

Nano3 Facility Policies and Procedures

University
of California
San Diego

The intent of the policies and procedures outlined in this document is to ensure that an environment is created in which researchers can work together safely and productively while maintaining the integrity of the class100/1000 cleanroom environment and equipment.

These policies and procedures will continuously adapt to changes to our facility as it evolves. We strongly encourage users to make us aware of how we can more effectively meet the goals of the facility.

Nano3 Staff Contact Information

Name	Title	Office	Email	Phone
Ahdam Ali	Equipment Engineer	1304	aali@ucsd.edu	858-534-4768
Patrick Driscoll	Equipment Engineer	1307	pdriscoll@ucsd.edu	858-246-2733
Bernd Fruhberger, Ph.D.	Technical Director	2101	bfruhberger@ucsd.edu	858-534-4518
James Koga	Fiscal Administrator	5305	jkoga@ucsd.edu	858-534-1749
Xuekun Lu, Ph.D.	Senior Nanofabrication Engineer	1302	xklu@ucsd.edu	858-246-0411
Maribel Montero, Ph.D.	Nanolithography Specialist	2401	mmontero@ucsd.edu	858-534-4222
Ryan Nicholl, Ph.D.	Microfabrication Process Engineer	2405	rnicholl@ucsd.edu	858-822-5663
Sean Parks	Equipment Engineer	1301	smparks@ucsd.edu	858-534-2076
David Prescott	Nanofabrication Engineer	2403	dtprescott@ucsd.edu	858-534-2986
Hal Romans	Equipment Engineer	1308	hromans@ucsd.edu	858-534-6674
John Tamelier, Ph.D.	Process Engineer	2103	jtamelier@ucsd.edu	858-246-2735
Jeff Wu, Ph.D.	Nanofabrication Engineer	1303	jianfengwu@ucsd.edu	858-534-6676

Table of Contents

1. **Safety**
 - 1.1. Requirements
 - 1.2. Resources
2. **General Emergency Procedures**
 - 2.1. Chemical Spill on Personnel
 - 2.2. Chemical Spills
 - 2.3. Emergency Evacuation Procedures
 - i Toxic Gas Leak
 - ii Fire
 - iii Earthquake
3. **Description of the Nano3 Alarm Systems**
 - 3.1. Toxic Gas Monitors
 - 3.2. Gas Cabinet Alarms Inside the Service Chases
 - 3.3. Fire Alarms
 - 3.4. Emergency Exit Door Sensors
 - 3.5. Facility Entry Door Alarm
 - 3.6. Fume Hood Flow Alarms
4. **Access Procedures**
 - 4.1. UCSD Internal Users
 - 4.2. UC System Users
 - 4.3. Non-UC System External Users
5. **Prior to Entering the Nano3 Cleanroom**
 - 5.1. Concept of the Cleanroom
 - 5.2. Materials Prohibited Inside the Cleanroom
 - 5.3. Card Swipe Access System
 - 5.4. Locker Policy
 - 5.5. Eye Protection
6. **Cleanroom Gowning Procedure**
 - 6.1. Entering the Cleanroom
 - 6.2. Exiting the Cleanroom
7. **Using the Fume Hoods**
 - 7.1. Handling Hazardous Chemicals
 - 7.2. Using Hydrofluoric Acid and Piranha
 - 7.3. Using TMAH and TMAH containing developers
 - 7.4. Hazardous Waste Disposal
 - 7.5. Bringing Non-Stock Chemicals into Nano3
 - 7.6. Glassware and Keeping the Fume Hoods Neat
 - 7.7. Fume Hood Features
8. **Using Nano3 Equipment**
 - 8.1. Training and Authorization
 - 8.2. Equipment Scheduling
9. **General Behavior Inside the Cleanroom**
10. **Visitor Policy**
11. **Explanation of Charges**
 - 11.1. Nano3 Services
 - 11.2. Materials Provided
12. **Enforcement**

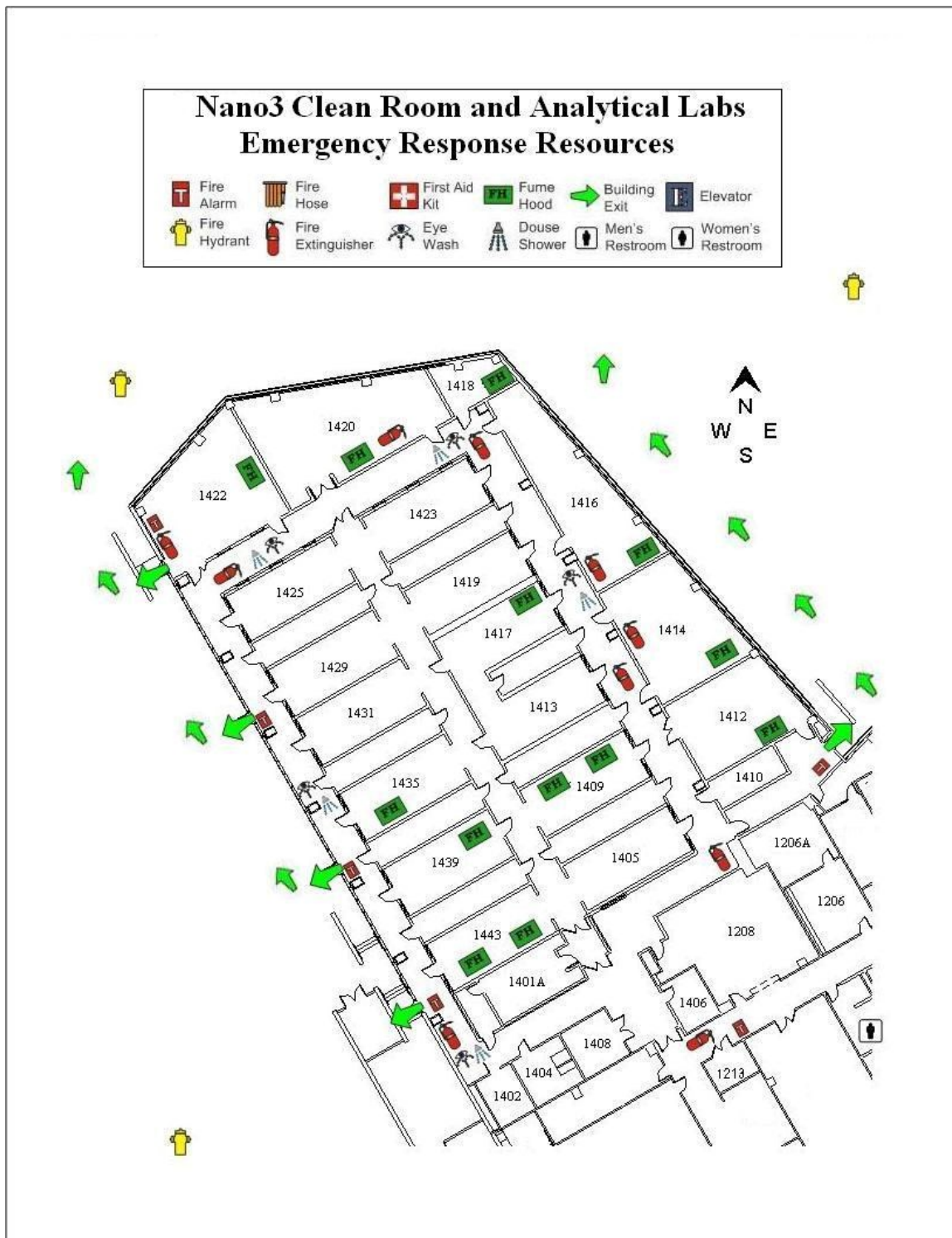


Figure 1: Nano3 facility overview. Note locations of fire extinguishers, emergency showers/eyewashes, fume hoods (FH) and emergency evacuation routes. The emergency evacuation routes are indicated by the green arrows. See section 2.3 for more information on evacuation procedures.

1. Safety

The Nano3 user facility at UCSD – Calit2 is committed to the highest possible safety standards. It is our goal to operate the facility in a manner that ensures that no unacceptable risks exist for all persons operating within the space. Safety is the responsibility of everyone. We require strict adherence to all applicable Federal and State health and safety regulations, and will enforce these as necessary.

1.1 User Safety Requirements

1.1.1 Each user must schedule and attend a general safety orientation (about 3.5 hours for full facility orientation, 60 minutes for analytical labs orientation) with Nano3 staff.

1.1.2 Each user must read the Nano3 Policies and Procedures document and complete the Policies and Procedures exam (accessible through the on line user account).

1.1.3 Each user must have their faculty sponsor sign the Nano3 User Agreement (accessible through the on line user account).

1.1.4 Each user will be required to complete an annual Nano3 safety quiz (accessible through the on line user account).

1.1.5 UCSD internal users and UC system users must a copy of their UC Laboratory Safety Fundamentals course certificate (provided by EH&S) to Nano3 staff. UCSD internal users can register for this course by following links at:

<https://blink.ucsd.edu/safety/resources/training/general-lab.html#Laboratory-personnel>

1.1.6 We invoke the buddy system for working inside the Nano3 facility. No one is permitted to work alone inside the facility. At any given time, at least two users (not visitors) must be present. The facility is open 24/day, 7 days/week, except for planned shut-downs, which will be announced one month prior.

1.1.7 UCSD internal users must follow protocols established in the Hazard Control Plans (HCP) in the UCSD EH&S Chemical Hazard Use Application (CHUA). See <https://ehs.ucsd.edu/myresearchsafety/do/mrsHome> for more information. These HCPs are developed by the users' PI and confirmed by the users for each hazardous chemical that the user will handle anywhere at UCSD.

1.2 Resources

1) UCSD Environment, Health and Safety:

<https://blink.ucsd.edu/sponsor/EHS/index.html>

2) Phone numbers:

a. Fire/Police/Emergency

Land Line: 9-1-1

Cell phone: 858-534-HELP (4357)

b. UCSD Poison Center

(800) 222-1222

c. Chemical Spill

(858) 534-3660

((858) 534-4357 Evening & Weekends)

3) Safety Data Sheet (SDS) Sources:

a. <https://blink.ucsd.edu/safety/resources/SDS/sources/index.html>

b. [ChemWatch](https://jr.chemwatch.net/chemwatch.web/home) (<https://jr.chemwatch.net/chemwatch.web/home>):

ChemWatch, the primary SDS source at UC San Diego, automatically recognizes a UC-affiliated computer. You must be using a UC San Diego IP

address to access or obtain; students are provided a login with course curricula.

- c. [SIRI SDS Index \(https://hazard.com/msds/\)](https://hazard.com/msds/)
- d. <http://www.ilpi.com/msds/index.html>

2. General Emergency Procedures

The Nano3 facility environment contains many potential hazards, posed primarily by the chemicals used. For all emergency evacuations the meeting point is across Voigt Drive and in parking lot P502. Follow the green arrows on the map at the beginning of this document.

Note: It is each user's responsibility to read through the SDS sheets associated with the chemicals they plan to use and to familiarize themselves with their potential hazards prior to using them.

2.1 Chemical Spill on Personnel

Follow these general guidelines regarding chemical spills on personnel:

- a) In case of **significant, general external exposure**, immediately exit the cleanroom using the closest emergency exit. Use a safety shower located in the corridor surrounding the cleanroom. Remove clothing while under the shower and flush for at least 15 minutes. Seek medical attention as soon as possible.
- b) In case of **localized external exposure** (small area of contact such as on an extremity (e.g. hand)) a DI spray gun, DI tap, or even a dump rinse module at a wet bench, may serve if these are the closest sources of water. Flush the affected areas with water for at least 15 minutes. Seek medical attention if necessary.
- c) If the chemical is **hydrofluoric acid (HF)**, another fluoride-ion containing solution (**BOE, PAD** etch), or **tetramethylammonium hydroxide (TMAH)**, including TMAH containing developers such as AZ300MIF, RD6, CD26, etc., you must act immediately as fluorine ions and TMAH will quickly penetrate skin to cause potentially life threatening injuries. Concentrated HF will immediately cause extremely painful burns on contact. However, more dilute HF solutions will not cause any pain; yet they can still cause considerable deep tissue or systemic damage. If contact with HF (or related solution) is suspected, treat the incident as an HF exposure. Calcium gluconate gel is used as an antidote for HF exposure to skin. Tubes of calcium gluconate are available at the polypropylene wet benches in Wet Processing Room 1443, Dry Etch Room 1439 and inside the first aid kit at the emergency shower adjacent to the cleanroom entrance. Calcium gluconate is for external use only and must not be used for chemical exposure to eyes. There is no known antidote for TMAH.

Follow these specific procedures in case of skin exposure to HF:

1. IMMEDIATELY rinse the affected skin area with lots of water. Being careful to wash the acid away from other parts of your body, especially finger/toe nails where acid can get trapped.
2. Remove all clothing exposed to the HF.
3. Continue rinsing for 1-2 minutes. Do not rinse for more than 5 minutes. Do not dry the skin.
4. Call for help.
5. Obtain Calcium Gluconate gel (available at the polypropylene wet benches in Wet Processing Room 1443, Dry Etch Room 1439 and inside the first aid kit at the emergency shower adjacent to the cleanroom entrance).
6. Puncture the tube using the inverted tube cap. Apply gel over the entire affected area.

7. Using gloves, gently massage the gel into the skin. Take the gel with you and continue to apply fresh gel while en route to the Emergency Room.
8. Elevate burned extremities, if possible.
9. Go immediately to a local emergency medical provider.
10. Tell them you have Hydrofluoric Acid on you.
11. Continue to apply fresh gel (and gently massage it in) while waiting to be treated.
12. Following treatment, the incident must be reported to Nano3 staff.

Follow these specific procedures in case of skin exposure to TMAH (including exposure to TMAH containing developers such as AZ300MIF, RD6, CD26):

1. IMMEDIATELY rinse the affected skin area with lots of water. Being careful to wash the materials away from other parts of your body, especially finger/toe nails where it can get trapped.
2. Remove all clothing exposed to the material.
3. Call for help.
4. Go immediately to the Emergency Room.
5. Tell them that you were exposed to trimethylammonium hydroxide.
6. Following treatment, the incident must be reported to Nano3 staff.

- d) In case of **exposure of the eyes** (corrosives are especially serious!), flush immediately, either with an eyewash bottle at your bench or with the eyewash station in the wet process area. If starting with an eyewash bottle, move to the eyewash station in the wet process area and continue flushing when the bottle is emptied. Eyes should be rolled up and down, and side to side, continuously, to allow clean water to flush behind the eyeball. The eyeballs sit rather loosely in their sockets, a splashed chemical can work its way around the eye to damage the optic nerve. Flush both eyes with water for at least 15 minutes. Both eyes should be held open with the thumb and forefinger. While the victim is at the eyewash, someone else should be calling the doctor for further instructions.

Upon any **exposure to corrosives**, the victim should be taken to the emergency center for evaluation and treatment.

In addition to the eye wash equipment inside, eye wash stations are also located in the corridor surrounding the cleanroom. You may use these eye wash stations in case of any trouble with the eye wash equipment inside the cleanroom, or if you need additional flushing after the eye wash stations inside the cleanroom are emptied.

Chemicals in the facility of the hazard class "corrosive" include:

1. The following acids and their mixtures -- sulfuric (H_2SO_4), nitric (HNO_3), acetic (CH_3COOH), hydrofluoric (HF), buffered oxide etchants (BOE -- pre-mixed ammonium fluoride and hydrofluoric acid), PAD etch (pre-mixed, fluoride-containing acids).
2. The following bases and their mixtures -- potassium hydroxide (KOH), tetramethyl ammonium hydroxide (TMAH).

2.2 Chemical Spills

A number of chemicals are present in the Nano3 facility that pose a potential for serious injury, major equipment damage or even death. It is necessary to know how to react quickly and properly in response to any spill to avoid possibly serious consequences. The following procedures are only intended as general guidelines. Always use common sense when handling a particular situation.

- a) If you are in the facility during normal business hours, notify Nano3 staff immediately. Place a sign near the spill before leaving the area to contact Nano3 staff so that other users are aware. If you are in the facility during off hours, notify another person in the lab that there is chemical spill and that you plan to clean it up.
- b) If the chemical spill is large or you feel you cannot handle it, alert others to its presence, and isolate the area via signage. Evacuate the cleanroom if the spill is large. During the day, notify Nano3 staff. After hours, call **(858) 534-4357** first, and then notify Nano3 staff.
- c) A **spill response kit** can be found in the gowning room, room 1443 and 1417. They are plainly marked and contain the following items:
 - i. Absorbent spill dam
 - ii. Absorbent pads
 - iii. pH paper
 - iv. Two pairs of acid gloves
 - v. Two pairs of vapor-resistant goggles
 - vi. Trash bags

The spill response kit in room 1443 also contains acid neutralizer and caustic neutralizer sprays.
- d) Retrieve the spill response kit:
 - i. If the chemical is an acid or a base, put on acid gloves and goggles before attempting to clean up the spill.
 - ii. Isolate the area around the spill.
 - iii. Select the proper equipment for the spill. For large spills (greater than a half-gallon bottle) an absorbent dam will be necessary to prevent spreading. For small spills, only absorbent pads are necessary. Select the proper neutralizer for the chemical (note: solvents do not require a neutralizer).
- d) Attack the spill (**MAKE CERTAIN TO ALWAYS WEAR THE APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT FOR THE SPECIFIC CHEMICAL**):
 - i. If you are using an absorbent dam, place the dam around the spill, approximately 4 inches from the liquid.
 - ii. Place the neutralizer bottle on the floor. Release the clamp and spray neutralizer, pushing the chemical into the spill dam. Be sure to cover the entire spill.
 - iii. Watch the color of the spill as you add neutralizer (Note that the spill can get hot during neutralization):
Use pH paper to verify that a pH of 7 has been achieved, indicating complete neutralization.
 - iv. Once the spill has cooled, place the absorbent pads on the spill until all of the liquid is absorbed.
 - v. In case of a *solvent* spill, do not attempt to neutralize. Soak up the chemical as quickly as possible to reduce damage to the floor. Do not use water on the floor until the chemical has been soaked up.
 - vi. Clean up:
Do not remove your safety equipment until you are completely finished. There may still be some active chemical on the floor. When the spill has been completely absorbed, place the absorbent dam and pads in a double trash bag. Place the bag in one of the fume hoods, leave a note describing the bag contents and your contact information, and alert Nano3 staff to its presence. If glass is involved, place the glass in a separate sharps container and label it as “SHARPS” along with the name of the chemical the glass contained.

- vii. Wipe down the entire spill area with cleanroom wipes and DI water. When finished, dispose of the cleanroom wipes.
- e) Inform Nano3 staff and complete an incident report form.

2.3 Emergency Evacuation Procedures:

Some emergency situations will require evacuation from the building. If evacuation is necessary please proceed to the nearest emergency exit and exit the building. If you are inside the cleanroom proceed to the nearest emergency exit and do not stop to remove your cleanroom garments. Follow the green arrows in Figure 1 (above) to parking lot P502.

Parking lot P502 is the designated assembly area in case of emergency evacuation from Atkinson Hall. Proceed to parking lot P502 and wait for further instructions.

2.3.1 Toxic Gas Leak

Several toxic gasses are used in the Nano3 facility. These gasses are kept in gas cabinets designed to contain leaks that might occur from the cylinders. However, it is possible that there may be a leak associated with equipment that employs these toxic gases or the gas lines running between the gas cabinets and the equipment. This would result in a release of toxic gas into the breathing space of the lab.

PLEASE SEE SECTION 3 FOR INFORMATION ABOUT THE TOXIC GAS MONITORING SYSTEM AND EMERGENCY PROCEDURES.

2.3.2 Fire

In case of fire, evacuate the cleanroom and building immediately through the nearest emergency exits without de-gowning. Do not try to extinguish any fire in a fume hood. The burning polypropylene material will not be extinguishable and the resulting smoke is highly toxic. There are three fire alarms located in the southwest hallway opposite the windows near the exits. Pull one of these fire alarms to alert the fire department.

2.3.3 Earthquake

In case of a large earthquake, take cover under a doorsill or sturdy table. Do not attempt to evacuate during the earthquake. Wait until the shaking has subsided and then evacuate the cleanroom and building through the nearest emergency exits without de-gowning. Move away from open containers of hazardous chemicals if possible as the shaking may cause them to spill and/or splash.

3. Description of the Nano3 Alarm Systems

The Nano3 facility is equipped with a variety of sensors that can trigger audible or visual alarms. It is important for the users to understand the various types of alarm signals, and the appropriate action to take. For certain types of alarms it will be necessary to leave the cleanroom through an emergency exit immediately without de-gowning. This will leave the cleanroom vulnerable to air borne particles from outside, but may be necessary to save lives. Alarm systems within the facility include:

3.1 Toxic Gas Monitors

The Nano3 cleanroom is equipped with toxic gas monitors in all areas where toxic gases are used. Multiple alarm condition indicators are hanging from the ceiling at multiple locations in and around the cleanroom. These are commonly referred to as “Light Sticks” because there are green, yellow and red colored lights on each one. These different colors indicate varying levels of alarm. The following table describes what each color means when lit and what actions to take when they are lit:

Lit portion of the light stick	Meaning	Action to take
Green	No toxic gas leaks, normal operation.	None
Flashing green	No toxic gas leaks, sensor needs maintenance.	Inform cleanroom staff.
Yellow	WARNING Toxic gas detected, but at a non-hazardous level of one half the Permissible Exposure Limit.	Calmly end your process and proceed to the gowning room to de-gown and leave the cleanroom. Inform cleanroom staff immediately.
Red	EVACUATION ALARM Toxic gas leak detected above Permissible Exposure Limit. Hazardous levels of toxic gas are present in the breathing area.	Evacuate the cleanroom through the nearest emergency exit and leave the building immediately. Inform cleanroom staff.

Important terms to know:

Permissible exposure level (PEL): A maximum allowable exposure level under OSHA (Occupational Safety and Health Administration) regulations. Exposure limits are established by health and safety authorities to control exposure to hazardous substances. In California the most important exposure limits are the Permissible Exposure Limits (PELs). These are exposure limits set forth in California OSHA (Cal/OSHA) regulations. Exposure limits usually represent the maximum amount (concentration) of a chemical which can be present in the air without presenting a health hazard.

Time weighted average (TWA): The average concentration of a chemical in air over the total exposure time - usually an 8-hour work day. The measured level may sometimes go above the TWA value, as long as the 8-hour average stays below. All chemicals with PELs have a TWA value.

Threshold limit value (TLV): An exposure limit recommended by the ACGIH (American Conference of Governmental Industrial Hygienists). The maximum permissible concentration of a material, generally expressed in parts per million in air for some defined period of time

(often eight hours), to which nearly all workers may be repeatedly exposed without any adverse health effects.

All gas concentrations are measured in either parts per billion (ppb) or parts per million (ppm).

Specific TLVs and alarm settings:

Gas	TLV-TWA (ppm)	Warning (ppm)	Evacuation Alarm (ppm)
NH ₃	25	12	25
BCl ₃	5	0.3	5
Cl ₂	0.5	0.3	0.5
*B ₂ H ₆	0.1	0.05	0.1
*GeH ₄	0.2	0.1	0.2
HCl	5	2	5
*PH ₃	0.3	0.15	0.3
SiH ₄	0.3	0.15	0.3
*AsH ₃	0.05	0.025	0.05

*Not currently in use at Nano3

3.2 Gas Cabinet Alarms (Inside the service chases)

Several gas cabinets are located within the service chases for the cleanroom. The service chases are not accessible to general users of the cleanroom. The gas cabinets are equipped with local alarms that will sound if a variety of malfunctions (such as, for example, low exhaust flow conditions) are detected. These local alarms do not indicate an imminent danger to personnel; they are not indications of a toxic gas leak. If you hear an alarm sound within a service chase, please notify Nano3 staff.

3.3 Fire Alarms

In the event of a fire alarm exit the cleanroom through the gowning area **without de-gowning** and leave the building, following the evacuation plan that you received with your initial safety orientation. Do not delay.

3.4 Emergency Exit Door Sensors

The individual cleanroom bays, as well as either end of the main cleanroom corridor, are equipped with emergency exit doors that open from the interior cleanroom space to the perimeter corridor. All of these doors are EMERGENCY ONLY doors, and are identified as such. If these doors are opened, the integrity of the cleanroom is breached! Each of the doors is outfitted with a local alarm that will sound if the door is opened. The alarm will sound continuously, and can only be turned off using a key. Please notify Nano3 staff if an alarm sounds

3.5 Facility Entry Door Alarms

The entries into the cleanroom and analytical labs are outfitted with a local alarm which is interfaced with the access card reader system. The alarm will sound if the door is opened from the interior without a prior card swipe. The alarm will also sound if the door is held open for a duration exceeding approximately 30 seconds, and it will turn off once the door is closed. The intent of this alarm is to remind users to swipe their access card upon exit from the facility, since only the swiping of the card will end the clocking of user time (and charge).

3.6 Fume Hood Flow Alarms

All fume hoods are equipped with local flow alarms. In case of recurring fume hood flow alarms, please notify Nano3 personnel.

4 Access Procedures

The Nano3 facility is a cross-departmental, general user facility, designed to support the campus research effort. The facility is open to all trained personnel on a recharge basis, including UCSD as well as external personnel. It is our mission to provide a state-of-the-art facility for advanced device fabrication at the micro- and nano-scale.

In addition to providing essential microfabrication capabilities for mainstream research on electronic and optoelectronic materials and devices, this facility is intended to facilitate the pursuit of research in emerging, interdisciplinary, and rapidly growing fields such as biomedical and biochemical devices, heterogeneous integrated devices and circuits, and nanoscale science and technology.

How to gain access:

4.1 UCSD Internal Users

1. Register your Nano3 FOM user account at <https://nano3fom.eng.ucsd.edu/fom>
 - o Click the link to sign in with UCSD ID.
 - o Log in with your UCSD email username only (not the entire email address) and password.
 - o Enter the required account information.
 - o You will be prompted to post an account number (enter UCSD index number).
2. Create your Nano3 user account on the facility webpage at <https://nano3.calit2.net/register/process.php> (see note below):
 - o Post your recharge index number in your Nano3 account.
 - o See section 11.1 of the Nano3 Policies and Procedures document for more information (<https://nano3.calit2.net/documents/policiesAndProcedures.pdf>).
3. Print the Nano3 UC San Diego User Agreement (<https://nano3.calit2.net/documents/Nano3%20UCSD%20UserAgreement.pdf>). Read and sign the agreement and have your faculty advisor sign, then scan and email to James Koga (jkoga@eng.ucsd.edu).
4. Email a copy of your UC Laboratory Safety Fundamentals (<https://blink.ucsd.edu/safety/resources/training/general-lab.html#Laboratory-personnel>) certificate of completion to James Koga (jkoga@eng.ucsd.edu).
 - o You can access a copy of your certificate in your UC Learning Center account in the transcripts page.
5. Once you receive notification that your FOM account has been confirmed, apply for the Nano3 safety orientation:
 - o Log in to your FOM user account.
 - o If you need access to equipment inside the cleanroom, click on "Full Facility Orientation" (at the top of the "Available Equipment" list).
 - o If you only need access to equipment in the analytical labs, click on "Analytical Labs Orientation" (at the top of the "Available Equipment" list).
 - o You will be prompted to pass an exam based on the Nano3 Policies and Procedures document (<https://nano3.calit2.net/documents/policiesAndProcedures.pdf>). When you pass the exam, a request to attend the orientation will be sent to Nano3 staff.

- Once Nano3 staff receives your orientation request, your paperwork will be processed, and you will receive an email stating that you are on the orientation wait list (typically within 2 business days).
 - Facility orientations take place every 1-2 weeks, and you will receive another email from a safety coordinator as soon as you can join the next orientation.
 - Please allow for up to 3.5 hours for the Full Facility Orientation which includes cleanroom and analytical labs.
6. Please allow for up to 1 hour for the Analytical Labs Orientation.
 7. **After** you have completed all of the above access requirements, you will receive an email that your campus ID card has been activated for facility access (within 1-2 business days).

For instructions to sign up for equipment training in your FOM account, please follow the instructions at <https://nano3.calit2.net/FOM equip training.php>.

NOTE: Nano3 UCSD Internal users must have accounts in two separate systems as we transition our lab management from our original system to FOM.

4.2 UC System Users

1. Register your Nano3 FOM user account at <https://nano3fom.eng.ucsd.edu/fom/>
 - Click the link to log in without a single sign on ID.
 - Click "I am a new user".
 - Select "External User" type.
 - Enter the required information (login name/password/first/last name/email/phone number):
 - Leave the "UC ID" field blank.
 - Select "Other University" for Affiliation.
 - Select a "Discipline".
 - Enter your university name under "Company Name".
 - Enter your university's address information.
2. Email the following information to James Koga (jkoga@eng.ucsd.edu):
 - Name of your faculty advisor.
 - Name of your campus department.
 - Have your business office email your inter-campus accounting codes to James Koga (jkoga@eng.ucsd.edu).
3. Print the Nano3 University of California User Agreement (<https://nano3.calit2.net/documents/Nano3%20UC%20UserAgreement.pdf>). Read and sign the agreement and have your faculty advisor sign, then scan and email to James Koga (jkoga@eng.ucsd.edu).
4. Email a copy of your **UC Laboratory Safety Fundamentals certificate** of completion to James Koga (jkoga@eng.ucsd.edu).
Once you receive notification that your FOM account has been confirmed, apply for the Nano3 safety orientation:
 - Log in to your FOM user account.
 - If you need access to equipment inside the cleanroom, click on "Full Facility Orientation" (at the top of the "Available Equipment" list).
 - If you only need access to equipment in the analytical labs, click on "Analytical Labs Orientation" (at the top of the "Available Equipment" list).

- You will be prompted to pass an exam based on the Nano3 Policies and Procedures document (<https://nano3.calit2.net/documents/policiesAndProcedures.pdf>). When you pass the exam, a request to attend the orientation will be sent to Nano3 staff.
 - Once Nano3 staff receives your orientation request, your paperwork will be processed, and you will receive an email stating that you are on the orientation wait list (typically within 2 business days).
 - Facility orientations take place every 1-2 weeks, and you will receive another email from a safety coordinator as soon as you can join the next orientation.
 - Please allow for up to 3.5 hours for the Full Facility Orientation which includes cleanroom and analytical labs.
 - Please allow for up to 1 hour for the Analytical Labs Orientation.
5. **After** you have completed all of the above access requirements, you will receive an email with instructions on how to obtain the necessary facility access card (\$25 per card) (within 1-2 business days).

For instructions to sign up for equipment training in your FOM account, please see: <https://nano3.calit2.net/FOM equip training.php>

4.3 Non-UC System External Users

2. Register your Nano3 FOM user account at <https://nano3fom.eng.ucsd.edu/fom/>
 - Click the link to log in without a single sign on ID.
 - Click "I am a new user".
 - Select "External User" type.
 - Enter the required information.
3. If **your company is new to Nano3**, complete the appropriate option below:
 - If your company only requests staff-assisted **services** (*no need for independent facility access*), complete the Nano3 External User Services-Only Agreement (<https://nano3.calit2.net/documents/ServicesOnly ServiceAgreement 9.11.1 5.doc>).
Skip steps 5 and 7 below.
 - If your company requests **independent access** to the Nano3 Facility, complete the Nano3 External User Service Agreement (<https://nano3.calit2.net/documents/externalServiceAgreement.doc>).
 - In either case:
 1. Enter the required information in Exhibit A of the respective agreement, then print and sign the document.
 2. Scan and email the signed agreement to James Koga (jkoga@eng.ucsd.edu).
 - Please note that approval may take one to two weeks.
4. If your company has already established a service agreement with Nano3, you can be added to the existing service agreement by signing the New User Form (<https://nano3.calit2.net/documents/New%20User%20Form.pdf>). Please note that your supervisor must also sign the New User Form.
5. Submit payment for Nano3 facility usage in the form of a check or PO for the cost stated in your service agreement:
 - Email a copy of your PO to James Koga (jkoga@eng.ucsd.edu)

- Nano3 cannot accept PO's for payments less than \$1000. If the payment is less than \$1000 it must be submitted by check. Make checks payable to "UC Regents".
 - PO's will be invoiced monthly based on usage. Monthly payments can be submitted by check payable to "UC Regents".
 - Facility usage rates are outlined at <https://nano3.calit2.net/rates.php>
6. Email a copy of the company insurance certificate to James Koga (jkoga@eng.ucsd.edu). See Section 8 of the service agreement for details.
 7. Once you receive notification that your FOM account has been confirmed, apply for the Nano3 safety orientation:
 - Log in to your FOM user account.
 - If you need access to equipment in the cleanroom click on "Full Facility Orientation" (at the top of the "Available Equipment" list).
 - If you only need access to equipment in the analytical labs, click on "Analytical Labs Orientation" (at the top of the "Available Equipment" list).
 - You will be prompted to pass an exam based on the Nano3 Policies and Procedures document (<https://nano3.calit2.net/documents/policiesAndProcedures.pdf>). When you pass the exam, a request to attend the orientation will be sent to Nano3 staff.
 - Once Nano3 staff receives your orientation request, your paperwork will be processed, and you will receive an email stating that you are on the orientation wait list (typically within 2 business days).
 - Facility orientations take place every 1-2 weeks, and you will receive another email from a safety coordinator as soon as you can join the next orientation.
 - Please allow for up to 3.5 hours for the Full Facility Orientation which includes cleanroom and analytical labs.
 - Please allow for up to 1 hour for the Analytical Labs Orientation.
 8. **After** you have completed all of the access requirements, you will receive an email with instructions on how to obtain the necessary facility access card (\$25 per card) (within 1-2 business days).

For instructions to sign up for equipment training in your FOM account, please follow the instructions at <https://nano3.calit2.net/FOM equip training.php>.

5 Prior to Entering the Nano3 Facility

5.1 Concept of the Cleanroom

A Class 10 cleanroom is defined as having less than 10 particles of 0.5 micron or greater in size within a cubic foot of air. Similarly, a Class 1000 cleanroom has less than 1000 particles 0.5 micron or greater in size within a cubic foot of air. This level of cleanliness is necessary to maintain the reproducibility of newly developed state-of-the-art electronic device processes. To reach this level of cleanliness, the transfer of particle and chemical contaminations must be eliminated wherever it is found. Hair and skin from people are the greatest possible sources of airborne particles within the cleanroom and thus must be covered at all times with proper cleanroom garments. Many common materials also shed particles into the air at all times and are not allowed in the cleanroom.

Normal air contains hundreds of thousands of particles per cubic foot, to prevent these particles from entering the cleanroom the pressure inside the cleanroom is kept higher than outside by constantly pumping filtered air into the cleanroom. This results in a constant flow of particle free air from inside to outside of the cleanroom through all openings such as between doors and doorsills and through fume hood and gas cabinet exhausts. This airflow pattern keeps all outside air and particles from entering. But even with this pressure differential we cannot commonly open the majority of the doors that lead into the cleanroom. By opening even one door the air balancing for the entire lab is compromised which allows the possibility of outside air - and particles - to enter. This compromises the entire cleanroom and jeopardizes particle sensitive processing in progress inside the lab. Thus, as cleanroom users, you may only use the main entry door and the subsequent air locks leading into the cleanroom to enter and exit under normal circumstances. All other doors to the cleanroom are emergency exits and are to be used only in the event of an emergency. Alarms will sound when any emergency exit is opened.

Even with a constant flow of filtered air from inside the cleanroom to the outside world, particles can still find their way into the space within the cleanroom. The strategy implemented to keep any particles within the cleanroom space from interfering with ongoing experiments push the particles downward. This is done by forcing filtered air into the room from above and pulling air out from below. With a constant downward flow of particle free air the resulting laminar flow around all objects in the room gives any dislodged particle only one option: down and out. But even with all the equipment used to keep the airborne particle count low, maintaining such a high level of cleanliness requires that the users strictly adhere to protocol, especially the gowning procedures outlined in this document.

It is important for each user to understand that their individual commitment to this protocol ultimately determines the success or failure of the facility.

All of the elaborate equipment installed to provide a microscopically clean and controlled atmosphere would be to no avail if our users do not believe in and help enforce these policies. We also understand that users are a tremendous resource for new ideas. With this in mind, we strongly encourage our users to recommend changes that may make the facility safer, cleaner, easier to use, or less expensive to maintain. When in the cleanroom, please be aware of your knowledge limitations. It is extremely important that you ask someone for help if you are unsure about the operation of these facilities.

5.2 Materials Prohibited Inside the Cleanroom

Materials that are fibrous or likely to degrade in normal use and create particulate are not allowed in the cleanroom. Materials with textured surfaces that can trap particles and cannot be cleaned are also not acceptable. Less obvious materials are polymers that outgas and release organic contaminants. Please consult Nano3 staff if you are not sure. All items that are brought into the cleanroom must be wiped with the provided isopropyl alcohol/DI water solution prior to entry. The following list of materials provides some examples of prohibited materials:

- Food or drinks
- Make-Up
- Paper (only cleanroom paper is permitted)
- Wood
- Fabrics and woven materials
- Fiberglass
- Soft plastics and elastomers that are easily abraded
- Pencils, Ballpoint pens (the ink can cake, dry, and flake); only cleanroom approved writing materials are permitted)
- Erasers
- Powders
- Foam materials including some tool handles
- Solutions or suspensions that will dry out to leave powders or particulates
- Most PVC materials
- Devices with hidden surfaces that cannot be cleaned
- Any materials that can easily shred or aerosolizes to become a source of particulate

Taking any materials in and out of the cleanroom should be avoided whenever possible. There is storage space available in the cleanroom for users' tools and personal supplies. Once brought into the cleanroom, these tools and supplies should remain inside as long as they are needed in the cleanroom. When you are finished with your work at Nano3, please remember to remove any items that you have brought in.

5.3 Card Swipe Access System

The Nano3 facility is equipped with a card system, which limits access to authorized users. Users must swipe a valid access card, typically your campus ID card, in order to be able to enter the facility. The card swipe is also used to record user hours for recharge. It is therefore also necessary to swipe the card upon exiting the facility, using the reader mounted inside the entry door. An audible alarm is positioned above the exit that sounds when the door is opened without a card swipe. The purpose of the alarm is to serve as a reminder, as time in the facility will continue to be recorded (and charged) until the card is swiped upon exit. Should a user ignore to swipe the card upon exit, time counting will end after 8 hours. In this case, you will need to communicate with Nano3 staff in order to reinstate your access.

Note: The access card is strictly for your own personal use. Please do not admit anyone other than yourself into the facility for any reason other than an emergency. Should you need to admit another person into the facility due to an emergency, both the authorized user and the person who was given access to the facility must notify Nano3 staff. Please see section 10 for visitor policy.

Please understand that we will enforce all lab rules and that any breach of these rules can result in nullification of your access privileges.

5.4 Locker Policy

A number of lockers and a coat rack are available to Nano3 users in room 1410. These lockers are intended for *temporary* use for cleanroom users. Users may store items that cannot be brought into the cleanroom space during their time inside the cleanroom. ***Storage of chemicals or food items is not permitted under any circumstances.*** Please note that locker space is limited. Please limit the amount of material that you need to store. The facility does not provide locks. User furnished locks are permitted, but may not be left in place after users swipe out of the cleanroom.

We retain the right to periodically remove locks and contents of these lockers if we determine that they are improperly left in place.

5.5 Eye Protection

Appropriate eye protection must be worn at all times in the lab, except perhaps when using a microscope or other equipment with eye pieces. Acceptable types of eye protection for everyday lab wear are:

1. Impact resistant safety glasses (type B, C, D, G, or H, with side shields) which conform to ANSI standard (marked "Z87".)
2. Vented safety goggles (these may be worn over normal prescription glasses.)
3. Prescription impact-resistant safety glasses, with side shields (available from many optical shops.)

Impact-resistant safety glasses are designed to protect only against flying fragments, not chemical splash hazards. Full face shields should be worn in addition to glasses when handling chemicals or working at chemical wet benches. Face shields and additional Personal Protective Equipment are required when working with certain high hazard chemicals as detailed in various sections within this document.

Regarding contact lenses please follow the American Chemical Society recommendation that "contact lenses can be worn in most work environments provided the same approved eye protection is worn as required of other workers in the area." (C&E News, Vol. 76, p. 6.) Thus, contact lens wearers should wear standard safety glasses or safety goggles when working in the lab, and full face shields in addition to safety glasses when working at chemical wet benches.

6 Cleanroom Gowning Procedure

6.1 Entering the cleanroom

NOTE: The cleanroom garments are picked up for laundering once per week. Each week on laundry pick up day the used smocks are taken down for cleaning and the previously cleaned smocks are delivered, cleaned and packaged. You will see a sign in sheet in the main gowning room which consists of a list of numbers. If it is your first time entering the cleanroom during the laundry cycle, choose a number and write your name on that line. Each hangar has a number on it, the number you choose will be your personal hangar for that week's laundry cycle. Each laundry day the sign in sheet is replaced with a blank one and the process starts over.

In addition to the numbered hangars you will see a section of hangars labelled as "Shared". If you are entering the cleanroom only one time during the week and do not plan to return, please use a smock from the shared section. If you do not find your size in the shared section, you may obtain a new smock and hang it on the shared hangars when you leave.

DO NOT USE NEW SMOCK EACH TIME YOU ENTER THE CLEANROOM! In an effort to keep costs low, our smock inventory is kept at a minimum level. We cannot allow one time use of our smocks.

A. Entry area

1. **Using swipe access card, open and enter cleanroom entry area.**
2. **Step on tacky mat.** Take at least 6 steps, 3 for each foot.
3. The white line on the floor divides the clean area (on the cleanroom side) and the dirty area (on the main entrance side). Stay only within the dirty area until you put on shoe covers (step 4).
4. **Put on shoe covers.** Get a pair of shoe covers from the labeled dispenser bin on the wire shelf. Place shoe covers completely over the sole and sides of each shoe. Only flat or very low-heeled shoes may be worn. **No sandals or open-toed shoes are permitted.**
5. **Put on face cover.** Face covers can be found in a labeled bin on the wire shelf.
6. **Put on bouffant cap.** Remove a cap from the bin on the wire shelf. Place on your head below the ears and to the base of the neck to contain all hair. Tuck in any stray hair.
7. **Put on gloves.** Touch ONLY the cuffs of the gloves. Do NOT touch the palms or fingers of the gloves with bare hands. Oils and particulates from your skin adhere to the gloves and subsequently contaminate everything you touch. Get a pair of gloves from one of the labeled dispenser bins. Pull on the first glove holding it only by the cuff. Pull on the second glove making sure that the first glove does not touch your skin.
8. **Wipe down all materials.** Note that some materials may be damaged by isopropyl alcohol, so you may need to use DI water instead from the squeeze bottle provided. Moisten a cleanroom wipe with isopropyl alcohol. Wipe all surfaces of materials you will be bringing into the cleanroom. Wipe the length of the wiper cloth and then fold over. Repeat folding and get new wipes as necessary. Dispose of IPA wipes in Red Flammables can. ALL wipes with ANY amount of isopropyl alcohol MUST be disposed of in the red flammables waste can to contain the fire hazard.
9. **Proceed to the gowning area.** Do not open door to the gowning area while the door to the entry area is open.

B. Gowning area

The gowning area has benches arranged in a way that divides the area into two parts: the dirty area (on the gowning rack side) and clean area (on the cleanroom side). In order to proceed from the gowning area to the cleanroom, you will need to step over the benches. Please do so only in accordance with the procedure described below.

1. **Step on tacky mat.** Take at least 6 steps on the tack mat, 3 for each foot.
2. **Select your hangar number.** If it is your first time in the cleanroom between laundry pick up days
3. **Put on hood.** Align the hood so that your face will be at the opening. Pull the hood over your head.
4. **Put on coveralls.** DO NOT let your coveralls touch the floor because contamination from the floor will then be brought into the cleanroom on your coveralls. Always inspect your coverall for signs of contamination or wear. Hold the sleeves so that the coveralls do not touch the floor. Find a comfortable sitting position, but DO NOT allow your feet to cross the bench at this time. Put one leg in the leg of the coveralls and pull up to your ankle. Put your other leg in the leg of the coveralls and pull up to your ankle. Stand and pull the upper half of the coveralls up to your arms. Put your arms through the sleeves. Pull the coveralls up over your shoulders. Pull the zipper up halfway. Tuck in hood. Tuck the front and rear flaps of the hood under the coveralls. Pull up the zipper of your coveralls all the way.
5. **Put on boots.** DO NOT place your boots on the floor because contamination from the floor will get on the sides of the boots and be carried into the cleanroom. NEVER stand in boots on the gowning rack side of the benches. Note that boots fit either foot. Get your boots and put them sole side facing down in the clean area. Find a comfortable sitting position, but DO NOT allow your feet to cross the bench at this time. Raise one foot and pull on a boot, then rest this foot on top of the bench. Pull over the boot over the coverall's leg until your foot is snugly in the bottom of the boot (This will help to trap any particles falling down the coverall leg inside the boot). Swing your booted foot onto the other side of the bench. Clip the buckle and tighten the strap. Repeat with the second foot.
6. **Check proper gowning fit in mirror.** Is your hood tucked in, front and back?
7. **Put on second pair of gloves.** NOTE: the palms and fingers of the second pair of gloves should not touch the first pair of gloves. Pull on a glove holding it only by the cuff. Pull the glove cuff up over the coverall cuff as far as it will go. Repeat with the other hand. If necessary, pull up the glove fingers for a snug, comfortable fit. While in the cleanroom, keep your hands away from your face. Oils from your face can be transferred to the gloves and subsequently to the cleanroom equipment or your samples.
8. **Enter the air lock.**
9. **Put on protective eyewear.**
10. **Enter the cleanroom.**

6.2 Exiting the Cleanroom

1. **Enter the gowning area from inside the cleanroom.**
2. **Remove protective eyewear.** Place safety glasses in the bin.
3. **Remove boots.** DO NOT place your boots in the dirty area because contamination from the floor will get on the boots and be carried into the cleanroom. NEVER stand in boots on the gowning rack side of the benches. Find a comfortable sitting position on the bench, keeping your booted feet on the cleanroom side of the bench. Swing the first foot onto the top of the bench. Slide the boot off your foot and place in the clean area. Swing your foot to the garment rack side of the bench. Repeat with the other foot.

4. **Remove the outer gloves.** Discard them in the trash container.
5. **Remove Coveralls.** DO NOT let your coveralls touch the floor because contamination from the floor will then be brought into the cleanroom on your coveralls. Find a comfortable standing position. Pull the zipper down. Roll the coveralls from your shoulders. Pull out your arms from the sleeves and hold the sleeves and zipper so that the coveralls do not touch the floor. Roll the coveralls below your waist and hold the sleeves and zipper so that the coveralls do not touch the floor. Sit down and remove one leg from the coveralls while holding and gathering the coveralls so they do not touch the floor. Repeat with the other leg.
6. **Soiled Garment?** If you have worn your garment for more than approximately 24 hours or it has become soiled, the garment should be laundered. Place garments into the appropriate containers.
7. **Hang up coveralls.** The hangers cannot be removed from the garment rack. Avoid touching the coveralls with your clothes or bare skin. Hold the coveralls by the shoulders and lift them so they do not touch the floor. Hang them on your assigned hanger. Close the zipper.
8. **Remove and hang up hood.** Pull the hood over your head. Secure the hood to the coverall by fastening the snap at the top of the hood to one of the snaps on the collar of the coverall.
9. **Store the boots.** Place the soles of your boots together. Roll the tops of the boots around the soles. Place your boots inside a leg of your coveralls and connect the snaps on the outside of the pant legs so that the shoe covers will not fall out.
10. **Gather your swipe card and other materials.**
11. **Proceed to the entry area.**
12. **Swipe your access card.** Before exiting the entry area you must swipe your access card to stop the time count.
13. **Gather any materials and exit the entry area.** Please make sure the door latches properly behind you.
14. **Remove pre-entry garments.** Remove bouffant cap, face cover, shoe cover, gloves and place them in the trash.

7 Using the Fume Hoods

The fume hood allows users to handle materials that generate hazardous vapors by containing and venting these vapors out of the breathing space of the lab. The fume hood is the only place that hazardous chemicals should be handled in open containers. Each hood is clearly labeled as to what chemicals may be used in each hood. The stainless steel fume hoods are for the use of flammable chemicals since the steel will not burn. However; we cannot use acids and bases in the stainless steel hoods because, over time, these chemicals will corrode the metal. For this reason we must use the polypropylene fume hoods for acids and bases. Use of the wrong type of chemical in a given fume hood presents a serious safety hazard for all users in the area since incompatible chemicals may mix and create a dangerous reaction. Please use the proper chemicals in the proper fume hoods at all times. If you are unsure about which hood to use, please ask Nano3 staff.

In order for the fume hoods to effectively exhaust harmful vapors the sash must be positioned at or below the marks on each side of the fume hood and the fume hood exhaust ports (perforated surface near the front and sides of the bench) must be unobstructed by cleanroom wipes, hotplates, waste bottles, etc. With these two conditions met, the fume hood will function properly. If they are not met the fume hood will release vapors into the breathing space which may cause injury.

7.1 Handling Hazardous Chemicals

Users must employ the utmost caution when handling any and all hazardous chemicals. It is the user's responsibility to review the SDS and become familiar with the hazards associated for all chemicals involved in his or her processing. Near each fume hood the necessary protective gear is readily available and it is the user's responsibility to utilize it. Available near each fume hood are the following protective items:

- Aprons
- Face shield
- Heavy nitrile gloves
- Goggles

When using the heavy nitrile gloves, always make sure your regular nitrile gloves are clean before putting the heavy ones on. If you spill a small amount of any chemical on the surface of your heavy nitrile gloves, immediately rinse it with water. Always rinse the heavy nitrile gloves when you are finished using them. If you spill a small amount of any chemical on the surface of your normal nitrile gloves, immediately replace the gloves with a new pair, discarding the dirty pair. This is to avoid spreading chemicals and chemical residue to things like door handles, buttons, etc. Remember, part of the gowning procedure is to put on two pairs of gloves. This allows you to change the external glove within the cleanroom. Never take off both pairs of gloves inside the cleanroom.

ALWAYS label your beakers so that you and other users know which beaker contains what chemical. Proper labeling is essential since most chemicals are colorless and it is easy to confuse them. If your process requires a long period of time you may properly cover your beaker with a watch glass and leave a note with the following information:

1. Your name (legibly!)
2. A phone number where you can be reached
3. Chemical identification
4. Usage start time and date, and when you will be back to finish your process and clean up

All chemicals left out without a note containing this information will be disposed of, no questions asked.

If you empty a bottle of any chemical you should not rinse the empty bottle. Put the cap on the bottle and place the bottle on the floor out of the way. Nano3 staff will pick it up and dispose of it properly. You may get a backup from the chemical storage cabinets in room 1405. **YOU MAY ONLY GET A BACK UP IF YOU EMPTY A BOTTLE. DO NOT GET A NEW BOTTLE OUT OF STORAGE FOR ANY OTHER REASON.**

7.2 Using Hydrofluoric Acid and Piranha

Extra caution must be employed when using **HF (hydrofluoric acid)**, or any mixtures containing HF (e.g. BOE). Users **MUST** wear an apron, heavy nitrile gloves, goggles, and face shield when using any chemical containing HF. In addition, there are polypropylene bins provided on shelves in Wet Processing Room 1443 and in Dry Etch Room 1439. These must be placed on the wet bench/hood surface and all beakers or bottles containing HF must be placed within the secondary containment. HF waste is disposed of in separate waste containers labeled specifically for HF.

Hydrogen fluoride gas is an acute poison that may immediately and permanently damage lungs and the corneas of the eyes. Hydrofluoric acid is a contact-poison with the potential for deep, initially painless burns and ensuing tissue death. By interfering with body calcium metabolism, the concentrated acid may also cause systemic toxicity and eventual cardiac arrest and fatality, after contact with as little as 160 cm² (25 square inches) of skin. HF is particularly dangerous because, unlike other acids which cause immediate pain upon contact with skin, HF contact can cause latent burns that may take hours before they start to cause pain. If no action is taken to remedy the effects of the HF exposure, the fluorine ions will migrate through the flesh eventually reaching the bones causing serious bodily harm. Calcium Gluconate Gel is available at the polypropylene wet benches in Wet Processing Room 1443, Dry Etch Room 1439 and inside the first aid kit at the emergency shower adjacent to the cleanroom entrance. ***Please follow all the required precautions and use utmost care when handling HF!!***

When using **Piranha Etch** (concentrated sulfuric acid and hydrogen peroxide), you must wear an apron, heavy nitrile gloves, goggles, and face shield. The Piranha solution will remain reactive and produce gaseous byproducts and heat for several hours after the mixture is made. For this reason Nano3 uses special waste bottles with vented caps to store the waste. These bottles are also coated with a polymer for extra strength against explosion in case of pressurization. **Please be very careful not to confuse the cap labeled “Piranha” with a normal non-vented cap.** Doing so will result in very high pressure within the waste bottle which could lead to an explosion.

7.3 Using TMAH and TMAH containing developers

Extra caution must also be employed when working with TMAH (tetramethylammonium hydroxide). The material is used in the facility as a 25% concentration solution in water and is also a component (up to 3%) in many common developers (e.g. AZ300MIF, RD6, CD26).

When using the 25% concentration solution, users **MUST** wear an apron, heavy nitrile gloves, goggles, and face shield. In addition, any use of this material **MUST** be carried out inside a secondary containment for TMAH use (stored on shelves in Wet Processing Room 1443 and in Dry Etch Room 1439).

When using TMAH containing developers (e.g. AZ300MIF, RD6, CD26), users **MUST** wear an apron, double layers of standard cleanroom gloves, goggles, and face shield.

TMAH poses a potentially lethal risk upon skin exposure and it has high acute systemic toxicity when ingested. Immediate removal of the material using a safety shower/eyewash is critical when skin is exposed. Skin exposure to >1% TMAH solutions (e.g. TMAH containing developers such as AZ300MIF, RD6, CD26) over a few percent of the body must be treated as a life-threatening event.

7.4 Hazardous Waste Disposal

It is imperative that users only put the correct chemicals in the waste receptacles. Failure to do so will result in a possibly violent reaction between incompatible chemicals. A list of chemicals is posted on the receptacle that indicates which chemicals may be disposed of in each bottle. **For your own safety and the safety of other users, always double check to be sure that the chemical you are disposing of is on the list attached to the receptacle into which you are pouring the chemical.** Always adhere to the following procedure when disposing of your chemical waste:

1. Plan your chemical processing and determine which waste bottles you will need
2. Go to the waste bottle storage cabinet and select the appropriate chemical waste bottle
3. Carry the required waste bottle to the fume hood in its secondary container. If you require multiple waste bottles, transport them ONE AT A TIME.
4. When you are ready to dispose of your chemical waste, place the waste bottle and secondary container in the sink and remove the waste bottle cap. **MAKE SURE YOU ARE USING THE PROPER WASTE BOTTLE!**
5. Dispose of your chemical waste using the funnel (**POUR SLOWLY AND WATCH FOR A POSSIBLE CHEMICAL REACTION!** See note below)
6. Screw the bottle cap back onto the waste bottle
7. Remove the waste bottle and secondary container from the sink, place it near the sink on a cleanroom wipe
8. Rinse the funnel thoroughly with DI water in the sink
9. Carry the waste bottle back to the storage cabinet and place it in its original location
10. Close the cabinet. When you are finished with your process, no waste bottles will remain inside the hood

NOTE: When disposing of waste

- If you see any reaction happening in the waste bottle (fuming, bubbling, foaming, spraying, etc.), step back from the fume hood. If the reaction is so violent that liquid is spraying out of the fume hood leave the area immediately. If it is safe to do so, close the fume hood sash and notify staff immediately.
- If this happens after hours place a sign on the fume hood sash indicating that there is a dangerous waste bottle and include the text “DO NOT USE THIS FUME HOOD”. If the chemical has sprayed outside of the fume hood place a sign near the entrance to that area of the lab indicating the hazard and include the text “DO NOT ENTER”. Then notify staff by email or voicemail. Use a cleanroom wipe to make the sign and use tape to post it in clear view for other users.
- Normally you should not see any reaction when adding waste to the proper waste bottle. After verifying that it is safe, you can proceed to add more waste, but keep a close watch for any reaction that may increase as you add more waste.

Please note:

- You should never remove a waste bottle from its secondary container
- You should always use a funnel when pouring your waste into the bottle. Failing to do so will result in spillage
- NEVER ALLOW THE WASTE CONTAINER TO OVERFLOW!! Stop adding waste and get a new waste bottle when the volume inside the waste bottle gets to the “MAX FILL” line.
- Always check for liquid in the secondary container and notify Nano3 staff if you see any
- Pre-labeled spare waste bottles and spare secondary containers are stored on the bottom shelf of the chemical waste cabinets

Always use a funnel when disposing of your waste. For safety, place the waste bottle in the sink before pouring your waste. To avoid dangerous reactions, pour a small amount of your waste into the waste bottle then step back and observe. If you see any fuming or foaming close the fume hood sash and notify Nano3 staff immediately. If you do not see any reaction, slowly pour the rest of your waste into the bottle but continue to watch very closely as there may be an increased reaction that was not observable with the small amount previously added.

If one of the waste receptacles fills up please use a pre-labeled waste container and secondary container on the bottom shelf of the waste bottle storage cabinet and the spare secondary container. Leave the full waste bottle in the waste bottle cabinet in its original secondary container. Nano3 staff will remove the full waste bottle and affix a new waste tag on the new waste bottle.

7.5 Bringing Non-Stock Chemicals into Nano3

Nano3 supplies a wide variety of chemicals to the users. If you would like to bring any chemical into the Nano3 labs, **YOU MUST RECEIVE APPROVAL FROM NANO3 STAFF BEFORE BRINGING ANY NON-STOCK CHEMICAL INTO THE FACILITY**. We will need to examine the SDS in order to provide proper storage and disposal for all non-stock chemicals. Users that bring in chemicals without notifying Nano3 staff create a safety hazard for all users. Please note that certain chemicals may not be permitted to enter the facility. Requests will be handled on a case by case basis. Please contact Nano3 staff via email to inquire about bringing non-stock chemicals into Nano3.

7.6 Glassware and Keeping the Fume Hoods Neat

The Nano3 facility does not supply glassware. Users must bring in their own glassware and store it in the lab. The fume hoods are not a place for glassware storage. All glass wear left in the fume hoods will be removed each morning unless it is properly labeled with the user’s name, chemical identification, phone number **where you can definitely be reached** and time that the user will return. There are bins located near each fume hood where left out glass wear will be put by Nano3 staff. All glassware in these bins is considered up for grabs.

7.7 Fume Hood Features

7.7.1 Photoresist spinners

The fume hoods in the photolithography areas are equipped with photoresist spinners. The spinner controls are located on the front of the bench below the counter top. These spinners are equipped to handle runoff from liquids spun of the substrate, but it is required to line the spinner bowl with aluminum foil to catch the liquid. This aids the clean-up

process and keeps the drains clear and clean with little maintenance. Please line the spinner bowls with aluminum foil for each use. The Nano3 facility will provide a variety of spinner chucks to fit varying sample sizes. If you need a different size chuck, please ask Nano3 staff. It is ok for users to purchase their own chucks to keep with their personal supplies in the cleanroom. If you would like to purchase your own spinner chuck, please ask Nano3 staff about specifications and part numbers to insure that you purchase the correct chuck. ***Remember that you MUST clean the spinners with solvent soaked wipes after each use!*** For PMGI/LOR resists, use PG remover wipes to clean up the spinner bowl. For other resists, use acetone wipes. ***PDMS spin coating is only allowed in the spinner in PDMS clean space.***

7.7.2 Hot plates

Hot plates are labeled with the room number they are in. Do not move the hot plate to another room. When using the hotplates, **always remember to turn them off when you are done.** Never set a hotplate to higher than the flash point of the material you are heating. **NEVER leave a hotplate unattended while in use!** Heating flammable solvents is especially dangerous and should be avoided if possible. Make sure you are aware of the flash point (temperature at which the material can ignite in air) of the material you are heating and keep the temperature well below that level. You can find the flash point temperature and other information in the SDS. Be sure to familiarize yourself with the material properties and safety issues before handling any chemical. Some hotplates are resting on leveling tables. Feel free to adjust the leveling of the hotplate to insure that your photoresist does not flow to one side during soft bake. When you are finished with the hotplate, allow it to cool and place it back in the storage location, unplugged. Do not stack the hot plates.

7.7.3 Sash/splash guard

Each hood is equipped with a see-through sash that freely slides up and down. The proper functioning of the fume hood depends on the correct positioning of the sash. If the sash is open too far the hood will fail to effectively contain and vent chemical vapors from the breathing area. When you are using the fume hood the sash should be as low as possible. This also provides you with a splash guard as well. It does not, however, replace the necessity of eye protection.

7.7.4 Ultrasonic baths

Some fume hoods have ultrasonic baths. No beaker should ever come in contact with the bottom of the bath, this will prevent the transducers from transmitting the vibration into the water. The water should be one inch from the top of the bath during operation.

7.7.5 Hot baths

Some fume hoods have reservoirs with heaters. These may be filled with DI water and heated using the controller on the front of the bench below the counter top.

8 Using Nano3 Equipment

No user is allowed to operate any piece of Nano3 equipment without supervision until he or she has completed sufficient training AND authorization by Nano3 staff.

All equipment/processes must be carried out within the guidelines provided by Nano3's management. Materials and/or processes not in common use at the facility need to be reviewed by Nano3 management, and the facility reserves the right to disallow processes that might harm equipment or disrupt other processes.

Each instrument in the Nano3 facility has a Nano3 Staff Member in charge of maintenance and repair, and Authorized Users. To become an authorized user, please follow the procedure below. Note that these procedures apply to most pieces of instrumentation inside the facility. However, there are a number of more complex instruments that require more extensive training procedures.

Nano3 equipment have log books. **It is essential that users make a log book entry for every equipment usage.** These log book entries enable Nano3 staff to track equipment malfunction and/or equipment abuse. In addition, they also provide a record of process parameters and results for previous usage which can be valuable to new users.

8.1 Training and Authorization

Equipment training is scheduled from your Facilities Online Manager (FOM) account. Log into your FOM account, make a training request from your user home page (top right field; follow the instructions in the dialog boxes), and sign up for training sessions posted on the equipment reservation calendar. Please sign up for or cancel your training sessions at least 24 hours before the session start time. You may work with already authorized users of the particular piece of equipment to obtain training prior to requesting formal training with a staff member. Note that you may NEVER utilize a piece of equipment by yourself until you have been formally authorized by a Nano3 staff member. An authorized user **MUST BE WITH YOU** at all times while you are learning/practicing. Authorized users are expected to have a good understanding of the primary equipment functionality; they should not only know how to “push buttons”.

Equipment authorization will expire after a certain period of inactivity on that piece of equipment. The expiration time limits are listed on the equipment reservation calendar.

To insure the safety of people in the lab and to minimize equipment down time, it is absolutely necessary that all Nano3 users follow this procedure. Equipment authorization will only be done by Nano3 staff.

8.2 Equipment Scheduling

The Nano3 equipment reservation calendar can be accessed through your FOM account. Please make your reservations as far in advance as possible. If you make a reservation and then will not use the equipment for any reason, please be sure to remove the reservation so that other users can schedule time.

Please be prompt. You must log in to your reserved equipment via FOM within 10 minutes of the start of your reserved time slot. After 10 minutes you will lose your reservation privileges and the equipment is considered available to other authorized users.

The maximum reservation time for general equipment is three hours, and the general maximum reservation time in the FOM system in 21 days is nine hours, but the exact value varies depending on the type of equipment and is listed on the equipment reservation calendar. Please reserve your time slots according to your needs. Most processing can be finished in less than the max allowed reservation time. In the rare occasion that you need a piece of equipment for more than the max allowed time, please contact Nano3 staff to reserve the extra time.

9 General Behavior Inside the Cleanroom

We strive to keep the user rates for our facility as low as possible. Please help us by being committed to **preservation of resources**, and to keeping to a minimum the necessity for facility staff to spend time on cleaning up after users, repairing things, etc. **Never, however, hesitate to request staff time to help you with things that you are unsure about.**

The following bullets are meant as a brief reminder of appropriate general behavior while inside the cleanroom. The list is by no means comprehensive, but contains items we believe are of particular importance.

- **Eating, drinking and gum chewing are prohibited** while inside the lab.
- Avoid sudden and fast movements (i.e., **NO RUNNING**). Approach corners and turns slowly, to avoid collisions with others. Remember that other users may be handling sensitive materials.
- **Never open your suit** while inside the cleanroom.
- **Never touch your skin** with your gloves. If you do, immediately put on a new pair of gloves.
- **Do not walk around** unnecessarily and be cautious when approaching another work area. Personnel movement is to be restricted to minimize disturbing settled particulate matter.
- **If you turn it ON, remember to turn it OFF.**
- If you make a mess, **clean it up**. Return everything to its original condition, or ideally, leave conditions a little better than you found them. This includes your entire set-up for experiments or projects.
- **Excess storage** in the cleanroom is not permitted.
- Be aware of **supplies**. If quantities of stock appear to be low, report it to the Nano3 staff.
- Use special care to keep **fume-hoods** in ultra-clean conditions.
- **Hot plates** (one of the main causes of cleanroom fires):
 1. Never leave on when unattended
 2. Make **sure** that the temperature is: 20°C BELOW flash point of contents and 20°C BELOW melting point of beaker materials.
 3. Ask for help if you are unsure of any part of the process.
- Any work or tools **dropped on the floor** shall be considered contaminated, and must be cleaned.
- **ANYTHING left unattended** MUST be labeled with your NAME, PHONE NUMBER WHERE YOU REALLY CAN BE REACHED (**not** the number of your department's front office), WHAT IT IS THAT IS SITTING THERE, and the DATES AND TIME of when you left it AND when you will return to get it. We will **THROW OUT** anything not appropriately labeled....no questions asked.
- **Disposal of solvent and/or photoresist-soaked materials:**

We have several containers in the cleanroom built specifically for the disposal of solvent soaked materials, and require that they be used for the disposal of all such materials. The cleanroom is constantly recirculated, so all released vapors will find their way back into the space eventually for everyone to breathe. The following materials should be put in the solvent cans:

 - Any alcohols (ethanol, methanol, isopropanol, etc.)
 - Acetone
 - TCE (Trichloroethylene)
 - Chlorobenzene (especially hazardous)
 - Photoresist and related products

- **Disposal of acid-soaked materials:**

We have several containers in the cleanroom built specifically for the disposal of acid-soaked materials, and require that they be used for the disposal of all such materials. The following materials should be put in the acid cans:

Acetic acid

Buffered Oxide Etch (HF)

Chrome Etch

E-6 Metal Etch

Hydrochloric acid

Hydrofluoric acid

Nitric acid

Phosphoric acid

Hydrobromic acid

Sulfuric acid

10 Visitor Policy

No user is allowed to bring any person into the cleanroom that has not completed the Nano3 Cleanroom Orientation unless permission to do so is granted by Nano3 staff.

A cleanroom qualified faculty/staff member or staff authorized user must escort the visitor AT ALL TIMES. The escort is responsible for ensuring that the visitor adheres to gowning requirements and follows the facility policies and procedures.

Whenever possible, visitors should remain outside the cleanroom (the entire facility may be viewed through the windows in the corridor).

11 Explanation of Charges

The Nano3 facility is a campus recharge facility open to all UCSD affiliated students and researchers as well as users from companies outside the university. We charge by the minute for time spent in the lab plus surcharges for certain special pieces of equipment.

11.1 Recharge Index Number (Internal UCSD users only)

Nano3 uses an automated billing system which will automatically bill the recharge index number posted in your Nano3 account. The billing system will check your Nano3 user account on the 25th of each month to find out which index number should be billed and the usage for that entire month will be billed to the number listed on the 25th. It is not possible to split your charges into time frames less than one month.

To post an index number in your Nano3 user account:

1. Check with your faculty advisor to find out which index number you should use
2. Log in to your user accounts (Nano3 and FOM) to maintain your index number.
3. Type the index number and select start and end dates. The dates you choose will indicate to our billing system that the index number is valid for billing during the specified time frame. If the end date passes your account will be flagged as missing an index number to bill and your ability to reserve time on Nano3 equipment will be on hold until the end date is extended.
4. Edit the index number and dates anytime by clicking on the index number

Please note that it is the user's responsibility to post a valid index number.

11.2 Nano3 Services

The Nano3 facility is designed to promote research in a wide range of fields ranging from physical to biomedical sciences. Even if you have little or no experience with the types of equipment found in the Nano3 facility, we will guide you through the process of determining which equipment is necessary for your process and provide detailed training for that equipment. Throughout your usage of the Nano3 facility Nano3 staff will be there to help. We will be available to discuss your process needs and give advice to help you achieve your research goals. We will do what we can to make sure that each Nano3 user understands the operation of the equipment to a degree which will insure the safety of the users, the well-being of the equipment and that the user can effectively use the tool to achieve, and perhaps go beyond, the desired results. Nano3 staff will do its best to keep equipment on line and minimize downtime. We are aware that many users are operating under strict deadlines and we will do our best to help you meet them.

11.3 Materials Provided

The facility is equipped with ultra-high purity, electronics grade DI water and ultra-high purity nitrogen gas. In addition, the chemicals and materials listed below are typically supplied. **Please note that the availability of the chemicals and materials on the following lists is subject to change depending on user demand.**

Sputter targets:

Ag (99.99%)

Al (99.999%)

Al (1% Cu) (99.999%)
Al (0.5% Cu) (99.999%)
AlN (99.8%)
Al₂O₃ (99.99%)
Au (99.99%)*
Cr (99.95%)
Cu (99.99%)
Ge (99.999%)
IGZO (99.99%)
ITO (99.99%)
Nb (99.95%)
Ni:Cr (80:20wt%) (99.9%)
Ni:V (93:7wt%) (99.95%)
Mo (99.95%)
Pd (99.5%)
Pt (99.99%)*
Ru (99.95%)
Si undoped (99.999%)
SiN_x (99.9%)
SiO₂ (99.995%)
Sn (99.999%)
SnO₂ (99.999%)
Ta (99.95%)
Ta₂O₅ (99.99%)
Ti (99.995%)
TiN (99.5%)
TiO₂ (99.99%)
W (99.999%)
W:Ti (90:10wt%) (99.995%)
ZnO (99.99%)
ZnO:Al₂O₃ (98:2wt%) (99.999%)
Zr (Grade 702)
ZrO₂
ZrO₂:Y₂O₃ (92:8wt%) (99.9%)

* Provided at cost (surcharge applies)

Materials for e-beam evaporation:

Ag (99.99%)
Al (99.99%)
Al₂O₃ (99.99%)
Au (99.99%)*
Co (99.95%)
Cr (99.998%)
Cu (99.99%)
Fe (99.95%)
Ge (99.999%)
Ni (99.995%)
Ni:Cr 80:20wt% (99.98%)
Ni:Fe 81:19wt% (99.95%)
Pd (99.95%)

Pt (99.99%)*
 Si undoped (99.999%)
 SiO₂ (99.999%)
 Ti (99.995%)
 TiO₂ (99.99%)
 V (99.7%)

* Provided at cost (surcharge applies)

Chemicals listed by location inside the cleanroom:

Room 1405 Acids Cabinet
Acetic Acid
Buffered Oxide Etch (BOE)
Chrome Etch 1020
Hydrobromic Acid
Hydrochloric Acid
Hydrofluoric Acid
Nanostrip
Nickel Etch TFB
Nitric Acid
Phosphoric Acid
Sulfuric Acid
Room 1405 Corrosives Cabinet
Ammonium Hydroxide
AZ MIF 300
AZ 400K 1:4
Futurrex RD6
Potassium Hydroxide Pellets
Room 1413 Flammables Cabinet
Acetone
AZ NMP Rinse
Chlorobenzene
EBR PG
Ethanol
HFE (Novec) 7100
Isopropyl Alcohol
MCC 80/20 Primer
Methanol
PG Remover
RR41 Remover
SU8 Developer
Room 1413/1417 Developers
AZ 400K 1:4
AZ MIF 300
Futurrex RD6

Room 1413/1417 Photoresists
AZ 12XT-20PL-05
AZ 12XT-20PL-10
AZ1505
AZ1512
AZ1529
AZ1518MIF
Futurrex NR5 8000
Futurrex NR9 1500PY
Futurrex NR9 3000PY
Futurrex NR9 6000PY
Futurrex NR71 1500PY
Futurrex PR1 1000A
PMGI SF13
PMGI SF3
SU8 2002
SU8 2005
SU8 2010
SU8 2015
SU8 2025
SU8 2050
SU8 2100
SU8 Thinner
Room 1431 Fume Hood Cabinet
Acetic Acid
Ammonium Hydroxide
Buffered Oxide Etch (BOE)
Chrome Etch 1020
Hydrochloric Acid
Hydrofluoric Acid
Nanostrip
Nickel Etch TFB
Nitric Acid
Phosphoric Acid
Potassium Hydroxide Pellets
Sulfuric Acid
Room 1435 Flammables Cabinet
Acetone
Isopropyl
Methanol
Room 1443 Flammables Cabinet
Acetone
Ammonium Sulfide
AZ NMP Stripper

Ethanol
Isopropyl Alcohol
Methanol
Methyl Isobutyl Ketone (MIBK)
MIBK:IPA
PG Remover
RR41 Remover
Toluene
Trichloroethylene
Room 1443 Fume hood cabinets
Acetic Acid
Ammonium Hydroxide
Buffered Oxide Etch (BOE)
Chrome Etch 1020
Hydrobromic Acid
Hydrochloric Acid
Hydrofluoric Acid
Nickel Etch TFB
Nitric Acid
Phosphoric Acid
Potassium Hydroxide Pellets
Sulfuric Acid
Nanostrip
Room 1443 Refrigerator
Hydrogen Peroxide

12 Enforcement

We embrace the idea of a user facility and recognize that the success of the facility depends on making it a friendly and accessible environment for the users. Although we hope to never have to penalize users for not following the policies outlined above, the user must recognize that the successful operation of the facility depends on strict adherence to these policies. Adherence to these policies is essential for maintaining a clean environment; it is in everyone's best interest to follow them. Unfortunately we must prepare for breaches of cleanroom policy. We reserve the right to invoke the following penalties for the listed transgressions:

- Failure to create an entry in the logbook for a particular piece of equipment:
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the cleanroom for 3 weeks.
- Failure to properly label chemicals:
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the cleanroom for 3 weeks.
- Not wearing proper safety equipment or not following proper gowning/de-gowning procedure (Safety glasses, face shield while working with acids/bases at hoods, cleanroom attire):
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the cleanroom for 3 weeks.
- Not cleaning up after use of the facility.
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the cleanroom for 3 weeks.

Suspension from the cleanroom for 3 weeks without prior warning:

- Use of any cleanroom equipment without being an authorized user for the equipment.
- Granting access to an unauthorized user to use equipment. No user can grant access to an unauthorized user to use equipment without his/her **constant** supervision. Authorized users are allowed to train other users on the equipment.
- Using the facility without swiping your access card.
- Using the facility with someone else's access card without being an authorized user and/or not under supervision.
- Using equipment reserved for another user. A user may not use any equipment reserved by another user for the first 5 minutes of the first hour the equipment is reserved. After that time, the equipment may be used until the next reservation. If a user's run exceeds a scheduled time, the next user who has reserved the equipment should try to reach a compromise with the previous user. The machine does, however, belong to the user who reserved it, and he/she may ask the previous user to terminate their run.
- Using equipment when it is undergoing maintenance and is marked not to be used or "Machine Down". Under no circumstances is a user allowed to perform any maintenance on any equipment. Any abnormalities while using the equipment must promptly be reported to Nano3 staff.
- Not leaving the cleanroom during an emergency. During an emergency, the emergency lights and/or siren will go off. The lights are located in visible places throughout the

cleanroom. In such a situation, every user must immediately leave the cleanroom. Users should not take time to de-gown.

- Installing software on any computers or modifying equipment settings on equipment dedicated computers.
- Removing supplies and/or equipment from the facility.