

# CARNEGIE MELLON NANOFABRICATION FACILITY GUIDELINES

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## 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 cleanroom 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

Chris Bowman is the Director 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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Cleanroom Phone: (412) 268-8795

Web Address: <http://www.nanofab.ece.cmu.edu>

## Gaining Admittance

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

The facility may be accessed after meeting with the Nanofab Director under direct supervision of a qualified user. Independent access is attained after meeting with Mike Sakaluk to complete the following:

- Nanofabrication Facility Process Inventory Form
- Cleanroom 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. External researchers may request access to the facility. Applications are reviewed by the Nanofabrication Facility Committee. Contact Chris Bowman 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 (i.e., pencils, cardboard, newspaper, wood, dirty equipment, especially dirty fans). No Scotch tape is allowed in the lab because of contamination problems.

## 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. 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 Roberts Hall labs, may be obtained after an initial training period and on a case-by-case basis with approval of the Nanofab staff. 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: 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 three areas: the F.I.B. room, the Wet Chemistry Bay and the Photolithography Bay with the S.E.M. 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

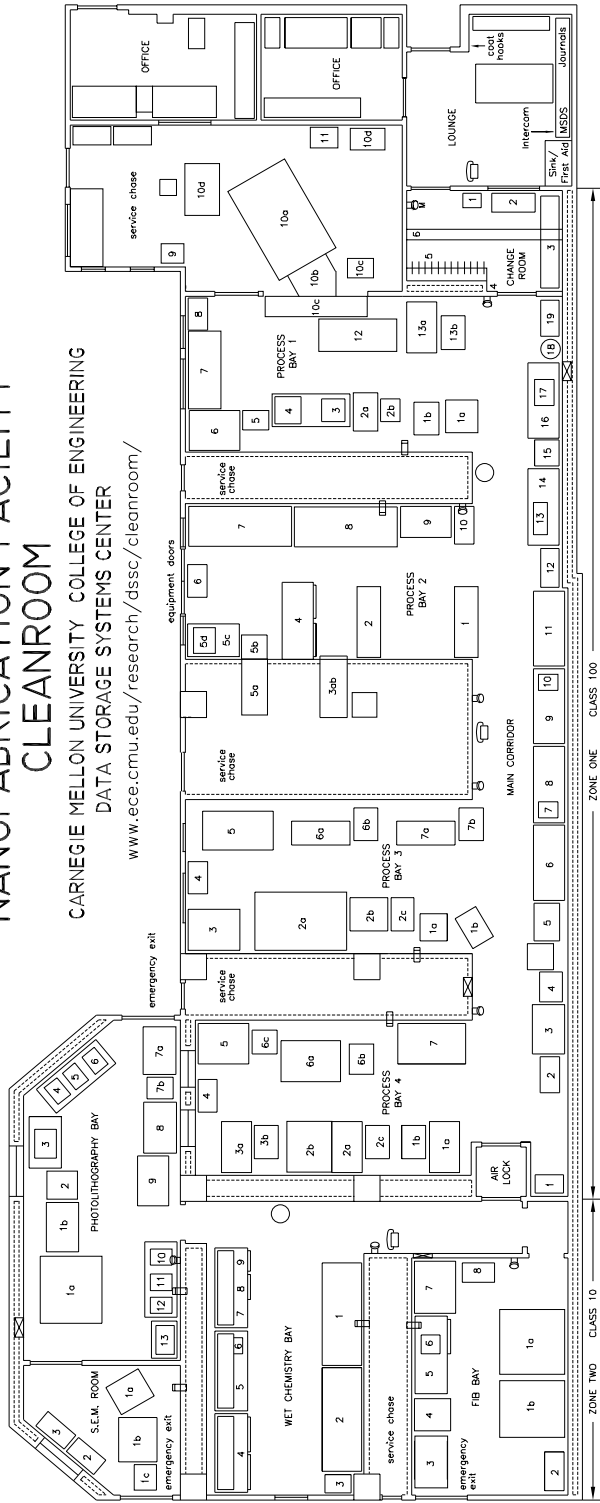
The change room is divided in half by a bench. This bench is sealed to the floor and acts as a dirt barrier. One side of the floor is for street shoes only and the other side is for cleanroom boots only. To gown up, sit down on the bench and put on one boot, step across, put on the next boot, and step across. Next put on the hood. Finish by putting on the coverall. 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/



- PHOTOLITHOGRAPHY BAY**
1. CO<sub>2</sub> Laser
  2. Photorealist
  3. Proffometer
  4. Olympus Inspection
  5. Olympus Automatic
  6. Camera
  7. Zion Microscope
  8. Contact Aligner
  9. UV Controller
  10. Soltec Spinner
  11. Blue M Oven - 200°C
  12. Blue M Oven - 220°C
  13. Vacuum Oven Below
- WET CHEMISTRY BAY**
1. Wet Bench -
  2. Wet Bench -
  3. Acids Only
  4. Lab Shelves/Bins
  5. Acid Storage
  6. Cabinets Below
  7. Table - Shelves/Bins
  8. Glassware Washer
- FIB BAY**
1. Micron 2500 Fib
  2. Column
  3. Cabinet
  4. Table
  5. Heat Pulse Rapid
  6. Contact Aligner
  7. Storage Cabinet Below
  8. Wet Bench
  9. Spattering System
  10. Solvent Cabinet
  11. Supply Shelf
- PROCESS BAY 1**
1. Utek E-Beam
  2. Control Rack
  3. Chamber
  4. Rig System
  5. Chamber
  6. Chamber
  7. Chamber
  8. Chamber
  9. Chamber
  10. Chamber
  11. Chamber
  12. Chamber
  13. Chamber
  14. Chamber
  15. Chamber
  16. Chamber
  17. Chamber
  18. Chamber
  19. Chamber
- PROCESS BAY 2**
1. Table
  2. Three Stack Furnace
  3. Oxide Growth Furnace
  4. Table Acid Storage
  5. Cabinets Below
  6. Surface Tech
  7. Chamber
  8. Chamber
  9. Chamber
  10. Chamber
  11. Chamber
  12. Chamber
  13. Chamber
  14. Chamber
  15. Chamber
  16. Chamber
  17. Chamber
  18. Chamber
  19. Chamber
- PROCESS BAY 3**
1. Leybold Z-500
  2. Control Rack
  3. Control Rack
  4. Spattering System
  5. Chamber
  6. Chamber
  7. Chamber
  8. Chamber
  9. Chamber
  10. Chamber
  11. Chamber
  12. Chamber
  13. Chamber
  14. Chamber
  15. Chamber
  16. Chamber
  17. Chamber
  18. Chamber
  19. Chamber
- PROCESS BAY 4**
1. GMR 5 Target
  2. Control Rack
  3. Spattering System
  4. Chamber
  5. Chamber
  6. Chamber
  7. Chamber
  8. Chamber
  9. Chamber
  10. Chamber
  11. Chamber
  12. Chamber
  13. Chamber
  14. Chamber
  15. Chamber
  16. Chamber
  17. Chamber
  18. Chamber
  19. Chamber
- HOUSE FACILITIES**
- Filtered Dry Air
  - Water
  - 18 Meg. Ohm Deionized Water
  - 20" Hg Process Vacuum
  - Temperature Controller
  - Humidity Control
  - Corrosive Exhaust
  - Solvent Exhaust
  - 10 Kilom Filtered Chilled Water
  - Bulk Liquid Nitrogen Tank
- Symbols**
- Window
  - Telephone
  - Shower and Eye Wash
  - Master Emergency Power Disconnect Switch
  - Emergency Power Disconnect Switch
  - Supply Shelves
  - Cleanroom Log
  - Vacuum Cleaner Port
  - Fire Extinguisher
- CHANGE ROOM**
1. Socks
  2. Socks
  3. Socks
  4. Socks
  5. Socks
  6. Socks
  7. Socks
  8. Socks
  9. Socks
  10. Socks
  11. Socks
  12. Socks
  13. Socks
  14. Socks
  15. Socks
  16. Socks
  17. Socks
  18. Socks
  19. Socks
- S.E.M. ROOM**
1. Hitachi S-800 SEM
  2. Console
  3. Power Supply
  4. Vacuum
  5. Anatech Gold Coater

## Cleanroom Log

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.**

## 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
- Acetone (Finyte Grade)
- 2-Propanol (Finyte Grade)
- AZ Developer
- AZ 400K Developer
- AZ Kwik Strip Remover
- Nitrogen Gas for the Nitrogen Guns and Vacuum Systems
- Liquid Nitrogen Dewar Maintenance
- Tacky Mats
- Chemical Gloves
- Cotton Tipped Applicators
- Microclean Soap
- Hydrofluoric Acid Antidote Gel
- Wet Bench Maintenance: Sinks, Nitrogen Guns, DI Guns, Timers, Ultrasonics, and Plumbing

## Facility Fees (continued)

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  
Olympus Wide Field Zoom Microscope  
Olympus 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

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.

External rates are calculated using Carnegie Mellon's current F & A Rates for Budgeting Proposals plus 5%. The F & A Rates may be seen at: [http://www.cmu.edu/provost/sponsors/preaward/server/FA\\_Rates.pdf](http://www.cmu.edu/provost/sponsors/preaward/server/FA_Rates.pdf). Note: Published F & A rates may not be current.

There is a one hour minimum charge per day on all equipment which is charged by the hour. This does not apply to the Surface Technology System ICP RIE System, the Plasma-Therm 790 RIE System, and the IPC Plasma Etcher.

**Facility Fees (continued)**

NAME	CARNEGIE MELLON	EXTERNAL
Entry Fee	\$20.00/Day	\$30.70/Day
Nanofab Process Development/Labor	\$60.00/Hour	\$92.10/Hour
Nanofab Sputtering Systems #1 - #5	\$75.00/Run	\$115.13/Run
Perkin-Elmer 2400 8L Sputtering System	\$75.00/Run	\$115.13/Run
Perkin-Elmer 2400 6J Sputtering System	\$75.00/Run	\$115.13/Run
CVC Connexion Sputtering System	\$75.00/Run	\$115.13/Run
Commonwealth Ion Beam Deposition System	\$75.00/Run	\$115.13/Run
Leybold Heraeus Z-400 Sputtering Systems	\$75.00/Run	\$115.13/Run
Leybold Heraeus Z-650 Sputtering System	\$75.00/Run	\$115.13/Run
Anelva SPF-730 Sputtering System	\$75.00/Run	\$115.13/Run
Anatec Gold Coater	\$50.00/Run	\$76.75/Run
Copper Electroplating System	\$50.00/Run	\$76.75/Run
Micrion 2500 Focused Ion Beam System	\$75.00/Hour	\$115.13/Hour
Surface Technology Systems ICP RIE System	\$30.00/Up To A 15 Minute Run \$50.00/Up To A 30 Minute Run \$75.00/Up To An Hour Run \$25.00/Each Additional Hour Per Run	\$46.05/Up To A 15 Minute Run \$76.75/Up To A 30 Minute Run \$115.13/Up To An Hour Run \$38.38/Each Additional Hour Per Run
Plasma-Therm 790 RIE System	\$25.00/Up To A 15 Minute Run \$40.00/Up To A 30 Minute Run \$65.00/Up To An Hour Run \$10.00/Each Additional Hour Per Run	\$38.38/Up To A 15 Minute Run \$61.40/Up To A 30 Minute Run \$99.78/Up To An Hour Run \$15.35/Each Additional Hour Per Run
IPC Barrel Etcher	\$20.00/Up To A 15 Minute Run \$35.00/Up To A 30 Minute Run \$50.00/Up To An Hour Run \$10.00/Each Additional Hour Per Run	\$30.70/Up To A 15 Minute Run \$53.73/Up To A 30 Minute Run \$76.75/Up To An Hour Run \$15.35/Each Additional Hour Per Run
Commonwealth Ion Beam Etching System	\$75.00/Run	\$115.13/Run
Karl Suss MJB3 Mask Aligner	\$50.00/Hour	\$76.75/Hour
Karl Suss MA56 Mask Aligner	\$60.00/Hour	\$92.10/Hour
Karl Suss MA6 Mask Aligner	\$70.00/Hour	\$107.45/Hour
GCA 4800 Wafer Stepper	\$75.00/Hour	\$115.13/Hour
Olympus MX80 With Optronics Camera System	\$25.00/Day	\$38.38/Day
FEI Sirion S.E.M./Nabity E. Beam Lithography	\$75.00/Hour	\$115.13/Hour
Tencor Alpha-Step 200 Profilometer	\$40.00/Hour	\$61.40/Hour
KLA-Tencor P-15 Profilometer	\$50.00/Hour	\$76.75/Hour
Nanometrics Nanospec 210XP	\$40.00/Hour	\$61.40/Hour
Kulicke & Soffa 780-6 Dicing Saw	\$60.00/Hour	\$92.10/Hour
Micromech Diamond Saw	\$45.00/Run	\$69.08/Run
Strasbaugh 6EC CMP	\$75.00/Run	\$115.13/Run
Ultratech Scrubber	\$25.00/Run	\$38.38/Run
Ultek E. Beam Evaporator	\$75.00/Run	\$115.13/Run
CHA Thermal Evaporator	\$75.00/Run	\$115.13/Run
Vapor-Temp Relative Humidity Chamber	\$25.00/Run	\$38.38/Run
AG Heat Pulse Rapid Thermal Annealer	\$50.00/Run	\$76.75/Run
Hot Pack Vacuum Oven	\$25.00/Run	\$38.38/Run
Model Shop	\$25.00/Month	\$38.38/Month

## Precious Metal Fees

Precious metal thin film depositions are subject to an additional fee in order to compensate for the high cost of the targets. These prices are subject to change based on current market values.

Gold: 0.5 Micron or less: \$50 per run, \$25 for each additional 0.5 Micron per run.

Platinum: 0.5 Micron or less: \$65 per run, \$25 for each additional 0.5 Micron per run.

## Carnegie Mellon Personnel Monthly Expense Caps

The Nanofabrication Facility has a cap on monthly entry and equipment fees charged to Carnegie Mellon personnel. These caps are for Carnegie Mellon personnel working on projects with a Carnegie Mellon account number.

- The entry fee cap is \$250 a month per user per account number.
- The equipment fee cap is \$2,500 a month per user per account number.

## Equipment Training

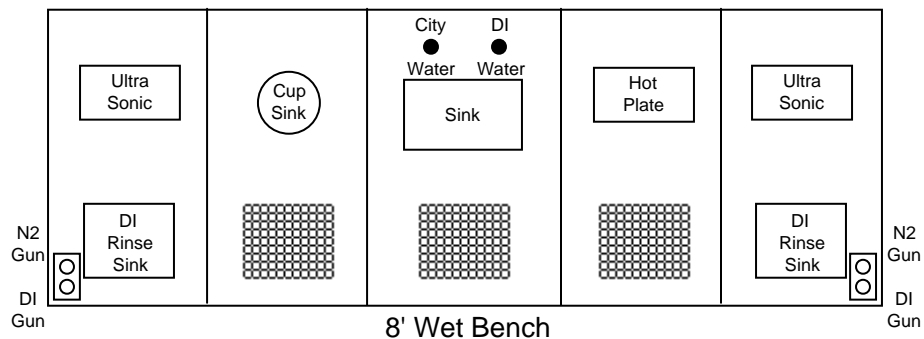
Training is required before using the majority of the equipment in the cleanroom. There is a **Qualified Users List** for each machine. To obtain training, arrangements are made with someone on the list to observe and practice operating the machine under direct supervision. After an initial training 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 using a sputtering system is more extensive and typically more time consuming. 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 cleanroom 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. 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 beakers. Any chemical drips or spills to the deck of the wet bench should be rinsed off with the DI spray gun. The N<sub>2</sub> guns and DI guns should always be placed into their holders when finished. The N<sub>2</sub> master valve should be turned off when finished.

Safety glasses or goggles and gloves should be used when working at the wet benches. Safety glasses and nitrile gloves are sufficient when work is limited to using solvent wash bottles, DI water, and developer. Chemical gloves and face shields 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 Benches

Concentrated acids may be poured down the drain, with the exception of hydrofluoric acid. Hydrofluoric acid will etch the ceramic neutralization sump and must be poured into empty plastic one gallon HF bottles marked with the appropriate labels found on the acid storage cabinet door. See the HF Particularly Hazardous Substance Protocol for complete details. To dump acids down the drain use the center sink. First turn on the city 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. **Acids may not be used under any circumstances after 5:00 pm on weekdays and at all on weekends.**

It is not our policy to stock standard acids - 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 one-gallon bottles of the same acid. All bottles should be labeled with the owners name and 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 one-gallon 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

Acetone and 2-Propanol one-gallon bottles are stocked in the solvent cabinets. Waste solvent bottles are stored in the solvent cabinets and are removed monthly. 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 and 2-propanol is poured from beakers into these 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 then poured into a plastic waste bottle.

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.

## **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 avoid contamination problems. Processing supplies used in the Wet Chemistry Bay and the Photolithography Bay may be kept in an assigned personal shelf with your name on it. Supplies are kept in plastic bins that will fit on the shelf. These are private supplies and no one should touch them without the permission of the individual owner. The trays and toolboxes are available in the supply area located in the change room. Shelves 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 security 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 two alarms in the cleanroom. One is a fire alarm and the other is an exhaust failure 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 CO<sub>2</sub> 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, smaller than an office waste container, use the extinguisher to put it out. If the fire is larger, evacuate the facility and pull the fire alarm outside the cleanroom. 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 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 cleanroom 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.

## **Chemicals and Gases (continued)**

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.

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://ehs-alert.fms.bap.cmu.edu/pdf/cmuphstable.pdf>.

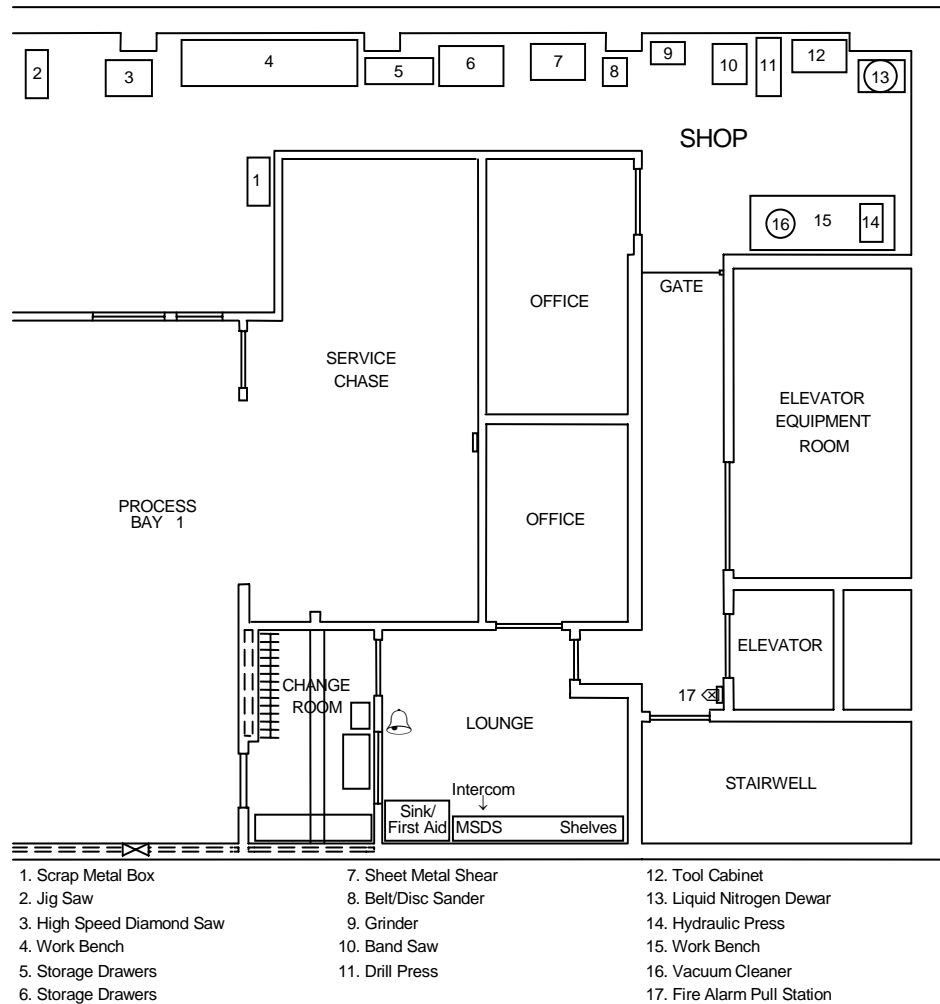
## **Intercom**

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



There is a model shop located outside the cleanroom on the F-level. This shop is for cleanroom equipment repair and modification, but is also available for graduate student use. 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<sub>2</sub> Storage Tank, LN<sub>2</sub> 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.

**Notes:**