



GUIDELINES

Contents:

Introduction.....	2
Management.....	2
Contact Information.....	2
Gaining Admittance.....	3
Materials.....	3
Visitors.....	4
Card Keys.....	4
Overview.....	4
Change Room.....	5
Cleanroom Layout.....	6
Entry Logs.....	7
Facility Fees.....	7
Equipment Training.....	9
Equipment Logbooks.....	9
Wet Benches.....	9
Acid Wet Benches.....	10
Solvent Wet Benches.....	11
Developer Wet Benches.....	11
Communal Glassware.....	11
Wet Chemistry Bay Storage Shelves.....	11
Shower/Eye Wash.....	12
Emergency Power Disconnects.....	12
Alarms.....	12
Fire Extinguishers.....	12
First Aid Station.....	13
Material Safety Data Sheets (MSDS).....	13
Chemicals and Gases.....	13
Particularly Hazardous Substances.....	13
Intercom.....	14
Central Vacuum Cleaner.....	14
Model Shop.....	14
Cleanroom Facilities.....	15
Addendum: Extended Hours Access.....	16
Notes:.....	18

Introduction

This guide is an attempt to address the most commonly asked questions about the Nanofabrication Facility. All lab users and their advisors should read it and be familiar with it. Hopefully, it will present a clear picture of how the facility operates and will eliminate confusion about rules that may at times seem to get in the way of research. Any suggestions concerning the operation of the facility will be appreciated. It is our intention to provide easy access to the Nanofab and efficient use of the equipment while at the same time ensuring the safety of lab users and the proper maintenance of a state-of-the-art processing facility. The behavior we promote is "always leave the cleanroom cleaner than when you found it." Explicitly - no activity may contaminate or cause damage to the laboratory or any equipment.

Management

Gianluca Piazza is the Faculty Director of the Nanofabrication Facility. He is in charge of strategic planning and oversight of the facility, including budgets, outreach, fundraising, etc. Matt Moneck is the Executive Manager of the Nanofabrication Facility. He supervises all of the day-to-day operations of the facilities comprising the Cleanroom on the E and F levels of Hamerschlag Hall and three Thin Film Processing Laboratories in Roberts Engineering Hall. The Nanofab staff works to maintain the operation of the laboratory and the equipment inside. While working in the Nanofab you will follow these Guidelines. The Nanofab staff will monitor your activities and expects your cooperation.

Contact Information

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Gaining Admittance

Anyone wishing to use the Nanofab should meet with the Nanofab staff to discuss their project. Graduate students who have been instructed by their advisors to use the Nanofab must still gain admittance to the facility from the Nanofab Executive Manager and follow the Nanofabrication Facility Guidelines.

The facility may be accessed after meeting with the Nanofab Executive Manager under direct supervision of a qualified user. Independent access is attained after meeting with the staff to discuss your process requirements and to complete the following:

- Process Inventory Form
- Chemicals and Gases Form
- EH&S class: Laboratory Safety & Hazardous Waste
- Nanofabrication Facility tour by a member of the staff

This facility is operated and maintained primarily for current students and employees of Carnegie Mellon University. External researchers may request access to the facility, but an External User Agreement must be signed and approved by the CMU Office of General Council and the Office of Sponsored Programs before access can be granted. Contact Matt Moneck (mmoneck@andrew.cmu.edu) for details.

Materials

All materials and equipment must be inspected and approved before entering the cleanroom. In general, no particle generating material will be allowed in the cleanroom. This includes:

- Cardboard, newspaper, and paperback novels
- Computer sleeves, bags, or backpacks
- Jackets/hats
- Food/drink
- Pencils and Erasers
- Dry erase markers
- Powders
- Wood
- Adhesives (tape, tack, glue, etc)
- Cosmetics, make-up, hair spray and gel, colognes, perfume, and fragranced lotions (if one can smell it, it's releasing particulate)
- Scotch tape (may cause contamination problems)
- Any other materials that could shed particles
- Any other materials that could leave a residue on surfaces

Visitors

Any qualified user who wishes to host a visitor inside the facility must obtain approval from the Nanofab staff at least one day in advance of the visit. Visitor hours are from 8:30 am to 5:00 pm. The host must accompany the visitor inside the facility at all times, and will be responsible for the actions of the visitor. In addition, the visitor must sign a waiver form, releasing the Nanofab and CMU of any liability. Once in the lab, the visitor is not qualified to use any equipment in the Nanofab, regardless of prior experience, unless otherwise approved by the Nanofab Staff in writing. **No one under the age of 18 is allowed in the Nanofab without the approval of a legal guardian.**

Card Keys

The cleanroom door is open from 8:30 am to 5:30 pm Monday - Friday. The tunnel door to Roberts Hall and the hall gate are open from 7:30 am to 6:00 pm. The Roberts Hall laboratories are locked all day. Access to the cleanroom at night and on weekends, and to the Roberts Hall labs, may be obtained after an initial training period and on a case-by-case basis with approval of the Nanofab staff (see page 19 Addendum). Once approved, present your Carnegie Mellon ID Card to the Nanofab staff. Your card will be entered into the card key system and activated for the period and areas approved. When this time has elapsed, your access will be removed. **Card keys may not be loaned to anyone.**

Overview

The cleanroom was constructed in 1983 for the ECE Department with university funds in support of what was then called the Magnetics Technology Center, now the Data Storage Systems Center. The laboratory is divided into two zones. Zone One is 2,600 square foot of Class 100 clean space. The class 100 specification has a maximum allowable particle count of one hundred 0.5 micron diameter and larger particles per cubic foot of air. This class 100 area consists of a change room and a main corridor with four 12 foot x 22 foot process bays referred to as Bay 1, Bay 2, Bay 3 and Bay 4.

Zone Two is 1,200 square foot of Class 10 clean space. The class 10 specification has a maximum allowable particle count of ten 0.3 micron diameter and larger particles per cubic foot of air. Zone Two is lighted with non-U.V. yellow light for photolithography work and is divided into four areas referred to as the FIB room, the Wet Chemistry Bay, the Photolithography Bay, and the SEM Room. The class 10 clean space is at positive pressure with respect to the class 100 clean space, which is at positive pressure with respect to the outside hallways.

There is a service chase between each process bay which is used for house facilities hookup, gas bottles, vacuum pumps, furnaces, and remote power supplies. Each service chase is accessible from the exterior of the cleanroom through a door. These doors should be kept closed when working in the chase in order to maintain the positive pressure of the cleanroom.

External to the cleanroom there is a lounge, two offices, a shop, a liquid nitrogen station and storage cabinets for spare parts. The E-level consists of nine large air handlers on a

deck with the associated piping, a loading dock, and the mechanical room that contains the equipment for the house facilities.

Change Room & Gowning Procedure

The change room is divided in half by a bench. This bench is sealed to the floor and acts as a dirt barrier. One side of the floor is for street shoes only and the other side is for cleanroom boots only. To gown up, users must start by putting on a bouffant and pre-gown gloves supplied at the gown room entrance. Next, the user will sit down on the bench, put on one boot, step across, put on the next boot, and step across with the other foot. Next put on the hood and face veil. Finish by putting on the coverall, nitrile gloves, and safety glasses (gloves and safety glasses must worn in the lab at all times). Regular users of the cleanroom are assigned a hanger and a nametag for their garments after averaging 7 entries for 3 straight months. All others users use visitor garments. Wear garments for an equivalent of one week's work maximum, or until soiled. Then pull out a new garment and deposit the old one in the soiled garment bin.

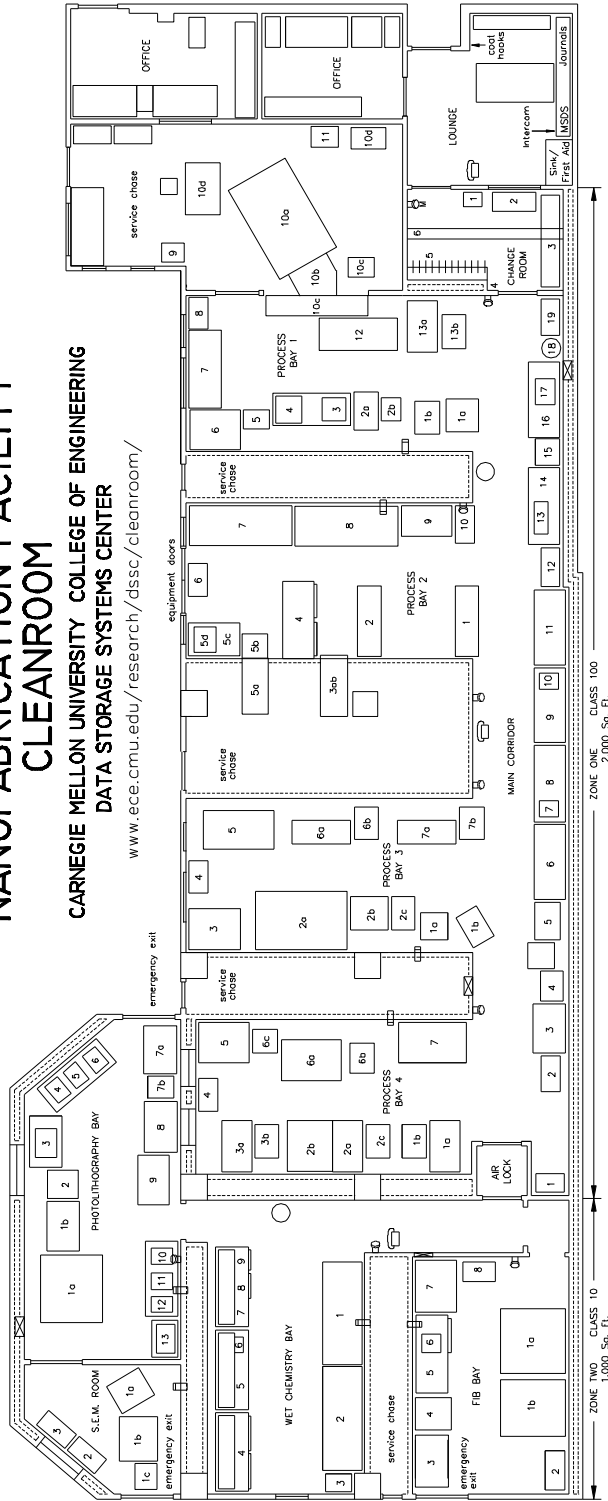
When entering or leaving the change room, only one door should be open at a time in order to maintain the positive pressure of the cleanroom and prevent contamination of the clean space by office area particulates. If both doors are open at the same time an alarm will sound. There is a similar air lock between the Class 10 and Class 100 areas that should be accessed in the same way. There are windows in these doors for this purpose. Be observant before entering these air locks. Typical particle counts for filtered office air range between 50,000 - 200,000 particles per cubic foot.

Cleanroom Layout

NANOFABRICATION FACILITY CLEANROOM

CARNEGIE MELLON UNIVERSITY COLLEGE OF ENGINEERING
DATA STORAGE SYSTEMS CENTER

WWW.ECE.CMU.EDU/RESEARCH/DSSC/CLEANROOM/



- HOUSE FACILITIES**
- Filtered Dry Air
 - 18 Meg Ohm Deionized Water
 - 20" Hg Process Vacuum
 - Central Vacuum Cleaner
 - Temperature Control
 - Humidity Control
 - Corrosive Exhaust
 - Solvent Exhaust
 - 10 Kohm Filtered Chilled Water
 - Bulk Liquid Nitrogen Tank
- Symbols**
- Window
 - Telephone
 - Shower and Eye Wash
 - Master Emergency Power Disconnect Switch
 - Emergency Power Disconnect Switch
 - Vacuum Cleaner Port
 - Fire Extinguisher
- MAIN CORRIDOR**
- 1. Cleaning Supplies
 - 2. Hose Storage
 - 3. Particle Counter
 - 4. Cabinet
 - 5. Tool Chest
 - 6. Cabinet
 - 7. Terminal
 - 8. Table
 - 9. Probe Station
 - 10. Rotating Furnace
 - 11. Cabinet
 - 12. Table
 - 13. Disc Luber
 - 14. Rotating Field
 - 15. Annealing Furnace
 - 16. Cabinet
 - 17. Wet Vac
 - 18. Wet Vac
 - 19. Cabinet
- PROCESS BAY 1**
- 1. Ultek E-Beam Chamber
 - 2. Control Rack
 - 3. Wet Bench
 - 4. Chamber
 - 5. Chamber
 - 6. Chamber
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 - 9. Chamber
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- PROCESS BAY 2**
- 1. Table
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- PROCESS BAY 3**
- 1. Leybold Z-400 Chamber
 - 2. Control Rack
 - 3. Wet Bench
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- PROCESS BAY 4**
- 1. GMR Target
 - 2. Control Rack
 - 3. Wet Bench
 - 4. Chamber
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- WET CHEMISTRY BAY**
- 1. Wet Bench
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- FIB BAY**
- 1. Micron 2500 FIB
 - 2. Column
 - 3. Console
 - 4. Table
 - 5. Table
 - 6. Table
 - 7. Table
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- PHOTOLITHOGRAPHY BAY**
- 1. GCA 4800 Water Stepper
 - 2. Control Rack
 - 3. Photorealist
 - 4. Refrigeration
 - 5. Olympus Inspection
 - 6. Olympus Automatic
 - 7. Camera
 - 8. Zomp Microscope
 - 9. Karl Suss MJB3
 - 10. Contact Aligner
 - 11. UV Controller
 - 12. Cabit Contact Aligner
 - 13. Console
 - 14. Contact Aligner
 - 15. Soltec Spinner
 - 16. Blue M Oven-90°C
 - 17. Blue M Oven-100°C
 - 18. Vacuum Oven Below
 - 19. Storage Cabinet Below
 - 20. Storage Cabinet Below
 - 21. Wet Bench
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- S.E.M. ROOM**
- 1. Hitachi S-500 SEM
 - 2. Console
 - 3. Power Supply
 - 4. Power Supply
 - 5. Power Supply
 - 6. Anatech Cold Cooler

Entry Logs

Each person entering the cleanroom, including any visitors, must sign the log located in the change room once per day. This log assists us in assigning appropriate fees for cleanroom use. A valid account number must be included with each sign up. Daily sign-up is mandatory for anyone entering the cleanroom. **There are no exceptions.** Daily sign-up is also mandatory for each person entering the Roberts Hall labs. Only one entry will be charged per day per person, regardless of how many lab entry logs are signed.

Facility Fees

Each person entering the cleanroom is charged an entry fee. Solvents, developer, gloves, and wipes are stocked in the cleanroom for the convenience of the users. The entry fee covers only the supplies stocked in the cleanroom and these supplies are for cleanroom use only.

There is a stock of additional supplies located in the change room. These are common supplies needed for processing and are stocked and sold for the convenience of cleanroom personnel. Each item must be signed out properly using the supply sign out sheet located in the change room. There is a binder with a complete listing of stocked supplies and prices located on the shelf.

The entry fee is used to cover the cost of the following items:

- DI Water: Maintenance of the entire system
 - Salt for Softener
 - Carbon Filter
 - 1 micron Filters
 - 0.2 micron Filters
 - Ion Exchange Cartridges
 - U.V. Lamps
 - Pump Repair
 - Reverse Osmosis Repair
 - Plumbing Repair and Modification
- Cleanroom Garment Rental, Cleaning, and Shipping
- Nitrile Gloves
- Chemical Gloves
- Acetone
- 2-Propanol
- Wipers
- AZ Developer
- AZ 400K Developer
- MIBK Developer
- SU-8 Developer
- Shipley Microposit Remover 1165
- Nitrogen Gas for the Nitrogen Guns and Vacuum Systems
- Liquid Nitrogen Dewar Maintenance
- Tacky Mats
- Cotton Tipped Applicators

Facility Fees (continued)

Microclean Soap
Hydrofluoric Acid Antidote Gel
Wet Bench Maintenance: Sinks, Nitrogen Guns, DI Guns, Timers,
Ultrasonics, and Plumbing
Particle Counter Calibration (yearly) and Maintenance
Acid/Solvent Spill Pillows
First Aid Cabinet Supplies
Air Flow and Balancing Equipment and Supplies
Humidity and Temperature Measuring Equipment and Repairs
Janitorial Supplies
Glassware Washer Maintenance and Supplies
Communal Glassware and Wafer Holders
Exterior Doormats
Vacuum Cleaner Accessories and Maintenance
Acid Drain System Maintenance
Acid/Solvent Cabinet Maintenance
Shelves
Carts
Office Supplies
Telephone Charges
Terminal Maintenance
Signs
Miscellaneous Facility Maintenance and Supplies
Technical Handbooks and Literature

The Entry Fee also covers use of the following equipment:

Blue M Ovens
Despatch Oven
Olympus Wide Field Zoom Microscope
Olympus BH Inspection Microscope
Semitool 870 Spin Rinser Dryer (3" and 4" Wafers)
Semitool 880 Spin Rinser Dryer (4" and 5" Masks)
CEE 100B Developer Spinner
CEE 100CB Spinner/Hotplate
Solitec Photoresist Spinner
CEE Hot Plate
Thermolyne Hot Plate
PMC Hot Plate
Gel-Pak Vacuum Release Stations
4-Point Prober
Micromanipulator Probe Stations

A fee is charged for using the majority of the equipment in the cleanroom. The charges are used to maintain the existing features and specifications of the equipment. All upgrades and modifications are charged to individual or group research accounts. An up to date list of fees can be found at <http://nanofab.ece.cmu.edu/access/rates.pdf>.

Equipment Training

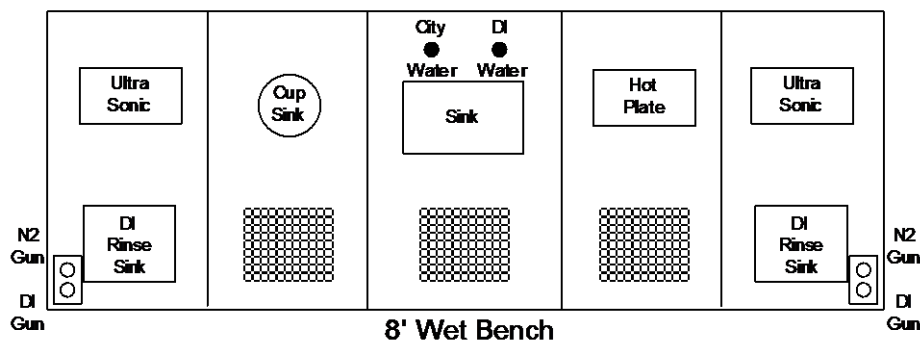
Training is required before using the majority of the equipment in the Nanofab. There is a **Qualified Users List** for each machine. To obtain training, arrangements are made with someone on the list to observe and practice operating the machine under direct supervision. After an initial training period of five times, and when the qualified operator decides the individual is prepared, arrangements are made with a member of the Nanofab staff for final check out. No one is allowed to use the equipment without **direct supervision** until after final check out. Direct supervision means that a qualified operator must be standing at the machine at all times.

The training required for some systems, such as a sputtering system, is more extensive and typically more time consuming. In order to make the training process efficient for you and those doing the training, we encourage you to first observe and practice using the machine with a qualified operator. Then sign up for the machine and gain experience and training using your materials with direct supervision by a qualified operator. Then you are ready for check out on the sputtering system operation.

Equipment Logbooks

The logbook for each machine must be filled out completely for each use. These records are maintained for reference regarding process parameters, history of materials used, maintenance history, communication between users, a record for intellectual property, and for assessing fees.

Wet Benches



The wet benches are designed for multi-user multi-task convenience. The Nanofab is a multi-user research environment. In this facility some basic laboratory habits are required to accommodate the many different research projects. First and foremost, always leave the wet bench cleaner than when you found it. No beakers, chemicals, wipes, tweezers, etc. may be left on the wet bench. If you are leaving the immediate area for a short period of time e.g., to use the restroom, go to your office, or take a short lunch break, chemicals in labeled beakers may be left on the bench. No chemicals may be left on the bench overnight without Nanofab staff approval. Any unattended unlabeled chemicals left on a wet bench will be removed. The Nanofab staff will inspect the benches daily and after attempting to find the owner will remove any unattended and unlabeled chemicals or

Wet Benches (continued)

beakers. Any chemical drips or spills to the deck of the wet bench should be rinsed off with the DI spray gun. The N₂ guns and DI guns should always be placed into their holders when finished. No chemical solutions may be heated without consultation and prior approval of Nanofab staff.

Safety glasses and nitrile gloves are sufficient when work is limited to using solvent wash bottles and DI water on the solvent wet bench. When working at the developer bench, face shields must be worn at all times in addition to safety glasses and nitrile gloves. Chemical gloves, face shields, and chemical aprons must be used at all other times e.g., pouring from one gallon containers, using beakers, heating solvents or acids. Small acid or solvent drips to the floor should be wiped up using chemical gloves and micro wipes. The wipes should be deposited into the plastic waste containers and then reported. Larger spills should be reported immediately for clean up by the Nanofab staff. Do not attempt to clean large spills by yourself.

Acid Wet Bench (Bay 2)

All users of the acid wet bench must receive training by Nanofab staff before working at the bench. Separate training is required for Hydrofluoric (HF) Acid. See the HF Particularly Hazardous Substance Protocol for complete details about HF handling and disposal. Concentrated acids (e.g. sulfuric acid) may be poured down the drain, with the exception of HF and specific metal etchants. These exceptions must be poured into empty plastic one gallon bottles marked with the appropriate labels found on the acid storage cabinet door. To dump acids down the drain use the center sink. First turn on the water and then slowly pour the acid into the sink. Let the water run for a minute to thoroughly flush the acid down the drain. If you are uncertain about any disposal procedures, contact Nanofab staff for assistance. Never pour acids into unmarked containers or a container intended for a different acid. **Acids may not be used under any circumstances after 5:00 pm on weekdays and at all on weekends.**

The Nanofab stocks common acids that can be purchased by users in small quantities. Contact the Nanofab staff for a list of acids available for purchase. Acids stocked by the Nanofab must be dispensed by Nanofab staff. It is the responsibility of the people who need to use acids to work together to share the available space in the acid cabinet. This is best accomplished by sharing acid purchases to eliminate multiple bottles of the same acid. All bottles should be labeled with the type of acid, the owners name, and the date. In this way we minimize the quantity of acids that are stored in the cleanroom and the associated hazards. Occasionally, some acid will drip down the side of the bottle when acid is poured from containers into a beaker on the wet bench. This dripping should be washed off before returning the bottle to the acid cabinet. The acid cabinets are inspected on a regular basis to remove any old, unwanted, or non-labeled bottles. Nitric acid storage is kept to a minimum due to incompatibility with other acids. Small amounts of nitric acid may be kept on a plastic drip tray beneath the acid wet bench.

Solvent Wet Benches (Bay 2 & Wet Chemistry Bay)

Acetone, 2-Propanol, and solvent-based developer one-gallon bottles are stocked in the solvent cabinets. Waste solvent bottles are stored in the solvent cabinets and are removed monthly. Waste chlorobenzene, photoresist, and HMDS are also kept in empty bottles in the solvent cabinet in the Wet Chemistry Bay and are marked with a waste label. No solvents may be dumped down the drain. Empty one-gallon plastic acetone and 2-propanol bottles are marked with the waste labels provided on the door of the solvent cabinet. Waste acetone, 2-propanol, MIBK, and SU-8 Developer are poured from beakers into these labeled plastic one-gallon containers. 500mL wash bottles of acetone and 2-propanol are provided at each solvent wet bench. Small amounts of acetone and 2-propanol, that will quickly evaporate, may be washed over a substrate on the deck. Larger amounts from the wash bottles should be washed into the solvent cup sink. This cup sink drains into a stainless steel one-gallon container beneath the wet bench and is for wash bottle use only. Photoresist should be rinsed with an acetone wash bottle over the cup sink. Soaking and extended rinsing should be done in a large beaker and poured into a plastic waste bottle.

Developer Wet Benches (Wet Chemistry Bay)

Standard photoresist developers (e.g. AZ400K, AZ Developer) in one-gallon bottles are stocked in the developer cabinets. Waste developer bottles are also stored in the developer cabinets and are removed monthly. Waste bottles should be properly marked with a waste label. Pre-diluted developer is stocked under the developer wet bench for use in the automated photoresist developer station. Pre-diluted developer should not be dispensed into beakers for puddle development. For this purpose, standard developers should be poured from one-gallon bottles into appropriate beakers for dilution with DI water at the wet bench. Used AZ400K and AZ Developer may be diluted with water and dumped down the drain for disposal. Tetramethyl Ammonium Hydroxide (TMAH) based developers are highly toxic and must be disposed of in a properly labeled one-gallon plastic waste bottle and stored in the developer cabinet. Solvent based developers, such as SU-8 Developer (PGMEA) and MIBK, must be stored in solvent cabinets, used on the Wet Chemistry Bay solvent bench, and collected as solvent waste. They are not permitted on the developer bench or in the developer cabinet. In addition, MIBK is a PHS. See the MIBK Particularly Hazardous Substance Protocol for details.

Communal Glassware

There is a selection of glassware and wafer holders available for general use located in Bay 2 and the Wet Chemistry Bay. Plastic bins are labeled 'dirty glassware' and 'clean glassware.' The Nanofab staff cleans the dirty glassware and wafer holders in the glassware washer on a regular basis. Stained glassware is cleaned in a stripping solution or is replaced. Return all communal glassware and wafer holders to the dirty bin immediately after each use.

Wet Chemistry Bay Storage Shelves

There is a set of shelves located in the Wet Chemistry Bay used for storing individual processing supplies. The amount of storage space for this purpose is kept to a minimum to

Wet Chemistry Bay Storage Shelves (continued)

avoid contamination problems. Processing supplies used in the Wet Chemistry Bay and the Photolithography Bay may be kept in an assigned personal tray with your name on it. These are private supplies and no one should touch them without the permission of the individual owner. The trays are available in the supply area located in the change room. Shelves and trays are assigned on a first come first serve basis and according to the frequency of cleanroom use. Those individuals using the Wet Chemistry and Photolithography Bays on a daily basis will have priority. All others are encouraged to store their processing supplies in a plastic toolbox in their office in a clean drawer and bring them into the cleanroom when needed.

Shower/Eye Wash

If you spill a chemical on your body or in your eyes, flush the spill immediately with large quantities of water and seek assistance. This can be accomplished by using the DI spray gun if the spill is on a hand, the shower if on the body, or the eyewash if in the eyes. Call **Campus Police (412-268-2323)** for transportation to the hospital. A bottle of eye wash solution can be found in the first aid cabinet in the lounge for use during transportation. Hydrofluoric acid burns should first be flushed with water and then HF antidote gel should be massaged into the affected area on the way to the hospital. HF antidote gel is located on each acid wet bench and additional tubes may be found on the supply shelves in the change room. All users must be familiar with the proper use and treatment of hydrofluoric acid as described in the HF Particularly Hazardous Substance Protocol.

Emergency Power Disconnects

There is an emergency power disconnect switch for each bay in the cleanroom and a master switch for the entire facility. The switch is a red button located on the wall near the entrance to each bay. The master switch is located on the wall in the change room. The switch will disconnect the power to all equipment in the bay and should only be used in an emergency when an individual machine cannot be shut off. Most machines have their own disconnect switch.

Alarms

There are three alarms in the cleanroom. One is a fire alarm, one is an exhaust failure alarm, and the third is a hazardous gas detection alarm. When an alarm is sounded, stop what you are doing and immediately exit the cleanroom.

Fire Extinguishers

There are four hand held extinguishers located in glass door cabinets. The cabinets are mounted in the wall and have a blue light mounted above them. There are two in the class 10 area and two in the class 100 area. These are CO₂ extinguishers, so gross contamination is not a problem. In case of a fire seek help immediately from the Nanofab staff or University Police at (412) 268-2323. If the fire is small (e.g. smaller than an office

Fire Extinguishers (continued)

waste container), use the extinguisher to put it out. If the fire is larger, evacuate the facility, pull the fire alarm outside the cleanroom, and proceed to the nearest building exit. There is an alarm switch located on the wall next to the elevator and another located on the wall near the men's room on the F-level near the back stairwell.

First Aid Station

There is a first aid cabinet located above the sink in the lounge. This cabinet is available to all personnel on a self-serve basis. Ask for assistance whenever necessary.

Material Safety Data Sheets (MSDS)

There is a MSDS for each chemical used in the cleanroom. A binder of all the MSDS's is located in the lounge on the bookshelf next to the sink. If you plan to bring a chemical into the cleanroom that is not in the MSDS binder, talk to the Nanofab staff for authorization. Once authorized to bring in the chemical, a MSDS and a Chemical Description & Hazard Analysis Form must be provided before the chemical enters the cleanroom. Each chemical or gas that you use in the cleanroom must be included on your Cleanroom Chemicals and Gases Form.

Chemicals and Gases

Each Nanofab user must complete a Cleanroom Chemicals and Gases Form before the user may enter the cleanroom. These forms are kept on file in a binder next to the Material Safety Data Sheets in the Cleanroom Lounge. Each chemical and gas on the list must have a Material Safety Data Sheet and a Chemical Description and Hazard Analysis form on file and be initialed by a faculty advisor and the Nanofabrication Facility Director. Any new chemicals or gases brought into the cleanroom by existing users must first be added to this list and initialed. It is the users' responsibility to ensure that proper handling, storage, and waste removal procedures are in place - **before any chemical or gas enters the cleanroom**. All chemicals and gases **must be** labeled by the Nanofabrication Facility staff with the owners name, phone number, and date. Any unlabeled chemicals or gases found in the cleanroom will be removed. Each chemical and gas must be removed by the owner upon completion of the project or when no longer needed. Cleanroom users should purchase chemicals in quantities small enough to be used within three months. No more than one gallon of any chemical may be brought into the Cleanroom by a user.

Particularly Hazardous Substances

The Cleanroom is a Particularly Hazardous Substance (PHS) designated area for hydrofluoric acid. Hydrofluoric acid is used frequently in the facility and all users must be familiar with the health hazards and emergency procedures associated with it. The Nanofabrication Facility's PHS Safety Protocol for HF must be signed by each user and approved by the Nanofab staff. Hydrofluoric Acid will etch the ceramic neutralization sump and must be poured into empty plastic one gallon HF bottles marked with the appropriate

Particularly Hazardous Substances (continued)

labels found on the acid storage cabinet door. See the HF Particularly Hazardous Substance Protocol for complete details

Other Particularly Hazardous Substances will be handled on an individual basis by the Nanofab staff. A list of Particularly Hazardous Substances and may be found at <http://www.cmu.edu/ehs/chemical/cmuphstable.pdf>.

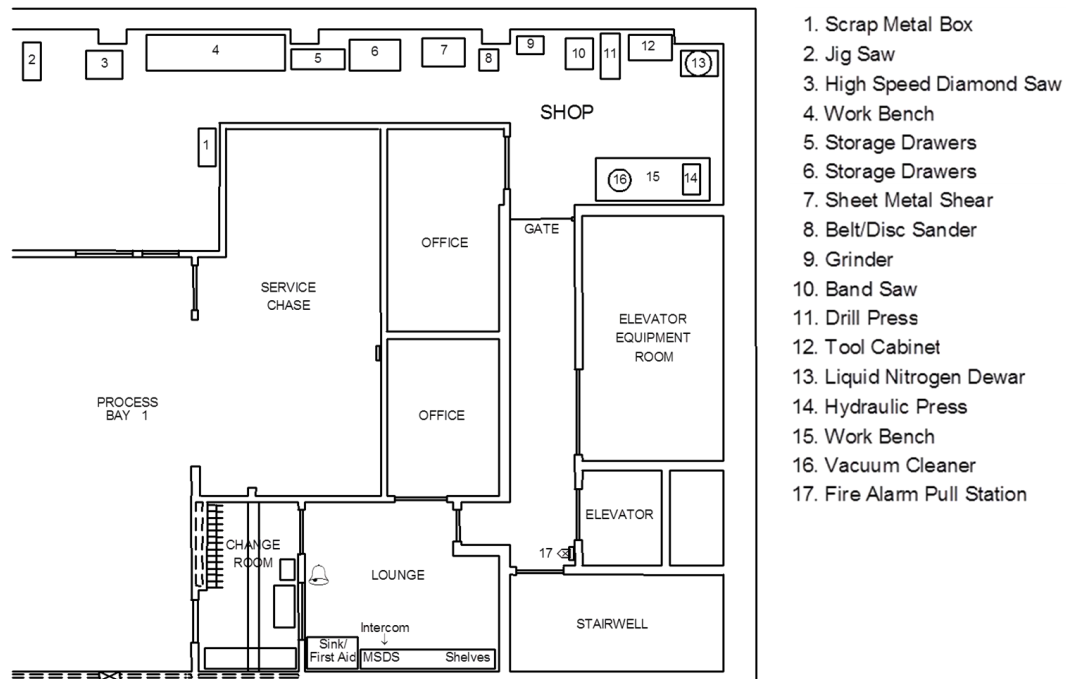
Intercom

There is a speaker/microphone for the intercom in each bay. The central unit is located in the lounge. When someone talks to you through the speaker while you are in the cleanroom, respond by simply talking into the speaker. To use the central unit turn on the switch that corresponds to the desired speaker location, then press and hold the talk button to talk, and release the talk button to listen.

Central Vacuum Cleaner

The cleanroom has a central vacuum cleaner with a port in each bay. The vacuum cleaner motor and pump exhaust are located in the equipment room on the E-level. The on/off switch is located in the change room above the drinking fountain. The vacuum cleaner hose and attachments are kept on a hanger on the wall in the main corridor next to the airlock into the class 10 zone. Return the hose and all attachments to the hanger after each use.

Model Shop



Model Shop (continued)

There is a model shop located outside the cleanroom on the F-level. This shop is for Nanofab equipment repair and modification. Access to the model shop may be granted after training by Nanofab staff. The model shop may not be used under any circumstances after 5:00 pm on weekdays and at all on weekends. Always use safety glasses when working in the shop area - glasses are found hanging on the power tools. Ask for assistance if you are not experienced with these tools. Always clean up after yourself and put all the tools back where they belong. There is a sign out sheet for tools in the toolbox. Sign out is for a maximum of 24 hours. Failure to sign out or return tools within twenty-four hours will lead to removal of tool privileges. The tools are for departmental use only - do not sign out any tools for home projects.

Cleanroom Facilities

Temperature:	68°, ± 1°F
Humidity:	35%, ± 3% RH
Deionized Water:	18 MΩ, 0.2 Micron Final Filter, Reverse Osmosis Feed Water.
Nitrogen Gas:	75 psi, Generated from Liquid Nitrogen in Bulk Storage Tank, Used for Nitrogen Guns and Vacuum Chamber Back Fill.
Compressed Air:	95 psi - 115 psi, Oil Free, Filtered, Maintained at -100°F Dew Point, Dual Compressor System, Used for Pneumatics.
Process Vacuum:	20" Hg Vacuum, Dual Vacuum Pump System, Used for Wafer Chuck Hold Down and Gel-Pak Vacuum Release Stations.
Process Chilled Water:	60° F, 100 KΩ, 5 Micron Central Filter, DI Water Makeup, Closed Loop System, 85 psi Supply - 10 psi Return.
Acid Drain System:	Polypropylene Drain System, Limestone Bed Neutralization Sump, Not Compatible With Hydrofluoric Acid.
Central Vacuum Cleaner:	External Vacuum Pump with Ports in Each Bay.
Corrosive Exhaust:	Stainless Steel Ductwork, Used Primarily for Acid Bench Exhaust, Static Pressure Alarm Switch.
Solvent Exhaust:	Galvanized Steel Ductwork, Used for Solvent Benches and Vacuum Pump Exhaust, Static Pressure Alarm Switch.
Toxic Exhaust:	Stainless Steel Ductwork, Static Pressure Alarm Switch.
Liquid Nitrogen:	1,500 Gallon Bulk LN ₂ Storage Tank, LN ₂ Is Dispensed Into Small Dewars from an LS160 Dewar and Sold By the Pound. The Dewar Sits On A Scale and Is Weighed Before and After Dispensing. LS160 Dewars Are Filled Directly From The Bulk Storage Tank.

Addendum to Carnegie Mellon Nanofabrication Facility Guidelines:

Extended Hours 24/7 Access (Updated September 2015)

This addendum supersedes any of the guidelines contained in the “CARNEGIE MELLON NANOFABRICATION FACILITY GUIDELINES” and is meant to regulate the use of the lab during non-staffed hours.

Cleanroom Staffed & Non-Staffed Hours of Operation

Staffed hours: M-F 8:30 AM-5 PM

Non-staffed hours: M-F: 5 PM- 8:29 AM and Sa-S: 12 AM- 11:59 PM

General Safety Regulations

The most important rule of the lab is that you CANNOT work alone. You always need a buddy in the lab. During regular staffed hours, the staff is your buddy and many additional users are present. During non-staffed hours you need to make sure that someone else is in the lab with you at all times. This buddy must be another Nanofab user who has been granted access during non-staffed hours. Furthermore, two new users cannot be buddies. A new user is considered to be any user who has fewer than 20 days of signed lab entry logs. Each new user must be accompanied by a senior user having more than 20 days of signed lab entry logs.

Before entering the lab you can check if someone is already in the lab by looking at the logs. If no one is in the lab, you must wait and log in with another user. With respect to the buddy system, you should plan ahead, especially if you consider working over the weekends. The Nanofab Extended Hours Distribution list (Nanofab-exthrs@lists.andrew.cmu.edu) is available to users approved for extended hours and can be used to find buddies to work with. Once in the lab, keep up with your buddy and other lab users. Locate other lab members and inform them where you will be working. Check up on each other regularly (every 30 min). If no one else is present (*i.e.* all other members have left), you must leave the lab until you can find another approved extended hours user.

To ensure safe use of the lab at all times, the lab space is monitored by a video recording system. The TV monitors in the entry lounge display the live video of all the lab cameras. The video recording system allows for monitoring of the whereabouts and well-being of lab members. These live feeds are network accessible to Nanofab staff and can be viewed at any time during non-staffed hours. The video feeds are also recorded to facilitate lab management and to review incidents of violation of safety rules. Camera recordings are sufficient grounds for suspending access privileges to the lab.

Violation of the buddy-system rule will result in suspension of access privileges to the lab.

Qualification Requirements for Use of the Lab During Non-Staffed Hours

In order to receive and maintain authorization to use the lab during non-staffed hours you need to follow the guidelines specified below:

- you must attend the Nanofab extended hours orientation;
- you need to sign the CMU Nanofab User Acknowledgment Form;
- you need to sign and submit the Non-Staffed Hours Process Approval Form for all processes you intend to use;
- you need to receive authorization for the requested processes;
- you must take a lab safety/policy quiz and score 90% or higher (users that score below 90% must review the guidelines and may retake the quiz after a minimum wait of 5 business days);
- your Andrew ID card needs to be activated for access during non-staffed hours;
- more than 50 % of the time you spend in the clean room on any given monthly billing cycle needs to be during regular staffed hours;
- you need to abide by the Carnegie Mellon Nanofabrication Facility Guidelines.

Emergencies

In case of an emergency, please call the Carnegie Mellon Police at 412-268-2323 (x8-2323 from a campus phone). Do not call 911. Campus Police will contact the appropriate emergency responders as well as the Nanofab staff. If an emergency poses an immediate threat to your personal safety evacuate the lab and contact Campus Police after reaching a safe location. In the event of a severe injury or if another user becomes disabled, call Campus Police and stay with that person until help arrives.

Examples of emergencies which warrant evacuation include, but are not limited to fire or fire alarm, flood, hazardous gas alarm, exhaust alarm, strong chemical odor, etc. Familiarize yourself with and follow standard evacuation procedures and routes when a safety issue occurs during non-staffed hours.

Chemical Safety & High Hazard Processes

No chemicals can be brought into the clean room during non-staffed hours unless such action has been previously approved by staff. Plan ahead if you need to use a chemical not generally available in the clean room during non-staffed hours.

During the extended hours, some processes will be also be off limits unless a safe operating procedure can be worked out. Those processes include:

- Acid etching and acid processes, such as electroplating, cleaning, etc.
- Work with any Particularly Hazardous Substance (PHS), such as HF, Piranha, Ni/NiFe Plating, etc.
- Any hotplate heating of bulk chemical (developers, solvents, etc)

Notes: