



Raith Step-by-Step NanoSuite Patterning Guide





0 Summary of patterning steps

This document describes how to do a patterning task in a step-by-step manner. Most of these steps have to be done in the correct order. Only change the order if you know that it is possible to do a patterning task in a step-by-step manner. Most of these steps have to be done in the correct order. Only change the order if you know that it is possible to do a patterning task in a step-by-step manner. Most of these steps have to be done in the correct order. Only change the order of the Adjust have the order if you know that it is possible to do a patterning task in a step-by-step manner.

This document describes how to do a patterning task in a step-by-step manner. Most of these steps have to be done in the correct order. Only change the order if you know that it is possible to do so. For example, it is not possible to change the order of the Adjust UV and the Writefield Alignment procedures. Although with enough practice and experience, it is possible to skip some steps depending on the type of exposure and the desired results. The best advice is to gain an understanding of each Module before deviating from the given outline.

Space for Notes

1 Start software

- Start the Raith EO software (user interface of electron column.)
- Start Raith NanoSuite software.

2 Load sample

- Place sample holder in LoadLock and close door.
- Start load procedure from the LoadLock window or the top toolbar.

3 Start column

- If not done automatically at the end of load procedure, turn on gun/EHT in the *Column Control* window.
- *Hint*: can recall pre-saved column settings from database in *Column Control* window.

4 Focus

- Drive stage in Z (or W) coordinate to desired height. (If necessary, calibrate W coordinate to the electron beam WD using the **Adjust** button of the *Adjust W* index tab of the *Adjust UVW* window.)
- Find the sample and focus on the top surface.
- Optimize aperture and stigmation alignment near to where you will do the patterning, and NOT at the very edge of the sample.
- *Hint*: Is focus good enough to create contamination dots? Is automatic brightness/contrast (ABCC) function turned OFF?

5 Adjustments XY-UV

- Start in the Global coordinate system. (Switch between Global/Local using button on *Adjust UVW* window or with globe icon on top toolbar.)
- Find lower-left corner of sample using stage joystick control.
- Reset the Global coordinate system.
- Select the *Origin Correction* index tab. Assign this XY stage location the UV coordinate 0/0 by pressing the **Adjust** button.
- Select the *Angle Correction* index tab. Use the **read** pipette to register this XY location as reference point P1.
- Drive stage to lower-right corner of the sample. (Return MAG setting if changed.) **Read** this XY stage position as reference point P2.

- (Return MAG setting if changed.) **Read** this XY stage position as reference point P2.
- Press Adjust button to calculate transformation angle between XY and UV coordinate systems. (NOTE: the +U axis is the vector going from point P1 to P2.)

The following steps apply to overlay (or mix-andmatch patterning.) The UV of *Coordinates* window need to be "linked" to the uv coordinates of the GDSII design.

- Set MAG ~3000X to avoid accidentally exposing a critical area.
- Use Drive index tab of Stage Control window to drive stage to coordinate of first mark.
- Center on mark with aid of image crosshairs. (Keep same relative MAG setting for remaining marks.)
- Switch to Local coordinate system.
- Select 3-Points index tab of Adjust UVW.
- Press the P1 **read** pipette to capture XY coordinates of current stage position.

- **Type** in the uv design coordinates of this first adjustment mark.
- Check the box corresponding to point P1 to "lock" this XY and uv coordinate pairs.
- Repeat same sequence for points P2 and P3. (...drive stage, locate mark and center with crosshair, read the stage XY, type the uv design coordinates, then check box.)
- After all 3 Points, calculate coordinate transformation by pressing Adjust button. Stage now drives in the coordinate space defined by the marks that are on the sample.

6 Writefield Alignment

- Set desired field size using *microscope control* window.
- Select *either* CASE A *or* CASE B below depending on type of patterning task.

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CASE A — for unpatterned (*i.e.*, bare) sample. This will align WF to the movement of the laser stage.

- Locate suitable reference particle with aid of crosshairs on live image display.
- From the Scan Manager window, select Writefield Alignment Procedures > Manual.
- Double-click on desired alignment procedure and adjust parameters using calculator buttons until all results are OK.
- Execute writefield alignment procedure. (Rightmouse and '**execute**', or [**F9**] key.)
- Identify the mark with the mouse each time it is scanned. Use [**Ctrl**] key + left-mouse.
- Repeat alignment procedure with sequentially smaller scan sizes. (If possible, use contamination dot for final iteration.) For optimal stitching, final scan size should be ≤ 1% of writefield size. (*e.g.*, 1 µm scan size for 100 µ WF.)

CASE B — for already patterned sample containing marks (*i.e.*, for overlay, or mix-and- match patterning task). This will align WF to marks that are already on the sample.

- Drag-and-drop GDSII pattern into a Positionlist.
- Perform manual (course) WF alignment using images. Scan GDSII layer 63 with appropriate Working Area and matching Position.
- Perform automatic WF alignment using mark detection. Expose GDSII layer 61. Open the Positionlist "ALIGN.PLS" to verify linescans and threshold algorithm for proper mark recognition.
- *Hint*: It's possible to repeat alignment more times to increase accuracy, and to check Protocol file for convergence of parameters.

7 Patterning Parameters

- Drive to Faraday cup holder using stage control. (Update coordinates if necessary, be certain to change only MAG and do not disturb beam focus, alignment or stigmation settings.)
- Measure beam current.
- Go to *Patterning Parameter* window and enable structure type line, dot, etc., as needed.
- Press **Calculator** button to set dwell times according to beam current, step size and required clearing dose.
- Perform calculation for each index tab displayed (area, line, dot, etc.) For reasonable results, the

 Perform calculation for each index tab displayed (area, line, dot, etc.) For reasonable results, the beam speed should not exceed 10 mm per second. (5 mm is good, 1 mm for best results.)

8 Patterning

- Open a new Positionlist.
- Drag & drop design(s) from the *GDSII Database* window into the Positionlist.
- Right-mouse-click the highlighted entry of the Positionlist and select **Properties** from the context menu.
- If necessary, use **Working Area** tool to select predefined area of file to pattern.
- Type in UV coordinates of where the center of the first WF should be.
- If needed, press **Patterning Parameter** button to adjust parameters for an individual position. This step over-rides any defaults set according to the main *Patterning Parameter* window.
- Start patterning task by selecting desired scan mode from the top pull-down menu, or from top of Positionlist window, or [F9].

9 Unload sample

• Start unload procedure from *LoadLock* window or the top toolbar.

10 Logout

- Exit the Raith NanoSuite software.
- Exit the Raith EO software application.

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