



Microfabrication Laboratory (Microlab)

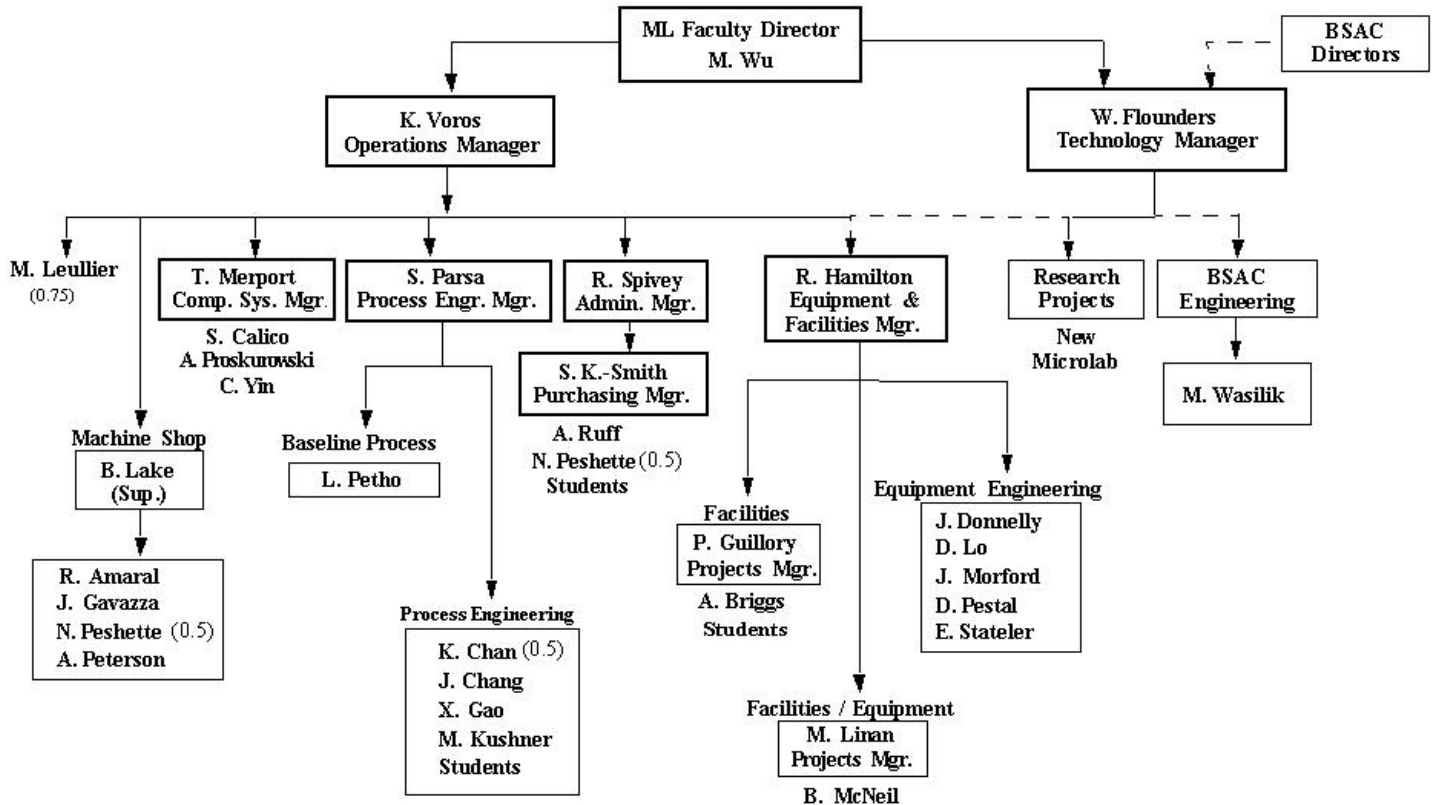
Engineering Research Support Organization (ERSO)  
Department of Electrical Engineering and Computer Science (EECS)  
406 Cory Hall  
University of California, Berkeley

# Orientation Notes

# Introduction

## Microfabrication Laboratory Staff Organizational Chart

April 2009



# Recharge Rates

Effective 7/1/2008

Access Fee	<b>\$88.00/month</b>
<b>General Lab Use</b> (Includes <a href="#">87 operating systems</a> )	<b>\$37.80/hour</b>
Special Equipment (For a complete list, click <a href="#">here</a> .)	<b>\$33.60 - \$38.40/hour</b>
Staff Services	<b>\$69.00/hour</b>

### University Professors

Max. monthly charge per student:

**\$1,200** in lab fees and  
**\$1,400** in equipment fee (separately)

## **Mode of Operation**

1. The Microlab is open for work 24 hours/day, 365 days/year (accessible with a key card). For safety reasons, you may not work alone in the lab at any time. There must be at least two people inside when working off-hours (other than 7:00 AM - 5:00 PM). We ask that new members for the first few weeks work only Monday-Friday, between 7:00 AM-5:00 PM, when staff is available, unless there is a senior member from their own research group with them.
2. Members learn from each other and, in turn, teach others. Motto: "Each one teach one."
3. For questions/advice/help: e-mail machine name at silicon from within the silicon domain.
4. Information available on the Internet at: <http://microlab.berkeley.edu/>
5. Everyone must qualify separately for each piece of equipment. This lab course qualifies you only to enter the lab and use the computer.
6. Microlab requires from each member a donation of one day of help lab cleaning during the Clean Fest held each October. This helps to raise consciousness and maintain awareness of your responsibilities to the facility and to other members.
7. Microlab status updates: by monthly e-mail report. Five labmembers may request a members meeting at any time (e-mail **Katalin Voros**)
8. Visitors: Only by permission from Katalin Voros, Bill Flounders, or Bob Hamilton. Email requests to visitor at silicon. All visitors must be escorted; photographs are allowed.
9. Results: Please submit to Katalin Voros preprints, reprints, data, etc., for Good News Bulletin Board.
10. Credits: In publications and talks identify devices as fabricated in the UC Berkeley Microlab.

## **Equipment Qualification**

Each piece of equipment has one or more Superusers, an equipment engineer in charge of maintenance, and **Qualified Users**. To become qualified for equipment, you must go through the following procedures:

1. Read the operation manual for the specific piece of equipment. Be sure you have a fairly good understanding of the operation of the machine before contacting a qualified labmember for training. This will save both of you time and trouble. The lab manual is available online on the Microlab's web page, and in hard-copy form in three binders located on a shelf above the workstations, in the lab lobby.
2. Email a qualified lab member and make an appointment to learn the operation of the machine. **DO NOT** ask staff members to train you on equipment. You can obtain a listing of qualified labmembers for any given piece of equipment on the wand. You may check the reservation program to identify members that plan to use a piece of equipment within the next 7 days.
3. Prepare and clean any necessary materials and accessories. Ask the qualified lab member about this when you make your appointment.
4. While being trained on equipment, the trainer should use the "recharge" option under the Equipment category on the Wand. This way the member-in-training incurs the charges for the equipment usage.
5. As part of your training, practice on the equipment under the supervision of a qualified labmember to become familiar with it. A qualified labmember **MUST BE WITH YOU** at the machine at all times while you are learning to operate it. You are not permitted to use any equipment alone before being officially qualified.
6. When you feel you can operate the machine independently, you may start the qualification procedure. Review the manual, paying attention to the study guide at the end. Not all manual chapters have a study guide at the end, only those that require a written test.
7. If a written test is required for the piece of equipment you wish to qualify on, take the test in the Microlab Office (406 Cory) and wait for an e-mail notification that your test has been graded. Come to the office to review your test. If you pass, you will receive the oral test form specific to that equipment. Then make an appointment with a superuser to take the oral qualification test. If you failed the written test, study some more and take the written test again.

8. If a written test is not required, proceed to make an appointment with a superuser for oral qualification. General equipment Qualification Forms are available in the lobby by the login terminal.  
You will notice that there are a few exceptions for qualifications. For especially sensitive equipment, such as the scanning electron microscopes, the pattern generator and furnaces, staff must qualify you. In these cases, the script (Superuser) will appear only next to staff names.
9. Have your samples and materials ready for the qualification process and bring your qualification form. During the oral test the Superuser will watch you use the system while you explain your actions. If you are well prepared, the Superuser will sign your qualification form.
10. Place the form in the marked box on the counter in the reception area in front of the lab or turn it into the office. Your name will be added to the computer database of qualified labmembers, permitting you to enable the machine through the Wand the following day.

K. Voros  
7/08

## ***The Microlab Computing Environment***

Activities in the Microlab are tracked, regulated, and accounted for with laboratory management software. This software is commonly known as the Wand. Members will utilize this software when logging into the lab, enabling equipment, and filing problem reports (and many other functions). The most common way to use the Wand is at a Windows terminal in the Microlab; these terminals are part of the CAPE system (Common and Personal Environment). Some of the software utilized for Microlab operations is available through the Microlab web portal; this includes reservations, qualifications, and member information. Outlined below are some basic steps required to get started.

### **1. Logging In**

The first step to logging in to the lab is to logon to a CAPE terminal. There are three CAPE (Common and Personal Environment) terminals available in the reception area. The CAPE terminals have the Wand sign-in screen running on a Windows desktop. Wand is the laboratory management software. A common hurdle to using the Wand is figuring out how to navigate in a ASCII application. After a few tries it is fairly straightforward. There are four important reasons to login:

- a. It lets others know that you are in the lab.
- b. It initializes accounting functions.
- c. It permits you to enable and disable equipment.
- d. You have access to on-line manuals and other Wand features.

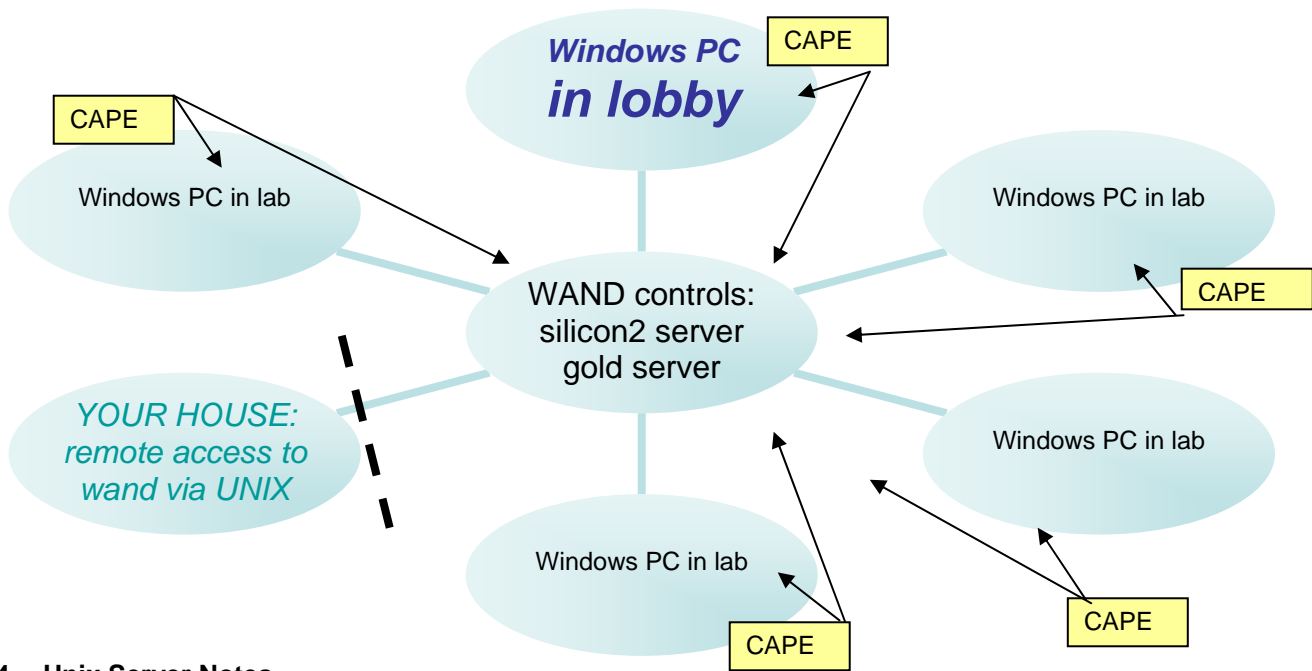
### **2. CAPE (Common and Personal Environment) – Overview**

CAPE terminals provide a Windows environment and access to a Wand session. The CAPE terminal acts as a "hot desk." Your session will stay active as you move from terminal to terminal in the Microlab. After logging into CAPE, you will need to login to the Wand session. Do not exit from your Wand session until you leave the lab. When ready to leave the lab, log out of the Wand session. Double-clicking on the icon "Hide your CAPE" can hide your session. Your CAPE will be hidden automatically after 10 minutes of non-activity to free up the terminal for others to use. Also, use "Hide your CAPE" prior to leaving the lab. Local mail clients (Outlook Express) are not allowed on Cape. You can check your department mail by using a web based mail client.

### **3. Wand - Overview**

When you log into the lab, the Wand will appear on the login terminal screen once you hit RETURN (<CR>). You will do most of your lab communication and documentation through the Wand. When you are finished using the Wand for a given function, such as looking at a manual chapter or enabling a piece of equipment, hide your CAPE terminal. You can then bring it back by typing your login name and password at any terminal.

You will find that once you begin using the Wand, its menu system makes its use self-explanatory. We suggest that once you have an account you log in and explore the Wand until you feel comfortable using it. Please do not hesitate to ask questions of your fellow labmembers or staff. Detailed instructions on using the Wand are found in Section IX of the Laboratory Guide handout (also online in the lab manual, [Chapter 1.16](#)).



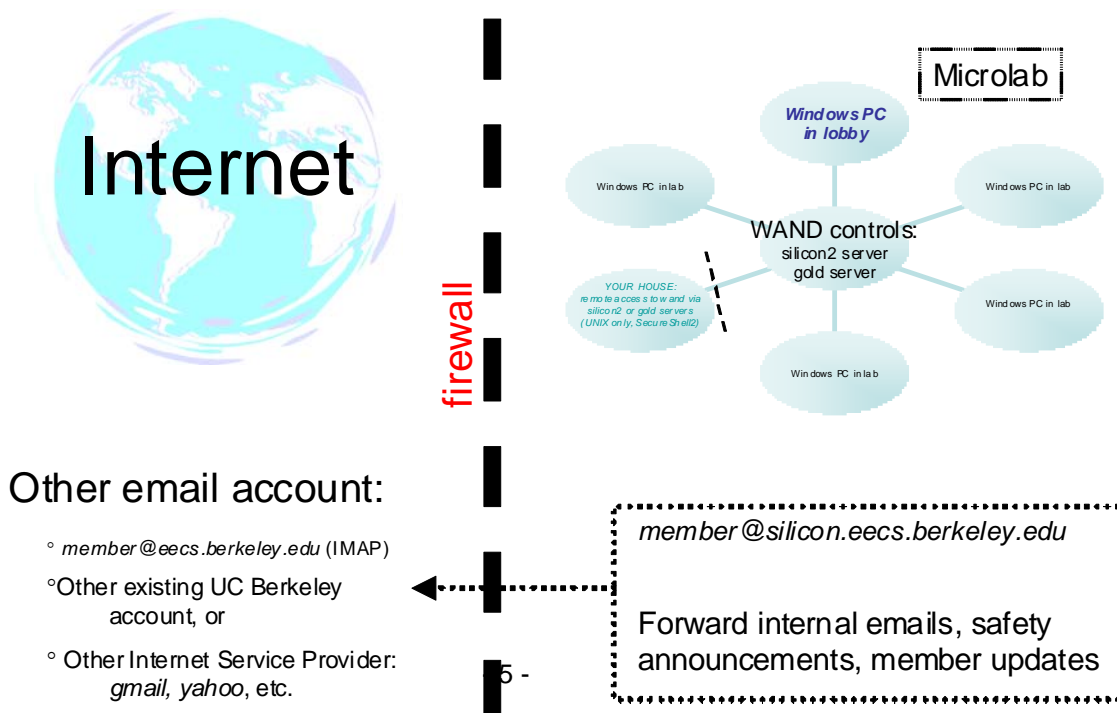
#### 4. Unix Server Notes

Remotely accessing your Microlab account is done through our Unix server, `silicon2.eecs.berkeley.edu` or `gold.eecs.berkeley.edu`. From the silicon2 command line you can type "wand" to start the Wand software. Some equipment in satellite labs can be enabled this way. Cad conversion software runs on gold. Please note that our servers are to be used for Microlab related tasks only. Your disk space allotment is 200 MB. Please do not exceed your quota. SSH2 is required to login and transfer files. Information regarding connecting to silicon2 and gold from outside campus can be found at our website:

**<http://microlab.berkeley.edu/computers>**, under the heading "Connecting to Microlab Workstations."

You will have e-mail forwarded off *silicon2* to your departmental server. Please check your mail regularly because we send out information pertaining to reservations, equipment shutdowns, and other important lab activity via e-mail. Also, when you login (to *silicon2* or Wand), a message program will display important messages. Please do not ignore these messages because they may contain information regarding safety and other operational news in the Microlab (in many cases these messages are not relayed via email).

### EMAIL USAGE



## 5. Reporting Equipment Problems and Maintenance

The cooperation of all labmembers is required to keep our equipment up and running. The computer provides an easy and efficient way of monitoring equipment problem status and notifying the equipment engineering staff when trouble arises with a given machine.

If you have a problem with a machine, proceed as follows:

- a. Determine whether the problem presents a danger to you and your fellow labmembers (gas leakage), or the system (electrical problem, water leakage).
  - i. If the problem poses a danger of injury or damage, call a staff member (at home if after hours or on a weekend). Telephone numbers are listed on the Wand under **Safety, Trouble & Prevention**. If the computer is down, consult the lists posted by the telephones or in the window by the card key sensor at the entrance to the lab. If there is a gas leak, assume it is dangerous and evacuate the lab.
  - ii. If the problem is not dangerous, try to locate another qualified labmember of the system in the vicinity who may be able to help you troubleshoot the problem.
- b. If the problem was easily solved with the aid of another qualified labmember, chances are it was your inexperience that contributed to it. In this case it is not necessary to report the problem on the Wand.
- c. If you are unable to solve the problem, remove your sample from the system if possible, and disable the equipment on the Wand. File a report on FAULTS.
- d. Computers associated with equipment, must not be modified in any ways. They are not to be used for playing games, surfing the net or storing labmember files. Do not install or modify screen savers or wallpaper. Failure to follow this rule will result in suspension from the Microlab. If there is an issue with an equipment computer, file a FAULT report.

## 6. Equipment Power

**Unless there is a life-threatening emergency, NEVER shut off power to a machine!** This may cause a system failure. When you disable any system, the computer will prompt you as to whether you have a problem to report. Answering 'y' (yes) will automatically place you into the FAULTS problem-reporting program in which you must describe, clearly and completely, the problem you encountered. A comment like "machine doesn't work" is not acceptable. Explain how the problem showed itself, what you were doing when it occurred, and what steps you took to correct it. Instructions for using the FAULTS program are given on-screen when the program is started. You can cc: (carbon copy) the problem report to anyone you think might want to see it, such as other people in your group who you know may want to use the system that day. It is not necessary to cc: problem mail to any staff members, as they receive copies automatically.

Once entered, the problem report will appear on the screen whenever anyone subsequently tries to enable this machine, until a staff member clears the problem.

Also, it will be mailed automatically to the technician-in-charge. Remember, the more detailed the description of the problem the more quickly and efficiently the tech will be able to isolate and correct it. Once the problem has been logged in the computer, you may try to locate the technician-in-charge by calling the office on the intercom if your need of the machine is pressing.

**You must enter a problem report on FAULTS each and every time you encounter a problem with any piece of equipment.** If you are charged for equipment time that you did not actually use because of the problem, you will not receive credit for the time unless you have filed a problem report. Filing a comment is not sufficient. Filing an equipment problem report on FAULTS updates the equipment's problem log and notifies the appropriate staff members of the situation.

T. Merport - 4/07  
ES - 7/08

## **General Lab Administration**

### **1. Microlab Membership & File Records**

Before becoming a Microlab member you must pass the safety test. After you pass and review your test, complete and submit the New Member form to the Microlab administrative staff. Microlab staff will take your picture during a break at the orientation and post it on the Microlab website once you become a member.

### **2. Card Keys**

You must have a card key to gain access to the lab. Obtain a card key application or card key access addition form from the Microlab administrative staff, after your silicon computer account has been set-up. Submit your completed application to Stewart Brown in 387 Soda Hall. The UC Police Department will activate your card key within 24 hours.

### **3. Computer Account**

When you are ready to begin using the lab, you must have a *silicon* computer account. Submit the completed New Member form to the Microlab administrative staff. If possible, use your last name as your login name. If you have an existing UC computer account, use the same login you have established on other machines. Your password must be at least 6 characters long (preferably 8), and should contain some special characters (control characters, punctuation, etc). See the "Computer Systems" heading on the Microlab homepage for details about email, UNIX, and cape, including the computer orientation seminar slides.

**Disk Usage:** Please write large and temporary files to /tmp. Compress large files and files that you do not use often. If you have any problems with or questions about our machines or software, please e-mail **root at silicon**.

### **4. Obtaining Supplies**

On your first day at the lab, a plastic box for storage of labwear and materials can be obtained in the office Store room. Office hours are Monday - Friday, 8:00 AM - 12:00 PM, 1:00 - 5:00 PM.

When you need supplies, such as wafers, wafer-handling items or glassware:

- a) Check the stock list on Wand.
- b) If it is not on the list, check with office staff.
- c) Obtain the materials you need (wafers, beakers, tweezers, etc.) from office staff. The item(s) will be charged to your account.

If you need special materials that are not kept in stock, a variety of catalogs are available in the office from which you can order the item(s) you require. Microlab office staff often can provide you with catalogs and vendor contact information, but such orders must be processed through your own department and not the Microlab.

### **5. Telephone Policy**

Lab telephones are restricted to local area (510) outgoing calls. Office staff only page labmembers working in the lab; they do not take messages for them. Use the intercom (ITCM button, then extension #) to contact staff/office personnel.

### **6. Cell phone Policy**

Cell phone use is restricted to the gowning and lobby area because cell phone signals interfere with and can disrupt the operation of some equipment.

## ***Clean Room Protocol***

The Microlab operates as a Class 100 cleanroom. Since the Microlab is not a for-profit organization, overall yield may not be an issue; nevertheless, defects can delay completion of a project leading to missed deadlines for submission for grant proposals, conferences, and publication deadlines. Each and every labmember has an interest in helping to maintain the standard of cleanliness required for success and it is important for labmembers to strictly adhere to the contamination controls and material compatibility policies. Violating these rules is not just inconsiderate, but you could also be jeopardizing someone receiving their degree.

### **1. Contamination Sources**

- a) The human body is the main source of contamination in a cleanroom. Humans are constantly shedding hair and dandruff and often spraying saliva when talking and have a mixture of sweat and oils on their skin. All of these can lead to defects in masks and on the microchips. Sodium and potassium in body fluids are semiconductor poisons which in small concentrations can drastically alter the conductivity of doped silicon. Minute traces of gold, which may rub off jewelry even in casual handling, can also poison semiconductors. This gold could also migrate to furnaces and other tool prompting major cross contamination issues in the Microlab. Absolutely no Gold is allowed in the VLSI area.
- b) Other sources of cleanroom contamination are ordinary paper, cardboard, pencils, floor dirt and dust in the air.

### **2. Control Measures**

- a) The Microlab provides bouffant caps, coveralls, shoe covers, nitrile gloves (blue colored surgical gloves), and safety glasses to all lab members, which are stored in gowning boxes in the lobby. You will receive your own gowning box, once you have activated your Microlab account. Gowning up is performed from the top down: cap, coveralls, shoe covers plus white Tyvek booties, as well as, nitrile gloves, and safety glasses. Check your labwear regularly, since once it's torn or ripped, then particles from your clothing and skin can find their way out of the torn area of the coverall or cap into the lab environment and/or clean surfaces. Full-length coveralls are worn by all labmembers; the short white frocks hanging in the lobby are for visitors only. The coveralls need to be zipped all the way up, not partially. If you are wearing a sweatshirt with a hoodie, keep the hood tucked inside the suit.
- b) Blue nitrile gloves are provided to labmembers and should be on your hands at all times when in the Microlab. These gloves are sized small to extra-large and can be found in bins located on the shelf on the "clean" side of the lobby. (A gowning-up bench separates the "clean" and "dirty" areas.) These gloves protect lab surfaces from contamination by the oils and salts on your hands. Keep your gloves clean, and try to avoid touching your face with them. Change gloves as needed.
- c) Clear polyethylene "poly gloves" are also available. These gloves are kept in baskets located strategically throughout the Microlab, especially the VLSI area. Use them to control contamination; they must always be worn on top of your nitrile gloves whenever handling wetsink cassettes, or any other contamination sensitive material; e.g. handling the sink to furnace transfer box and cassette, the loading of an evaporation boat or e-beam crucible.
- d) Lead pencils and cardboard of any type, as well as regular notebooks (wood products) are not allowed inside the cleanroom.
- e) Cleanroom notebooks made with special cleanroom paper are available for checkout in the Microlab office. These notebooks may be kept in your assigned storage drawers; however, if you need to take your notebook out of the Microlab, Ziploc bags are available at no charge from the office. Always remember to label your notebook with your name and/or login and other contact information, so if you misplace it in the lab it can be returned to you.
- f) Ballpoint pens, laptop computers and PDAs are allowed inside the Microlab; cell phones are allowed as well, but must be turned off inside the Microlab as the cell phone signals have been found to interrupt the lasers of the photolithography equipment. Cell phone use is, however, allowed in the Microlab lobby and the outside hallway.

### **3. A Cleanroom Can Never Be Clean Enough! The cleaner the better.**

Remember that you are working in a communal environment:

- When you drop something on the floor, pick it up
- When you spill something, wipe it up
- When you see an empty chemical bottle left behind by someone else (in a violation of lab policy) be the good lab citizen and rinse it thoroughly and dispose of it properly
- If you see someone not following policy, tell them or the staff, or leave a note in the safety box (next to the First Aid station) in the Microlab hallway. Members are easily identifiable by their required name tags, while working in the Microlab (top left side of their coverall).

### **4. Go the Extra Mile...**

If you are standing around waiting for a furnace tube to be vented or your wafers to get rinsed off at the sink, do something good for the lab; clean surface of a table or equipment and/or pick up something!

- If there are techni-cloths on the counters or on the floor, dispose of them in the trash. (There is a trash can in every room.)
- Gather up glass slides left behind after use and put them in the "SHARPS" container.
- Wipe down and dry the wetsink area you are working at
- Clean your computer screen with one of the wet-dry wipes found in the lobby on the shelf where the gloves are located.
- Peel off a sticky mat when the top layer is dirty and toss it in the trash, as you walk into the lab.

## ***Microlab Etiquette***

Please leave your work area in the Microlab as you would like to find it- always make it a rule to clean up before you leave for the day.

### **At the Wetsinks**

- No acid left behind! Acid and water look alike, so be sure to use the techni-cloths provided in the holders in each room to wipe up and dry down the work surfaces.
- \*Dilute the puddle or spill with DI water, using the sink deck hose first, and then wipe it up.
- Label your process with the blue process ID slips provided in a holder at each sink if you need to leave the immediate area for the time being.
- Empty chemical bottles left on the floor surrounding the sink area(s) pose a safety hazard. "If you empty a bottle, rinse it." Bottles that have been emptied are to be taken into the old lab, Room 432-C to be rinsed and properly disposed; specifically by being given a thorough rinse, the label X-ed out with a marking pen to indicate the bottle has been rinsed, then disposed into the proper receptacle.
- Be sure to check the chemical inventory log in the lobby first to see if the chemical you need is already in the work area; use up the existing stock first before bringing in a new bottle.
- Check out your own pair of chemical-resistant gloves from the office as there is really no way for you to know what the other person had on their (nitrile-gloved) hands before putting on the pair of chemical-gloves that you may have found on a tabletop, which may be contaminated with chemicals.

### **In The Yellow Photolithography Room Y-1**

- Always clean the manual photoresist spinner after each use and re-line it with clean foil.
- Dispose of the foil afterwards in the vented PR trash can at the sink area.
- Photoresist drips on the countertop or floor should be promptly wiped up with a techni-cloth then disposed into the above can. Small amount of acetone from the squeeze bottle at the sink may be needed to thoroughly clean up all traces of photoresist from a surface.

- Photoresist dropper bottles that you are finished with are to be placed into the “PR Dropper Bottle” collection container which is at the rear of the sink4 deck in that room.
- The organic waste bottles (for chlorobenzene and photoresist + acetone waste) in the white hamper underneath the spinner should never be filled to overflowing- when the waste is at the shoulder level of the bottle it’s time for a bottle swap. Follow the posted instructions at the hamper.
- Glass slides and razor blades are to be disposed in the “sharps” container on the process island table.
- Techni-cloths used for non-PR wiping and worn out gloves can be tossed in the general trash can in that room.

### **Gowning Up**

- Follow the correct sequence to gown up, first by putting on the bouffant cap, followed by the bunny suit and then the shoe cover and white Tyvek booties the last items to go on. This sequence is reversed when removing this attire to minimize particles from falling from your hair and skin onto these pieces.
- Wear the bouffant cap as it is meant to be worn: all hair needs to be covered and/or tucked in.
- If your bunny suit gets torn or ripped, get a replacement the next time you are in the lobby as particles from your closing and skin can find their way out, through the torn area of the bunny suit, into the lab environment and clean surfaces.
- If your white Tyvek shoe covers bottoms are encrusted with dirt, then it’s time for a change. The same goes for the blue shoe covers which are put on first.
- The bunny suits need to be zipped all the way up, not partially. If you are wearing a sweatshirt with a hoodie, keep the hood tucked inside the suit.

### **General Hygiene, i.e Lab Manners**

- Everybody needs to sneeze at some point, so be sure to sneeze away from your wafers and lab equipment (use the classic elbow rule.)
- If you do happen to sneeze into your gloves, please change them at once.
- The techni-cloths provided in each room also serve as the lab Kleenex, so please toss used ones into the trash rather than leaving them scattered on the work surfaces. The same goes for used foam ear plugs: if they are no longer in your ears, they belong in the trash.
- Chemical bottles that have been opened cannot be returned to the chemical storage cabinets in the lobby; there are chemical storage cabinets for opened bottles throughout the Microlab, generally wherever there is a room with a wet sink.
- Do not abandon failed experiments or walk away from broken equipment. They can be traced back to you and may lead to your suspension or expulsion from the lab.
- Report equipment problems promptly on the WAND via FAULTS.

W. Flounders  
M. Kushner  
5/09