NanoFabrication Facility
ADVANCED SCIENCE RESEARCH CENTER

Standard Operating Procedure: **NanoScribe**

Contents

Standard Operating Procedure: **NanoScribe**

Hardware Description and Principle of Operation

Nanoscribe Photonic Profession (GT)

The Nanoscribe is next generation 3D laser lithography system, whose primary use is in 3D micro printing and maskless lithography. It combines two writing modes: a piezo mode for arbitrary 3D trajectories and a galvo mode for rapid structuring in a layer-by-layer fashion. Can be utilized with compatible 3D CAD files (stl format) or through use of GWL scripting (implemented using Nanoscribe Describe software). **This SOP will focus on the higher resolution Dip-in Laser Lithography (DiLL) mode – the microscope objective is directly dipped into the photoresist.** The spherical aberrations are minimized and constant for the complete printing range. No interfaces limit the structure height in this configuration. The maximum structure height is limited by the sample holder used and may be larger than 2 mm.

Material Requirements

Equipment: substrate, tweezers, three glass containers (for Surpass [optional], PEGMA developer and IPA), tape and vertical substrate holder

Personal Protective Equipment: nitrile gloves, safety glasses and face mask

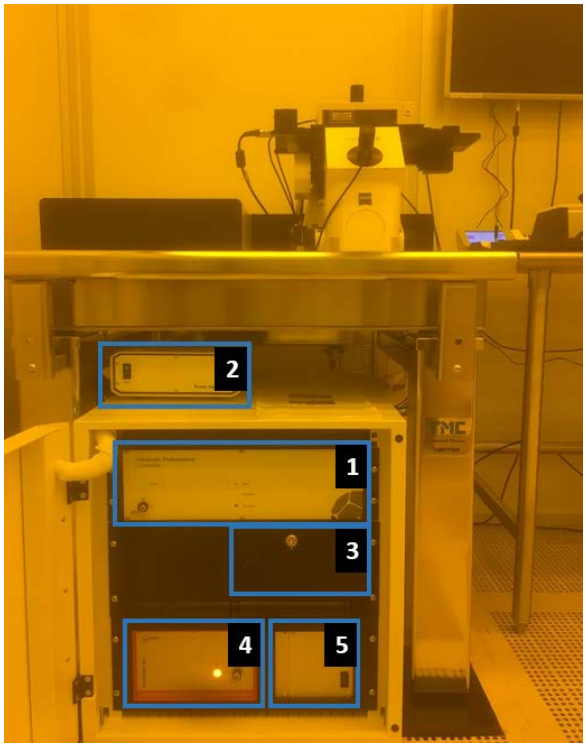
Chemicals: PEGMA (SU-8), IP-Dip Negative Photoresist, Surpass 3000 [optional] and IPA

Procedure

Estimated Time: ~40 minutes + write time

Start Up Tool

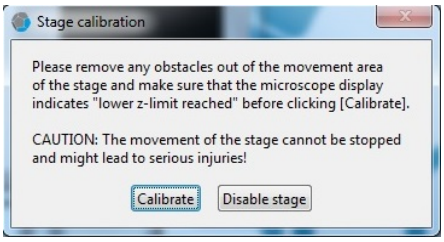
1. Turn on main power supply.
2. Turn on microscope power supply.
3. Turn on computer.
4. Turn on laser.
5. Turn on stage.
6. Log on to computer and open NanoWrite software. Select desired objective.



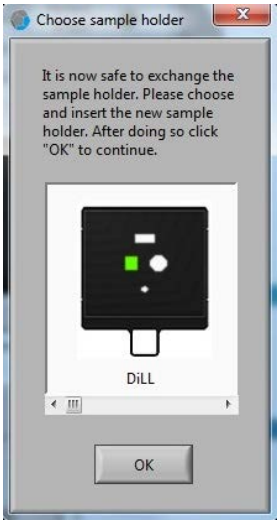
Initialize Software

1. Click NanoWrite software icon on the desktop.

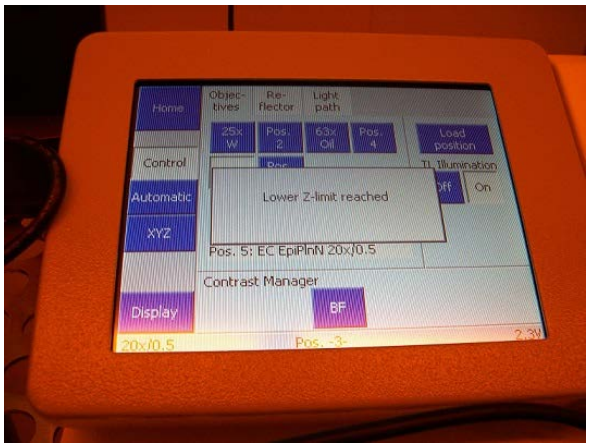
2. Click **Calibrate** in the "Stage calibration" window that pops up.



3. Wait until the calibration process is done.
4. The "Choose sample holder" window appears when the calibration process is done. It is ready to load the sample.



5. Make sure that there is no objective in the system, and confirm on the microscope controller that the objective turret (Z-stage) is in the lowest position.



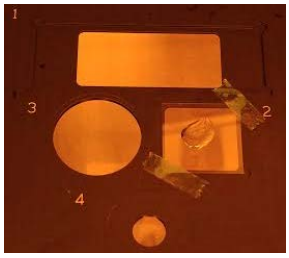
Standard Operating Procedure: **NanoScribe**

Sample preparation

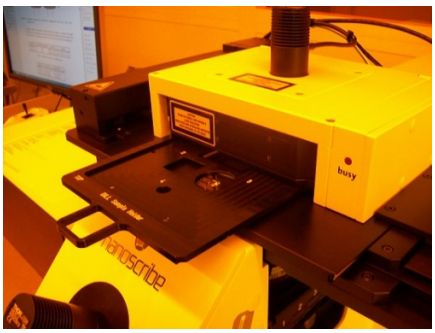
1. Choose the sample holder.
2. Clean the substrate.
    a. Here is the cleaning procedure in the user manual (Chapter 5.3 of User_Manual in Nanobox file directory on the PC):
        i. Rinse the substrate surfaces with acetone.
        ii. Rinse the substrate surfaces with IPA.
        iii. Rinse the substrate surfaces with distilled water.
        iv. Blow-dry the substrate with nitrogen.

    Notes:

    - Using this cleaning method, a droplet of resist will not spread strongly over the substrate surface. Alternative cleaning methods (e.g. oxygen plasma) might change the wetting properties of the substrate surface so that the droplet will cover a bigger area, which may be desirable in some cases.
    - IPA can be replaced by methanol in the above cleaning method.
3. Fix the substrate on the sample holder with tape.
4. Put a drop of oil or/and resist on the substrate carefully. *The following example is immersion configuration: resist on the bottom side.*



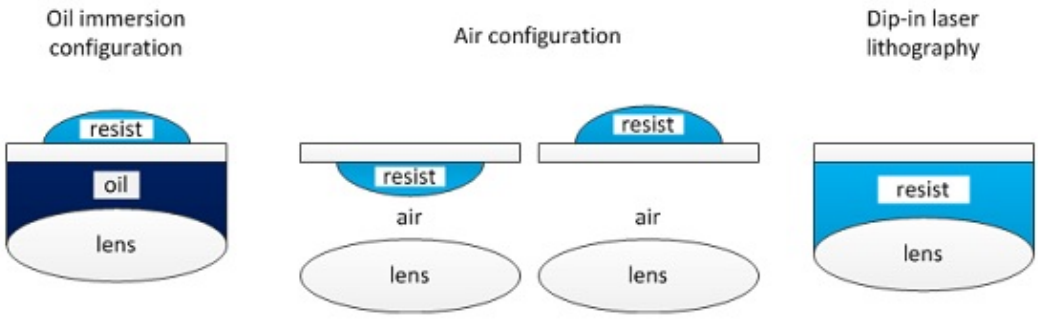
5. Insert the sample holder into the microscope module. Make sure that the sample holder is set at the right position. When the sample holder is inserted, you can hear a "click sound".



Standard Operating Procedure: **NanoScribe**

Note: There are the following three printing configurations (see Chapter 5.2 of User_Manual in Nanobox file directory on the PC).

a. Oil immersion configuration
b. Air configuration
c. Dip-in laser lithography (DiLL)

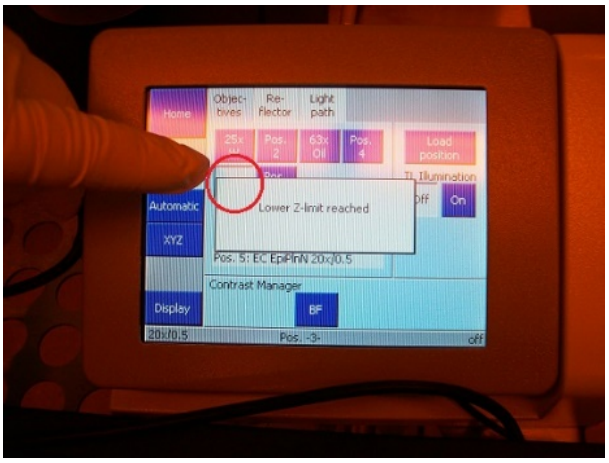


	objective	immersion medium	substrate	resist
Oil immersion configuration	63x NA 1.4	oil	glass 170 µm	IP-L 780, IP-G 780
	100 x NA 1.4	oil	glass 170 µm	IP-L 780, IP-G 780
Air configuration	20x NA 0.5	air	silicon	AZ resist
	20x NA 0.5	air	glass	AZ resist
Dip-in laser lithography	25x NA 1.4		ITO, silicon	IP-S
	63x NA 1.4		fused silica	IP-Dip
	100 x NA 1.4		fused silica	IP-Dip

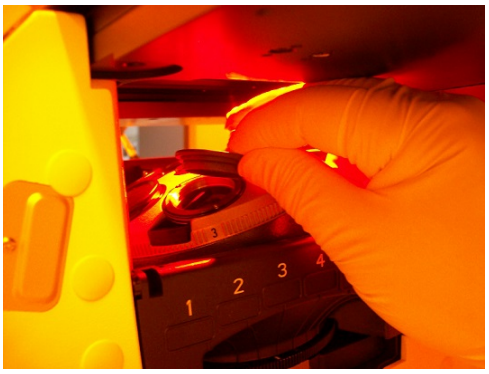
Note: Resolution depends on the objective lens and resist.

Install Objective Lens [Additional Training Needed]

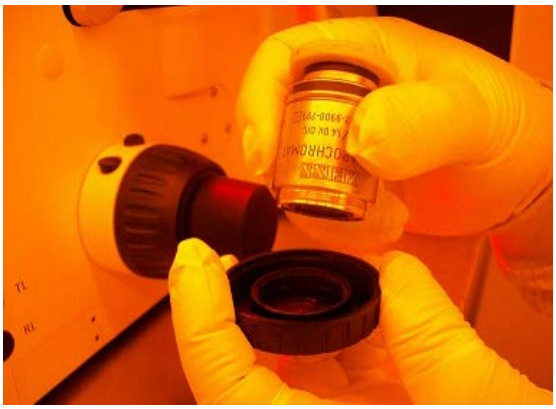
1. Press the objective lens button on the microscope controller for the replacement position.
    a. For example, if you want to use 63x objective lens, press the 20x button, and the #3 pocket for the 63x objective will rotate to the right side of the module.



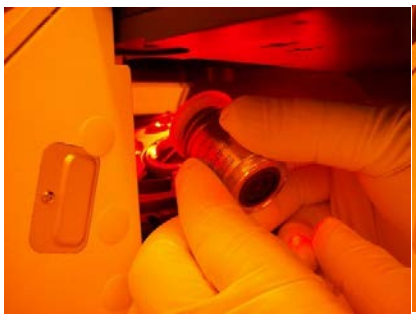
2. Remove the cap from the pocket of the turret if it is present.

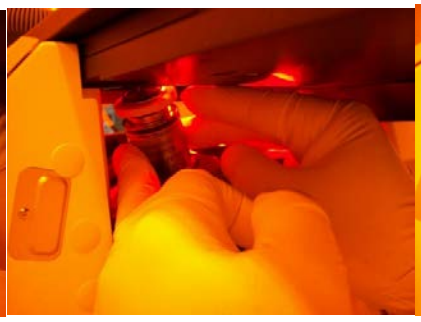


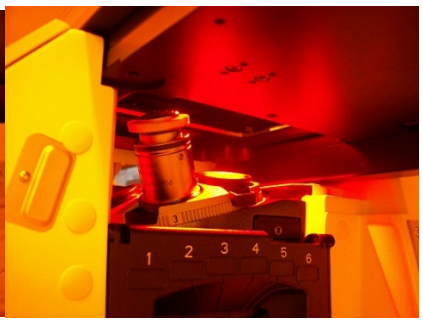
3. Remove the objective lens from the case. A white suction ring must be put on the objective lens.



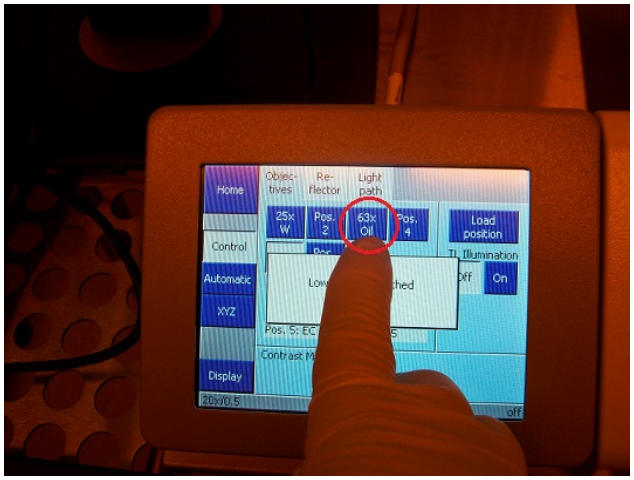
4. Install the objective lens on the objective turret of the microscope module.





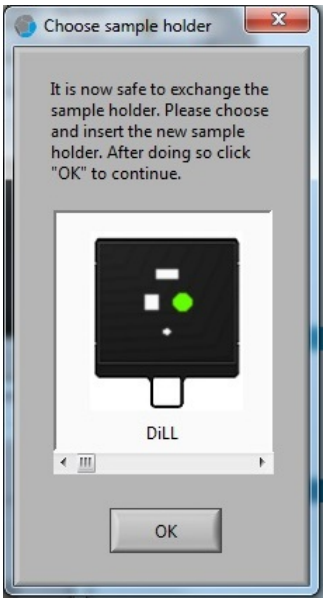


5. On the Zeiss touch screen, press the button of the objective lens installed, and the objective lens will move beneath the sample.

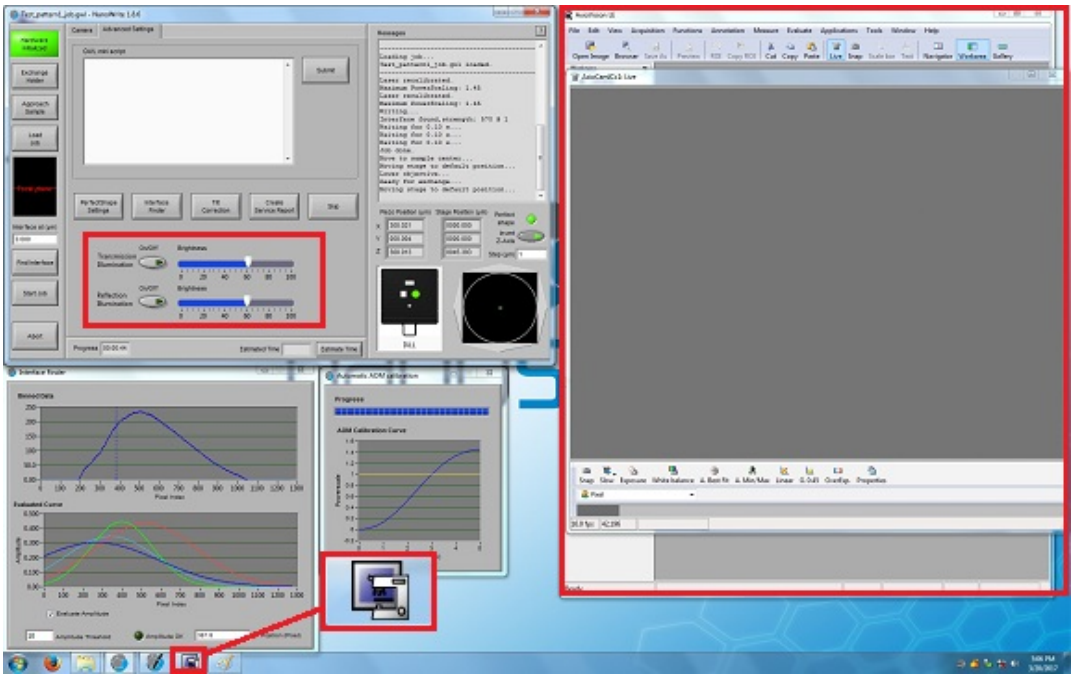


3D Writing Procedure

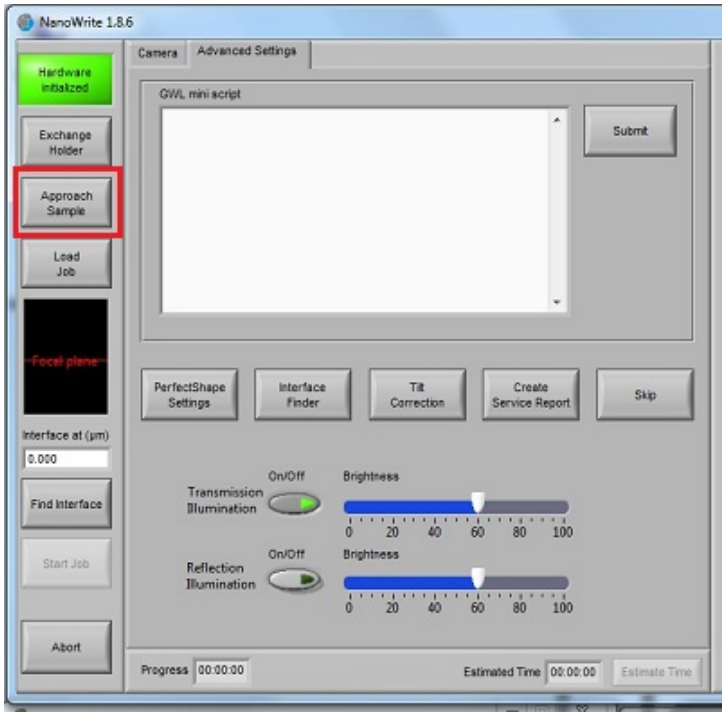
1. If you haven't done so already, click on the sample location in the "Choose sample holder" window, and the location clicked will be in green.
2. Click the **OK** button.



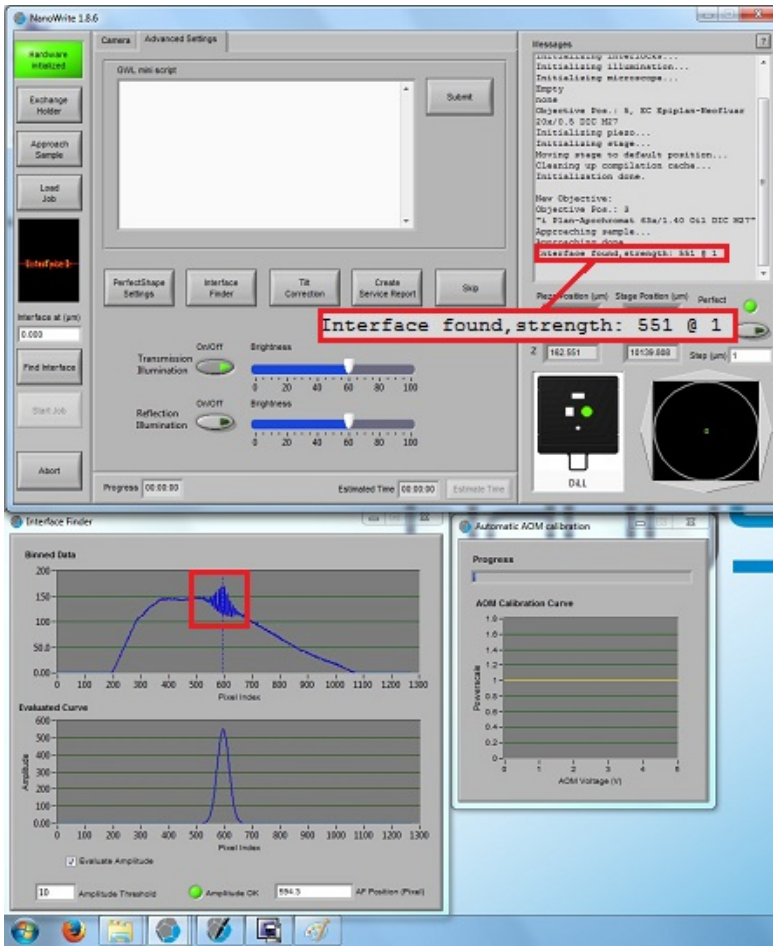
3. Click the  icon on the bottom of the screen, and the monitor window and illumination LED switches will be opened.
4. Click on the button of the transmission or reflection illumination.



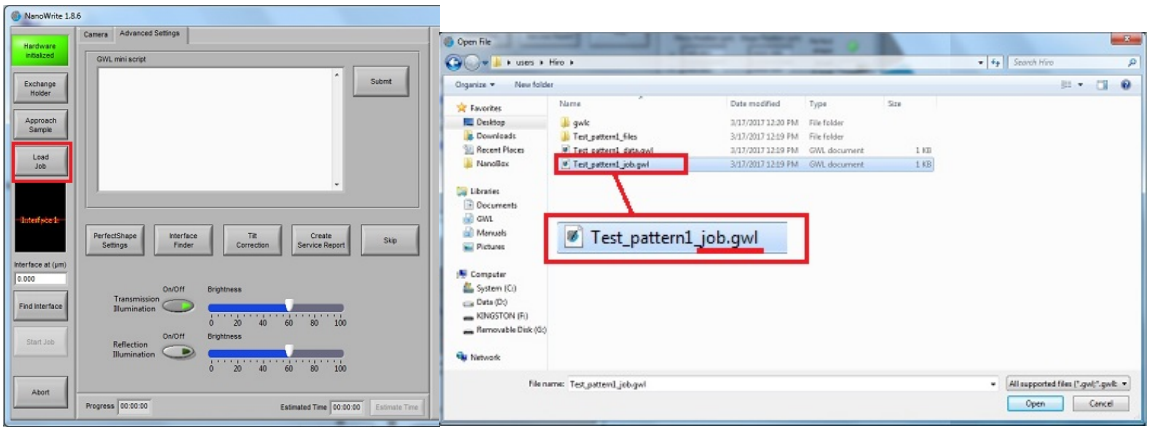
5. Click the **Approach Sample** button.



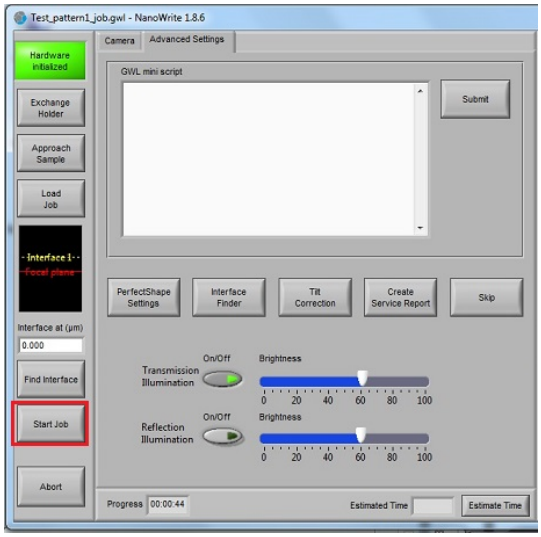
6. When the right working distance is automatically found, the small interference fringes will be observed in the "Interface Finder" window, as shown below. If the small interference fringes are not observed, or located at the wrong pixel, you have to click **Find Interface** later.



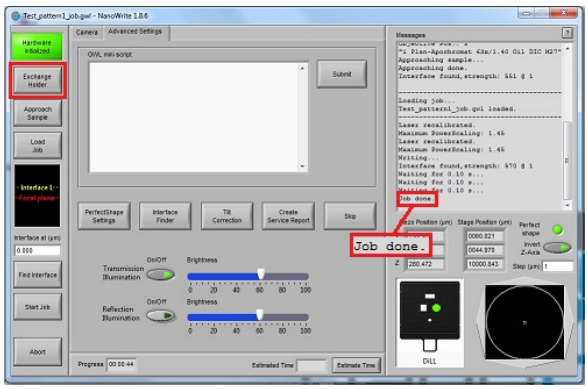
7. Click **Load Job**, and the "Open File" directory will be opened.
8. Open the xxx_job.gwl file.



9. Click **Start Job**.
    a. Note: If the interface is not found in the process of "Approach Sample", you must click **Find Interface** before starting job. Then, make sure that the small interference fringes are seen in the "Interface Finder" window.



10. After the job is done, click the "Exchange Holder" button.



Unload Sample

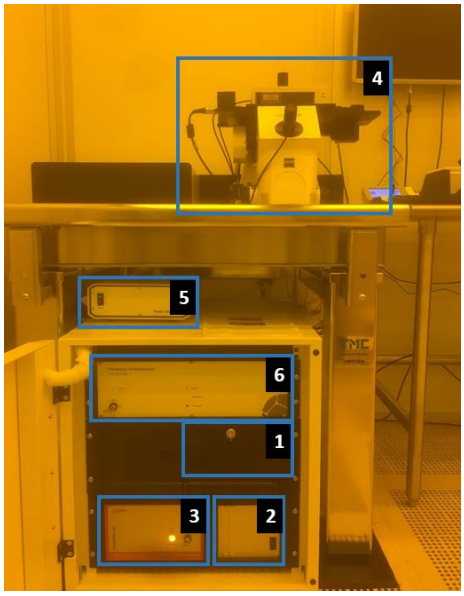
1. Click the **OK** button in the "Confirm exchange holder" window.
2. Remove the sample holder from the microscope module.
3. Remove the sample from the sample holder.
4. Turn off the illumination LED, if necessary.

Develop Sample

1. Use a bath of SU-8 developer (propylene glycol monomethyl ether acetate, PGMEA) in a 25 mL beaker. To fix the substrate vertically in the beaker, use the vertical substrate holder. Allow the substrate to develop for at least 10 minutes. Depending on the size of the structure, this step can take up to 30 minutes. However, the development time is not very critical – structures can be kept in the developer for much longer without changing the structure.
2. When development is done, carefully remove the holder from the PEGMEA and place into a second beaker containing IPA for 1-2 minutes. Do this carefully – the surface tension of the liquids can easily destroy fragile features.

3. Remove from the IPA and place the substrate on a clean surface to air dry. For more robust structures, methanol can be applied to the surface to expedite evaporation. DO NOT blow dry the substrate.

Shut Down Tool



1. Turn off software and shut down the computer.
2. Turn off stage.
3. Turn off laser.
4. Turn off microscope.
5. Turn off microscope power.
6. Turn off main power.

Cleanup and Waste Disposal

1. Check tool for any residual resist and clean with wipes and IPA.
2. Dispose of used developer in the correct SU-8 Developer (PEGMEA) bottle kept in the lithography bay waste cabinet across from the Nanoscribe system, under the table.
3. Rinse, dry and put away all glassware and tools used.
4. NanoFab Staff will routinely clean the objectives.

Emergency Stop

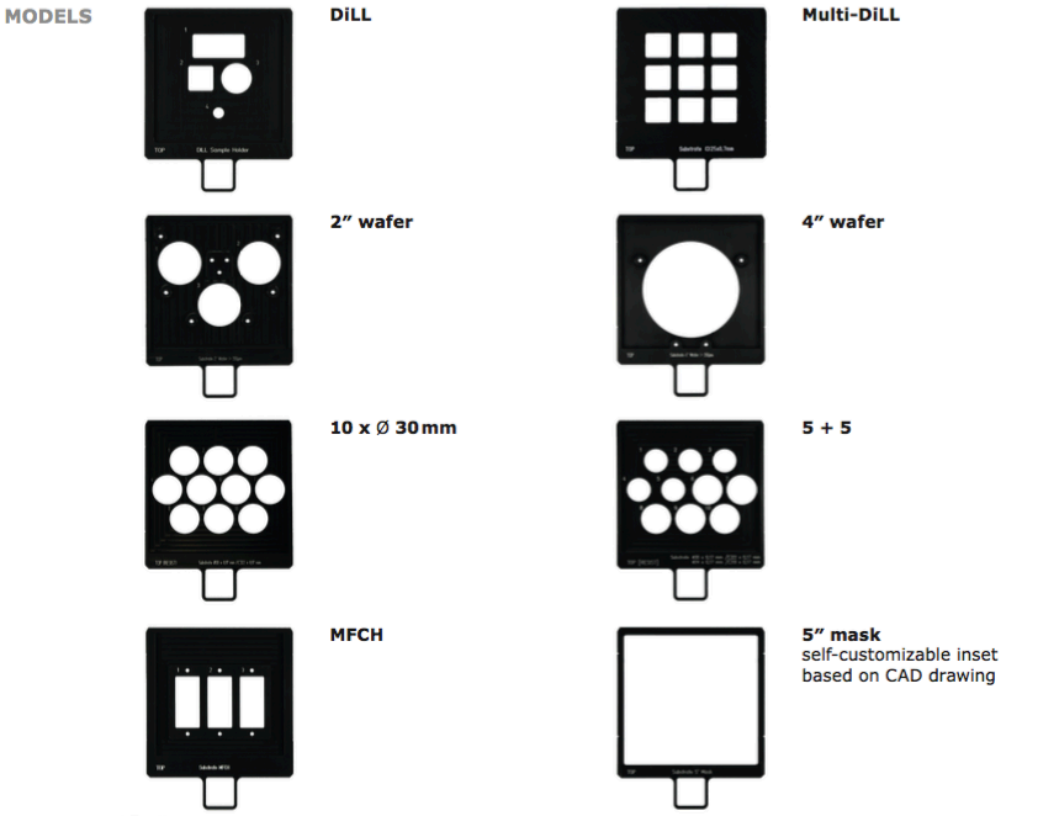
- NA

What to watch out for during operation

- Laser not firing.
- Interface not found during approach.
- Stage not initializing after the tool is turned on.

Allowed Activities

- Users may use substrate/holder combinations according to the following parameters:



Model	No. of Slots	Substrate Type	Substrate Dimension	Substrate Thickness
DiLL	1	DiLL substrate	□ 25mm x 25mm	0.7mm
	1	Microscope slide	□ 24-26mm x 50-76mm	1.0mm
	1	Cover slip	Ø 30mm	0.17mm
	1	Cover slip	Ø 25.4mm	0.3mm
Multi-DiLL	9	DiLL substrate	□ 25mm x 25mm	0.7mm
2" wafer	3	Wafer	Ø 2"	0.35-0.55mm
4" wafer	1	Wafer	Ø 4"	0.35-0.55mm
10 x Ø 30mm	10	Cover slips	Ø 30mm / □ 22mm x 22mm	0.17mm
5 + 5	5	Cover slips	Ø 30mm / □ 22mm x 22mm	0.17mm
	5	Cover slips	Ø 24 mm / □ 18mm x 18mm	0.17mm
MFCH	3	Microfluidic Channels (Translume)	□ 25.4mm x 50.8mm	1.5mm
5" mask/custom	1	Mask, self-customizable inset	□ 5" + self-customizable inset	2.2mm

- You must have permission from staff if you wish to use a holder/substrate combo different from this, which requires special training on finding the interface.
- Users are allowed to use non-Nanoscribe resists with NanoFab Staff permission and only in a **non**-dip-in mode.

Disallowed Activities

- Don't remove the sample holder unless the exchange holder window has been selected and the window is open.
- Don't crash the objective into the substrate.
- Don't use a resist that isn't already on the objective that you are using.
- Don't try to clean the objective unless you have been trained to do so.
- Use non-Nanoscribe DIP resists in dip-in (DiLL) mode.

Common Troubleshooting Tips

- If the previous user did not shut down the system in the instructed order, the tool will sometimes have issues finding the interface. If this is the case, shut down the tool in the instructed sequence and then restart from the beginning.
- If you continue to have issues finding the interface, schedule a meeting with NanoFab staff. The Nanoscribe interface finder is highly dependent on the substrate thickness, sample holder position used and index contrast at the interface. NanoFab staff can advise the best course of action if you are using a non-standard substrate.
- If you write, develop and inspect, to find nothing on your substrate, consult the NanoFab staff. Common issues are:
    - Adhesion issues, which can be improved with surface modification techniques, such as 0_2 plasma exposure, 0_2 ozone exposure, or adhesion promoters.
    - STL design issues, which can be improved by adjusting writing parameters (hatching and slicing) in the setup process of your run files.
    - Writing power and scan speed issues, which can be adjusted to optimize exposure dose for a particular design.

When to call staff?

- If the tool will not initialize.
- If the tool does not find the interface.
- If the objective crashes into the substrate at any point.

Badger Criteria

Report Problem

- Visible debris on the objectives (objectives need cleaning).

Shutdown

- Tool will not initialize.
- Tool will not power up.
- No laser power reported during interface finding.

Revision History: