedure
Samples generally do not require special cleaning, unless needed to remove prohibited materials before processing. All materials to enter the equipment will be handled with wafer tongs by an operator wearing latex, poly, or nitrile clean gloves.

Operating Instructions

General notes:

- When handling sample holders, **please take extra care** not to drop them or touch the reference plate assembly where the **Faraday cup and reference marks** are located. The holders are delicate, expensive and almost impossible to replace.
- If you're having trouble fitting a sample holder into the slot or alignment microscope, you're probably doing it wrong. Double-check that everything is lined up and fitting together correctly, **NEVER try to force a holder into anything!**
- **Be patient**. Some command can take a couple of minutes to run. Issuing the same command w/o waiting for the first one to finish can cause problems like stage lock. Always wait until the prompt returns.

Loading the piece part holder:

- Enable Raith EBL in iLab. This will power up the monitors at the operator's console.
- On the vacuum system GUI window (Top right corner of right monitor), click on vent airlock. It takes 2-3 minutes to vent the airlock.
- Open the airlock door **SLOWLY** and not let it bang against the airlock! Carefully remove the holder you intend to use. Carry it to the stainless steel table, and place it on a clean cloth wipe.
- If you have to do anything that will take more than a few minutes, pump the load lock down while you work. Click on the button pump airlock from the vacuum GUI window. Leaving the lock vented for more than a few minutes will drastically increase pump down time.
- Mount your sample(s) on the holder. Make sure the back of your sample is **CLEAN** and free of any tape or resist that could keep it from sitting flat against the stage. Move the clip around until your sample is secured between the clips.

Write preparation (need to manually level the sample so the beam stays in focus during your write):

- Carefully pick up the holder from the table by sliding it into the microscope tray; engage (SLOWLY!!) the stage lock to secure the holder in the microscope. Switch on the microscope light source and the height meter (if the display goes out during the leveling process, just press the start button again).
- Verify sample height and leveling:
    - Sample heights near the 3 height set screws have to be within -10 to +10 µm. If one side of the stage is too HIGH, use the Allen wrench to turn the set screw CLOCKWISE to lower it. If it is too LOW, the set screw should be turned COUNTERCLOCKWISE to raise it. RELEASE THE LEVER SCREW EVERY TIME you

adjusted the set screws. Re-measure the heights. Keep adjusting all three height set screws simultaneously until the absolute heights are well within the -10 to +10 µm range.
    - The set screws give approximately 200 µm of vertical translation per full turn, so adjusting in small steps.
- Locate the area on the sample you want to write on.
    - Find the Faraday cup on the reference plate, center it at highest magnification (rotate the magnification control on the microscope barrel and refocus as necessary), and zero the X and Y channels of the position readout.
    - Move from the Faraday cup to your write area: for aligned writes, drive to global markers and record their positions; for non-alignment writing, find the wafer center by recording the locations of opposite corners of your sample. Later you can find these positions in EBL stage chamber by moving to the Faraday cup first and then doing a relative move to the coordinates you just recorded.
    - Release the holder from the microscope while the airlock vents up. Make sure the microscope light source and height meter are turned off.

System loading:

1. Vent the airlock. Insert the holder into its slot by **sliding it in until it clicks into place**. Make sure the holder is seated on the rails in the cassette correctly; it should slide in with almost no force. During this process, **take great care not to bump the focus mark/Faraday cup assembly, at the leading edge of the holder, against any object**.
2. Close the door and click on "pump airlock" again. Wait until the airlock pressure is lower than 1.0×10^{-5} Torr. This will take 5 to 10 minutes.
3. Open a terminal window and type the command: **subl #**
    a. # is the slot number, e.g., 9. Wait for the holder to complete its move to the stage, at which time the command prompt will return.
4. Type the command: **pg select holder #**
    a. # is the table number upon which your sample is mounted, e.g., 15 or 16 for slot 9 holder. The system will proceed to verify the location of the Faraday cup aperture and the focus mark.
5. Move to the Faraday cup and measure the current by using the command: **mcur**. The last beam current used is displayed.

Non-Aligned Writing:

6. Switch into your jobs directory and execute your job using the command:

Job xxx.job -f <table #> 0 X,Y

    a. **-f** means relative moves from Faraday cup (0,0)
    b. Slot # here should ALWAYS BE **0**, which corresponds to "currently on the stage."

c. Do include a comma (but no spaces) between X and Y values.
d. When the write job completes, the command prompt will return.

Aligned Writing (following step 5):

6. Find the first global mark using the command: **pg move position x1,y1 --rel**
   - x1,y1 is the center of first mark recorded under alignment microscope
   - Turn on the SEM on the right screen and double click at the center of mark to center it
7. Find the accurate coordinates of the mark using the command:

   pg move mark 0,0 <ident> --rel

   - **<Ident>** is the name defined for your mark, and it should be the same name you choose in CJOB.
   - Don't forget the **--rel** at the end of command.
   - If the system finds the mark successfully it will return to the prompt with no output.
   - Record the absolute stage coordinates x and y shown on the SEM window: X1,Y1
8. Repeat step 5 – 7 for the second and third global mark, record their absolute stage coordinates X2,Y2 and X3,Y3
9. Switch into your jobs directory and execute your job using the command:

   job xxx.job <table #> 0 X1,Y1 X2,Y2 X3,Y3

   - Slot # here should ALWAYS BE 0, which corresponds to "currently on the stage."
   - Do include a comma (but no spaces) between X and Y values, and include a space between coordinate pairs.
   - When the write job completes, the command prompt will return.

System unloading:

- Unload the holder to the load lock use the command: **subu #**
  - # is the slot number, e.g., 9 (same as in step 1). Wait for the holder to complete its move back to the airlock, at which time the command prompt will return. Be patient!
- Click on "vent airlock". When the airlock has vented to atmosphere, open the airlock door and carefully remove the holder from the airlock, and place it on a clean cloth wipe on the table.
- Remove your sample from the holder. Tighten the screws to hold all the clips in place.
- Now CAREFULLY carry the empty holder back to the airlock, making sure it clicks into its slot. Close the airlock door and click on "pump airlock".
- End the section in the Kiosk of iLab.
- Tidy up the area, return tools to their proper locations, and collect your belongings.