Standard Operating Procedure (SOP)

Nanoscribe Photonic Professional GT+ 3D Printer

(LW-02)

In case of fire or injury please call 911 (511 from campus phones)

If there is an error on the system/tool, please report it in NEMO for staff to address

***DO NOT* run diagnosis without clear staff approval**

Common Issues and What To Do If You See Them:

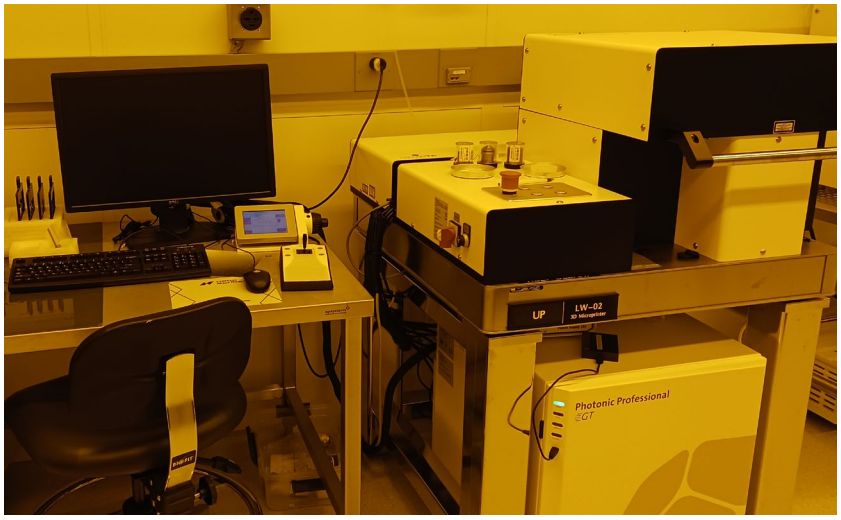
Windows isn't logged in: Select the user "User", no password

Objective not easily screwing in: **DO NOT USE TOOL.** Submit problem report. Objective height will not be reliable, putting both sample and objective at risk.

Interface not found:

- Confirm you have the correct configuration selected during "Exchange Holder", double checking the objective in description matches what is installed!
- Check if illumination needs to be adjusted. Increase reflection brightness for transparent substrates (glass) and decrease reflection brightness for highly reflective substrates (Si).
- Check if the microscope is zeroed correctly! Select Exchange Holder. When "Lower Z-limit reached", stage Z should be 30-50um. If it is off (would be 100s of microns), remove your sample, close Nanowrite and power cycle the microscope before restarting Nanowrite. The displayed position should now be in the correct range.
- Confirm you are using a standard substrate/resin/objective combination (other combinations are not allowed without prior discussion and approval by tool owner!)
- If all above are true, **DO NOT USE TOOL.** Submit problem report.

Nanoscribe PPGT+ 3D Printer



Content Guide

Common Issues, page 1
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Additional Resources

Wiki page
Nanoguide

Location: Soft Materials (QNF Bay 6)

Primary tool owner: Ana Cohen, coana@seas.upenn.edu

For processing or tool questions, contact Ana Cohen or email qnf-process@lists.seas.upenn.edu

For training requests, submit through NEMO

Reminder: Problems with the tool ***MUST*** be reported on NEMO. Do not directly contact staff members with tool issues.

Tool Policies –

Trainings:

- The standard tool training will be in three parts
    1. Remote training for the Describe conversion software, using your structure (~90min)
    2. In-person training session on LW-02 (~90-120min)
    3. Qualification run on LW-02, where you run the tool with minimal input (~60min)
- Separate training request required to align your pattern to existing features
- Separate training request required to write with non-standard resists or non-standard substrates.

Using unapproved materials can result in loss of access to the tool

Objective Care:

- Objectives shall only be used with the corresponding resists/samples unless coordinated with staff
- The standard training includes cleaning the objectives. Do not follow any other protocols.
- If you crash the objective into your substrate, you MUST report this on NEMO so staff can check the lens and remove any debris. Do not proceed any further without staff assistance.
- If objective cannot rotate easily during mounting, you MUST report this on NEMO so we can check the threads and focus heights as needed. Do not proceed any further without staff assistance.

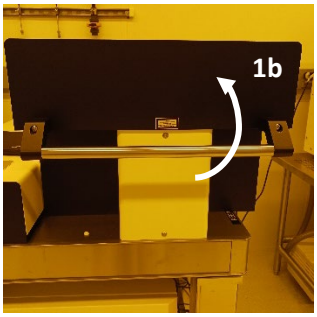
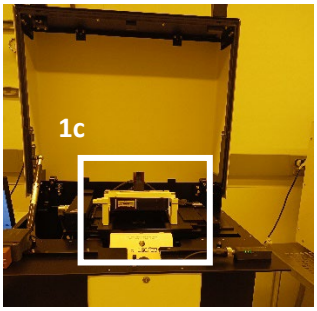
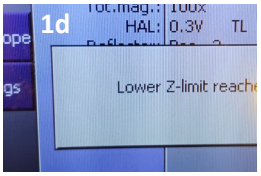
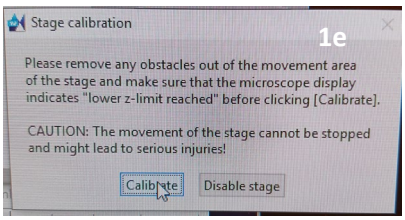
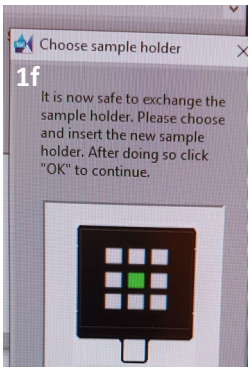
Handling objectives improperly can result in loss of access to the tool

Scheduling Etiquette:

- Reserve only the time that you intend to use on the tool. Do not book out blocks of time as a hold.
- Cancel reservations as soon as you know you will not be able to use them. If you cancel less than two days prior to the scheduled start, email all users through NEMO that the time is now available
- **You must log in to the tool when use of the tool begins.** This includes handling anything at the tool, such as mounting your sample to the sample holder.
- Tool use is considered active until all parts of the tool are clean and stored in their proper location.
- **You must remain logged in to the tool until you can retrieve your sample and clean up the tool.** Try to schedule reservations so you can be easily available in the lab when the tool is done writing.
- If an unforeseen issue makes you unable to pick up your sample, email all users through NEMO with instructions on how to safely remove your sample and email staff about objective cleanup.

Abuse of the reservation system and/or consistent failure to display proper etiquette and respect for other users can result in loss of access to the tool

Basic Procedure –

Prepare job files with DeScribe on EBL-02	*Select objective and recipe parameters for design* *Copy <u>all files</u> generated by Describe*
Clean your substrate, as needed	*For minimum spreading of resist, rinse with series of acetone, IPA, and water, then blow dry* *For maximum coverage of resist, use oxygen plasma (i.e., DE-07)*
Log into the tool via NEMO	
1. Opening Cover **a.** Press OPEN button on tool **b.** When button light activates, lift cover **c.** Confirm no sample holder loaded **d.** Confirm "Lower Z-limit reached" on microscope controller **e.** Open Nanowrite program and initialize stage **f.** <u>Wait for the Exchange Sample Holder pop-up window!</u> It is critical that the next few steps are done while this window is active. Otherwise, the piezo may be damaged.	     

2. Objective Access Position

a. Unlock piezo by turning clamps outward

b. With your right hand, pull out the pin at the back-right to allow the piezo to move

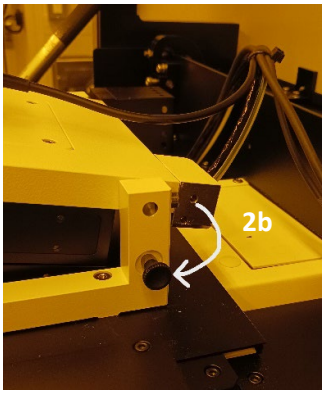
c. Securely hold the handle in your left hand to lift piezo

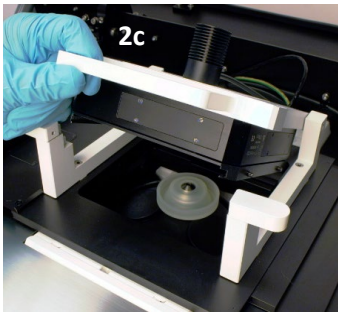
Be extremely careful when handling the piezo.

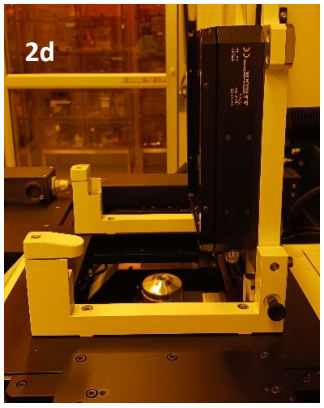
Always use the dedicated piezo handle as shown!

Never drop or force into place!

d. Once at 90° position, release the pin to lock the piezo in place before releasing grasp on handle







Steps 3 & 4 must be done with a second pair of gloves!

Always remove and replace gloves if you come in direct contact with resin.

3. Objective Set Up

a. Select the objective for your job
Available objectives are the 63x, 25x, 20x and 10x. <u>You must use the objective selected when converting in DeScribe.</u>

b. Use the two backmost buttons on the microscope controller to rotate objective positions

c. Check the screen of the controller to select the correct position for your objective
25x → #1, 63x → #3, 10x → #4

d. Remove the cover from the slot

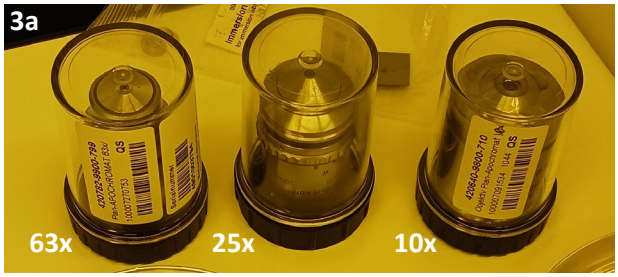
e. Unscrew the objective from the clear plastic case, then unscrew the cap
Objectives should <u>never</u> be left unattended in this state

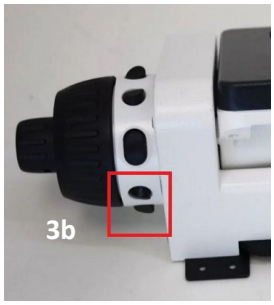
f. Insert the objective and rotate to screw it in
<u>Do not force</u>! Immediately inform staff if the objective cannot rotate easily during mounting.

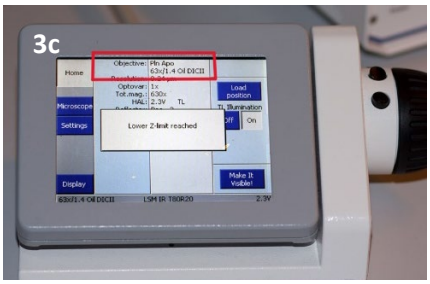
g. Install resist stop (silicone/felt ring) on objective to prevent resist/oil from spilling down the sides of the objective

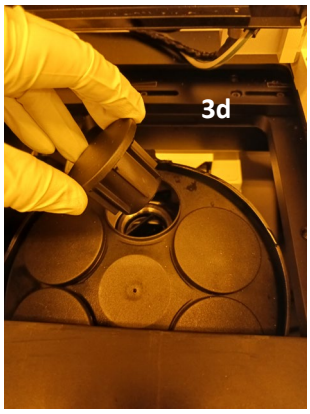
h. If using 10x or IP-PDMS, dispense some resist on the objective lens

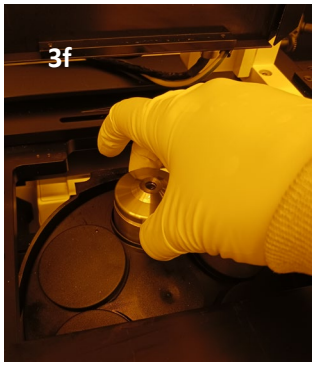
i. If using 25x, make sure the adjustment ring is set as shown here

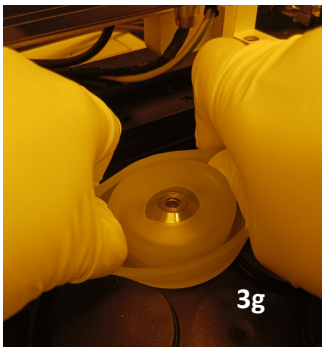


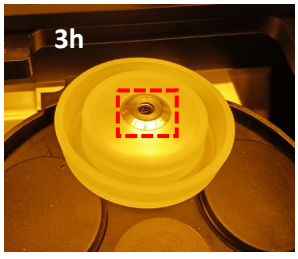


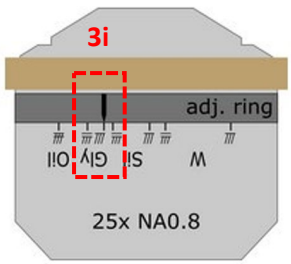












4. Sample Loading

a. Select sample holder and IP resist *(standard resists located at tool)*

b. Secure sample on sample holder with tape and/or screws

Each sample holder position is made for a specific size and thickness of substrate.

Do not introduce new substrate materials OR thicknesses without consulting tool owner!

c. Remove cap from resist syringe and dispense one drop at the sample center by gently pushing plunger**

d. Turn one piezo clamp back into locking position

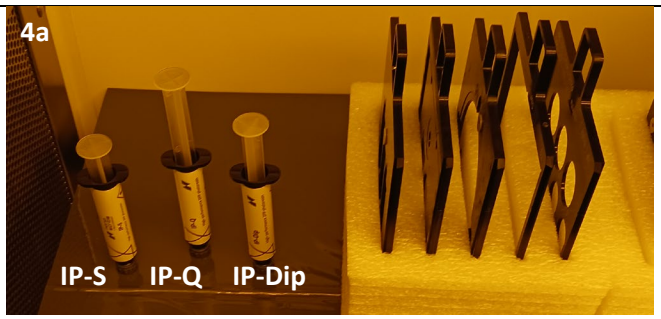
e. Securely hold the piezo handle in your left hand. With your right hand, pull out the pin at the back-right to allow the piezo to move

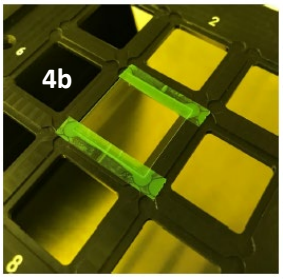
f. Lower piezo onto the turned clamp before releasing grasp on handle

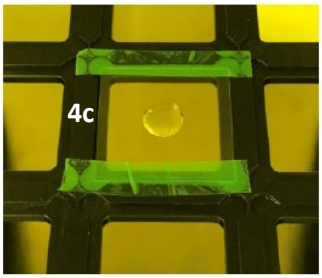
g. Gently insert the sample holder at the same angle as the piezo (no torque!) until edge of sample holder is flush with edge of piezo

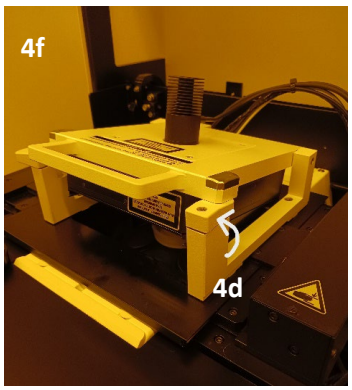
h. Securely hold the piezo handle and slightly lift to turn the clamp back out of the way

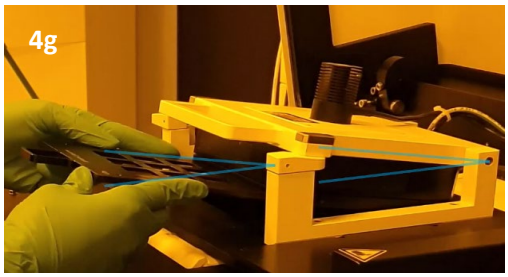
i. Lower piezo into original position, then place clamps back to lock in place

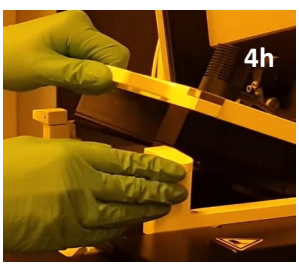


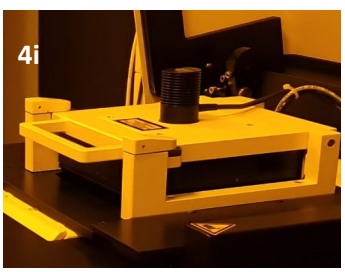












**You only need as much as the total area/volume of your design.
If extra resist on substrate, use a pipette to remove

Remove/discard extra gloves	Do not get resist on microscope controller or computer components!

5. Begin operation

a. Close cover

b. In Exchange Holder, scroll to the sample holder option you need, then click OK

Make sure both the configuration and objective match! Using the wrong one could crash the lens.

c. Open AxioVision and select Live, A. Best Fit and G. 0.45

d. Turn on the illumination and adjust the brightness

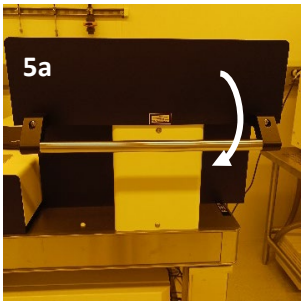
For glass, 40-60% is ideal
For Si, 0-20% is ideal

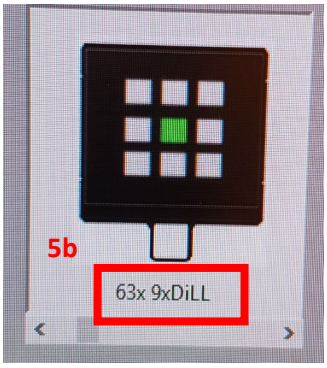
e. Click on “Approach Sample”, and then click OK on the popup window

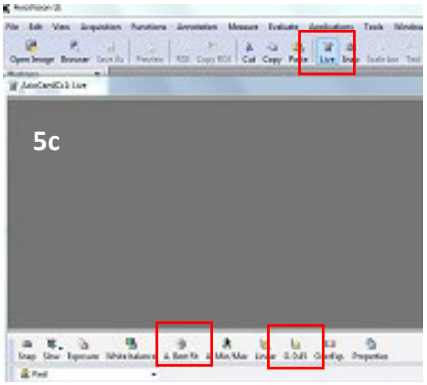
f. Click on “Load Job”, and then select your file ending with “_job.dwl”

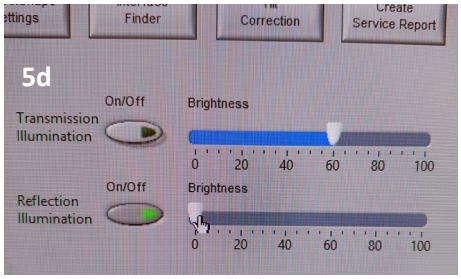
g. Click on “Find Interface”. When found, the small interference fringes will be observed in the "Interface Finder" window, as shown →

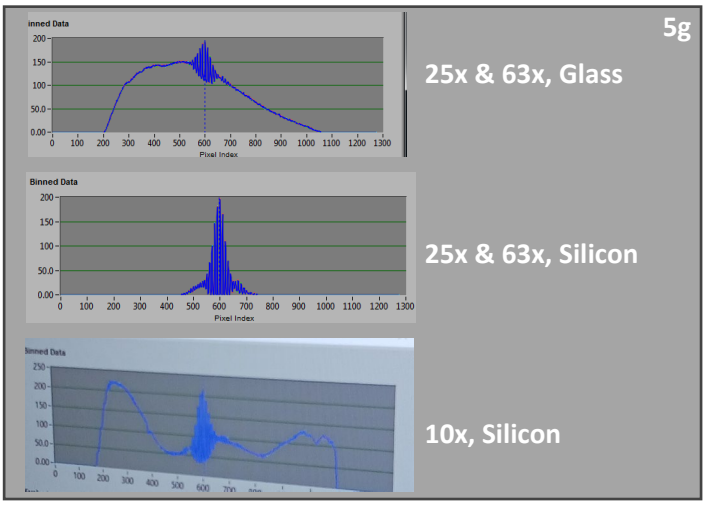
h. Click on “Start Job”

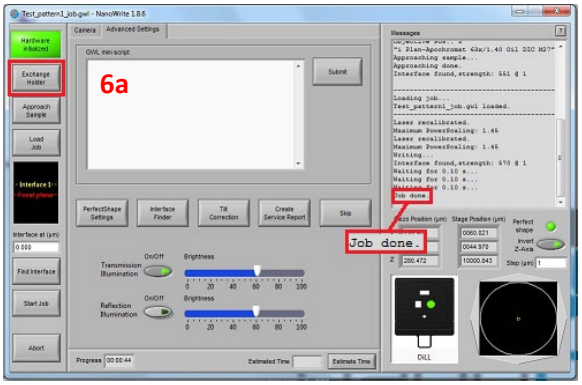
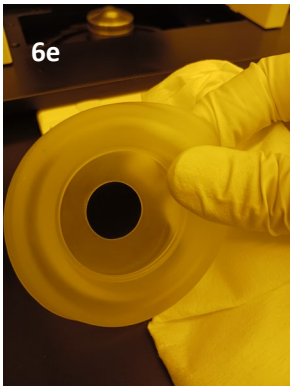
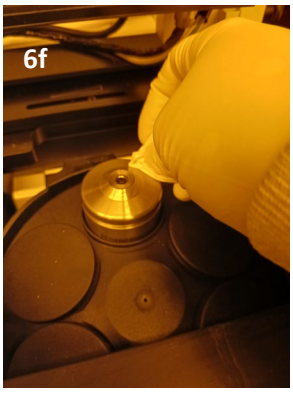
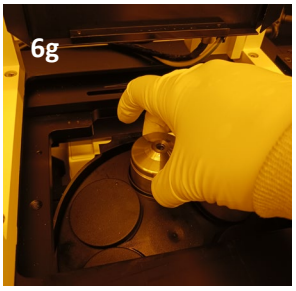
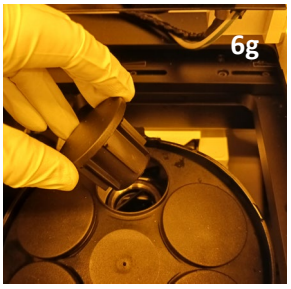


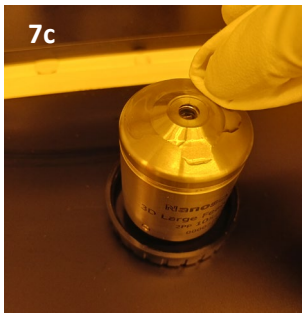
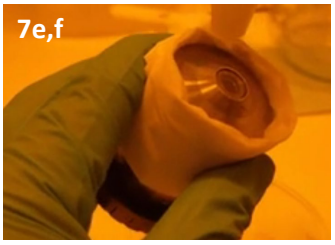








Put on extra pair of gloves, grab cleanroom wipes	**Always remove and replace gloves if you come in direct contact with resin.**
6. Unloading **a.** Once job is done, select Exchange Holder to unload **b.** Press OPEN button then lift open cover **c.** Set piezo in sample holder load position from Step 4, then carefully remove sample holder **d.** Set piezo in objective access position from Step 2 **e.** Remove and wipe down resin stop **f.** Wipe excess resin from the edges of the objective (to avoid contact during next step) Do not touch the lens with wipe! **g.** Unscrew objective and attach to plastic base. Replace cover in tool. **h.** Screw plastic casing on objective Do not overtighten! **i.** Lower piezo into original position, then place clamps back to lock in place, then close tool cover	     
Move to solvent bench with sample holder and objective for clean-up	**Remember to grab a face shield!**

7. Clean up **a.** Spray IPA on a wipe **b.** Remove cover of objective **c.** Wipe down excess resin from the top of objective—hold wipe steady and turn objective. Reminder: Do not touch the lens with wipe! **d.** Use N2 to blow excess resin from the lens surface, then repeat step 7c **e.** Wrap a wipe around the sides of the objective to protect from solvent **f.** Run a small amount of IPA over the lens surface, then gently blow dry **g.** Inspect the lens surface. If not sufficiently clean, repeat step 7f **h.** Make sure inside of objective base is dry, then screw on plastic casing Reminder: Do not overtighten! **i.** Remove sample from holder **j.** Wipe down sample holder with IPA	 7c  7e,f
8. Close out of tool **a.** Return sample holder and objective to proper location at tool **b.** Close Exchange Holder window **c.** Close Nanowrite **d.** Close AxioVision **e.** Log out via NEMO	
Development	*Develop sample in PGMEA and/or IPA to remove uncured resist (in Bay 6, additional space in Bay 5)*
Flood exposure	*Used to fully cure structures printed in Shell or Swift (available on MA-03)*

Chemical Hazard Information

IP-Dip

UFI-Code: N07U-35SX-5XF5-3S1C

Causes skin irritation. May cause an allergic skin reaction. Causes serious eye irritation. Suspected of damaging fertility or the unborn child. Harmful to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection. IF ON SKIN: Wash with plenty of water. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Take off contaminated clothing and wash it before reuse.

IP-S

UFI-Code: 0XRT-6YM9-ERFQ-3E98

May cause an allergic skin reaction. Causes serious eye irritation. Toxic to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection. IF ON SKIN: Wash with plenty of water. If skin irritation or rash occurs: Get medical advice/attention. Take off contaminated clothing and wash it before reuse.

IP-Q

UFI-Code: C724-0WH8-TN90-S1A8

May cause an allergic skin reaction. Toxic to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection. IF ON SKIN: Wash with plenty of water. If skin irritation or rash occurs: Get medical advice/attention. Take off contaminated clothing and wash it before reuse.

IP-Visio

UFI-Code: 2GRC-9MR6-6FCP-3G4D

May cause an allergic skin reaction. Toxic to aquatic life with long lasting effects. Avoid breathing dust/fume/gas/mist/vapours/spray. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection. IF ON SKIN: Wash with plenty of water. If skin irritation or rash occurs: Get medical advice/attention. Take off contaminated clothing and wash it before reuse.

IP-PDMS

UFI-Code: KYP8-XXTA-3H6N-XKWA

Causes serious eye irritation. Harmful to aquatic life with long lasting effects. Avoid release into the environment. Wear protective gloves/protective clothing/eye protection/face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

IP-L

UFI-Code: SU4T-4J21-PD8Y-D3KJ

Harmful if swallowed. Causes skin irritation. May cause an allergic skin reaction. Causes serious eye irritation. Avoid breathing dust/fume/gas/mist/vapours/spray. Wear protective gloves/protective clothing/eye protection/face protection. IF SWALLOWED: Call a POISON CENTER/doctor if you feel unwell. IF ON SKIN: Wash with plenty of water. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If skin irritation or rash occurs: Get medical advice/attention.

Chemical Hazard Information

IPA *(isopropyl alcohol)*

Also known as 2-propanol

Highly flammable liquid and vapour. Causes serious eye irritation. May cause drowsiness or dizziness. Keep away from heat/hot surfaces/sparks/open flames/other ignition sources. Keep container tightly closed. Use non-sparking tools. Take action to prevent static discharges. Avoid breathing dust/fume/gas/mist/vapors. Use only in a well-ventilated area. Wear protective gloves/protective clothing/eye protection/face protection. Wash skin thoroughly after handling. IF ON SKIN: Take off immediately all contaminated clothing. Wash with plenty of water. IF INHALED: Provide fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If skin irritation or rash occurs: Get medical advice/attention.

PGMEA *(propylene glycol monomethyl ether acetate)*

Also known as 1-methoxy-2-propanol acetate, HARE SQ Developer, SU8 Developer

Flammable liquid and vapour. May cause drowsiness or dizziness. May damage fertility or the unborn child. Keep away from heat/hot surfaces/sparks/open flames/other ignition sources. Keep container tightly closed. Use non-sparking tools. Take action to prevent static discharges. Avoid breathing dust/fume/gas/mist/vapors. Use only in a well-ventilated area. Wear protective gloves/protective clothing/eye protection/face protection. IF ON SKIN: Take off immediately all contaminated clothing. Wash with plenty of water. IF INHALED: Provide fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.

Version	Date	Author	Changes
1.0	30 March 2017	Not listed	Published on nanosop server
1.1	25 October 2024	A. Cohen	Addendum with new objective protocols
1.2	23 December 2024		Addendum with new procedure for GT+ upgrade
2.0	13 February 2025		New version, addendums removed
2.1	25 July 2025		Added Tool Policies
3.0	23 September 2025		Update to Tool Policies including reservation/logout policy, added objective cleaning instructions to Basic Procedure (Step 7), added Chemical Hazards, version history table