

Clean Room Orientation Notes: Overview and General Safety

May 2002

Completion of Clean Room Orientation allows you to gain access to the clean room to become more familiar with the clean room environment and to receive further training from other clean room users. It does not mean that you are immediately qualified to use any of the equipment without supervision. The privilege of using the clean room also carries the responsibility of helping new users learn the proper and safe use of the facility and its equipment.

1. Cleanroom Policies

- a. Only people who have completed clean room orientation are permitted to enter the clean room. The clean room manager or the clean room staff must approve visitors. Visitors must be under the direct supervision of a qualified clean room user.

CHTM Building Manager: Dan Bryant, phone: 272-7671

Cleanroom Manager: Beth Fuchs, phone: 272-7844

Cleanroom Technical Staff: Karen DeZetter, phone: 272-7835

- b. Open hours of operation are Monday through Friday, 7:30 am to 5:30 pm, except university holidays. All entrance to the clean room outside these hours requires a qualified "buddy" who must be present at all times. A qualified "buddy" is someone who has been a regular clean room user for at least two months and is CPR certified. Both users must be qualified "buddies".
- c. Your Lobo card is used to gain access to the clean room. Because we need to know who is in the clean room during any emergency, you must never loan your Lobo card to another user. If you temporarily do not have your Lobo card or it does not appear to be working, you may enter the clean room with another user after you have written a note on the white board with your name and the time you entered the clean room (make sure you erase the note when you exit). Temporary cards are available for long-term checkout.
- d. Safety violations will result in being locked out of the clean room for at least three days. If you make a second safety related mistake within six months, you will be locked out of the clean room for at least one week and your access will be restricted to daytime access for at least one month. A third mistake within six months of your second mistake will require a discussion with your advisor prior to being allowed to resume working in the clean room.
 - i. Users may regain cleanroom access sooner by performing tasks to be assigned by the cleanroom staff.
 - ii. Non-safety violations will be dealt with in a similar manner.
- e. Breaking equipment, not understanding how the equipment operates (including contamination issues), and/or continuous disregard for clean

room etiquette contribute to an unsafe work environment and will be addressed as a safety violation, depending on the severity of the incidents.

- f. All clean room users are expected to follow standard clean room procedures (as outlined in the following text) while working in the clean room and to be properly qualified before using any equipment. Exceptions will be made by permission of the Clean room Committee only.
- g. All persons entering the clean room will be properly attired: bunny suit, gloves, and eye protection are required. All equipment entering the clean room will be cleaned of contaminants. IPA and wipes are available in the gowning room. Wipe all incoming equipment until it is clean.

2. Cleanroom Etiquette

- a. Report any problems: PUT A NOTE ON THE WHITE BOARD WITH AS MUCH INFORMATION AS POSSIBLE.
- b. Clean up after yourself.
- c. Do not touch anything in the cleanroom without gloves.
- d. Return things to where and how you found them, or better.
- e. If you must leave something sitting out, label it with your name, the date and what it is.
- f. Do not leave open containers of chemicals sitting out; make sure that they are covered and properly labeled (name, date, contact phone number, contents, hazards).
- g. Do not borrow other people's supplies without permission.
- h. Do not play with equipment.
- i. Do not work on or use equipment that you do not completely understand or that you are not qualified to use.
- j. Always sign in the logbook when you use a piece of equipment.
- k. Some equipment requires advance sign-up. When signing up for equipment, make sure your name is legible or your sign-up will be cancelled. Do not exceed the time limitations or sign up too far in advance or your sign-up will be cancelled as well.
- l. Do not "hog" a piece of equipment. Other people might need to use the equipment as well.
- m. **Never** leave any equipment unattended while you are using it.
- n. Do not modify equipment.
- o. Smoking, eating, or drinking anything except water is prohibited.
- p. Never wear or apply cosmetics.
- q. Only ballpoint pens may be used. Pencils, erasers or other writing implements are prohibited. Ballpoint pens are available for clean room use; do not take them out of the clean room.
- r. Permanent clean room documents must be copied onto non-linting clean room paper. Laboratory notes should be kept in a clean room notebook. Standard copy paper and textbooks are discouraged. No newspapers or cardboard.

- s. The telephones are not to be used as a message service.
- t. If you notice we are running low on any supplies, let the clean room staff know before we run out: put a note on the white board, and include your name.
- u. If you are unsure about anything related to using the clean room, ASK!

This list is far from complete. The intent is to provide the best research environment possible for you and other users. Please respect it and each other.

3. Safety

- a. If you have any concerns about safety that the CHTM staff cannot address to your satisfaction, please call Campus Safety at 277-2753. If you need immediate help and you are unable to contact CHTM staff or Campus Safety, call 911.
 - i. Use common sense when thinking of safety. Think about how your actions will affect other users as well as yourself. Do not set a bad example for others.
 - ii. The rules for clean room use exist to protect you and your fellow users. Failure to follow them may result in losing clean room access. If you have any questions about safety please ask the clean room manager. There is no excuse for not following safety procedures.
 - iii. Report any safety problems or concerns you encounter to the clean room manager or a staff member. Your observations, concerns, and input are appreciated.
- b. The Buddy System is required for after-hours work in the clean room.
 - i. A qualified "buddy" is someone who has been a regular clean room user for at least two months and who is currently CPR certified.
 - ii. The buddy system will be enforced for all after hour work.
 - iii. Buddies should check up on one another periodically.
 - iv. Plan for after hours work. Find a buddy ahead of time.
- c. Chemicals
 - i. You must inform the clean room staff of any chemicals you plan to bring into the clean room and provide a Material Safety Data Sheet for that chemical before bringing it into the cleanroom.
 - ii. Know where the eyewash and safety shower are and how to use them.
 - iii. Do not use a chemical until you have familiarized yourself with its Material Safety Data Sheet (MSDS). The Material Safety Data Sheets are located in the hallway across from the electronics shop. Please notify clean room staff if we do not have the MSDS for a chemical that has been in use. In particular, pay attention to its

- properties, handling procedures, disposal, health hazards, and incompatibilities.
 - iv. Do not use a chemical or chemical procedure unless you are sure of the results. When in doubt, ask for help.
 - v. Chemicals are to be stored in designated locations only. Do not store chemicals in your lab box or locker.
 - vi. All chemicals transferred from their original containers must list the chemical name and the associated hazards as stated on the MSDS.
- d. Electrical
- i. All electrical wiring and electrical repair are to be done by staff only.
 - ii. Electrical disconnects for the equipment are located on the wall behind each piece of equipment.
 - iii. In the event of the electrocution of someone in the lab, DO NOT GRAB THEM! Disable the power immediately. In the event you are unable to safely reach the electrical disconnect, use the "Shepherd's Crook" hanging on the wall opposite the metal evaporator bay.
 - iv. Do not overload electrical circuits.
- e. Open toed shoes, shorts and dresses, and contact lenses are discouraged. Open clothing reduces your chemical protection in the event of an accident. Many contact lenses are permeable to water (and caustics) and may dissolve in solvents. This can dramatically increase the risk of permanent eye damage in the event of an accident.

4. Emergencies

- a. In the event of an emergency, CHTM is first concerned with the safety of individuals; secondly with equipment and lastly with experiments. Experiments can always be repeated and equipment repaired, but lives cannot.
- b. You should call for help from the location of the problem, or evacuate the building, pulling the fire alarm as you leave if the situation warrants, and then call for help. Call 911 for police, fire, and/or ambulance assistance. Stay on the phone with the operator until they give you permission to hang up. Follow all their instructions.
- c. Power Outage
 - i. Emergency lights will come on.
 - ii. Building facilities may not reset when power is resumed.
 - iii. If you are working in a chemical hood, close the shields. You are no longer working in a safe, exhausted environment.
 - iv. If you are working with a hazardous gas system that is manually valved, close all gas valves.

- v. If the power remains off, leave whatever you are doing in as safe a condition as possible and exit the clean room.
- vi. Do not resume your work until you have been given assurance that building facilities are back on.
- vii. When in doubt, seek help to return process equipment to a safe status.

d. Fire or Explosion

- i. Familiarize yourself with the location of the building's fire alarm pull boxes. There is one near each building exit.
- ii. Familiarize yourself with the use, capabilities and location of the various fire extinguishers.
- iii. In the event of a small fire, if it is safe and you feel comfortable doing so, use a fire extinguisher to extinguish the flames. If you do not feel able to use the extinguisher to extinguish the flames, get help immediately.
- iv. In the event that you do successfully put out a fire, it must be reported to the clean room manager.
- v. In the event of a fire that is uncontrollable or the alarm goes off, leave the building immediately. Do not finish what you are doing; do not try to save personal belongings; do not look for help, etc.... There are many substances present in clean room that, once burning, quickly emit large volumes of toxic dense black smoke. Save yourself by leaving immediately.

e. Gas Leaks

- i. A digital control system constantly monitors hazardous gas levels at critical areas throughout the building. The sensors for this system are located near the equipment using a hazardous process gas and in the gas cabinets located in the chase housing the gas bottles. If a hazardous gas is detected, alarms and operational sequences are activated.
- ii. TLV stands for Threshold Limit Value. It is the time weighted average concentration of an airborne substance that represents the condition under which it is believed nearly all workers may be exposed in a normal 8 hour day, 5 day work week without suffering adverse effects.
- iii. A gas level greater than $\frac{1}{2}$ TLV activates yellow beacons that can be seen from any point in the clean room. Safely shut down your process and exit the clean room.
- iv. A gas level greater than 1 TLV activates red beacons and audible alarms that can be seen and heard throughout the clean room. If your equipment has an emergency shut-off, activate it and immediately leave the clean room and then the building through the nearest exit. Clean room exit routes are posted on the gowning room entrance door. DO NOT exit the clean room through the chase housing the gas cabinets.
- v. Emergency shut-off valves are triggered at the gas cylinders to isolate the leak sources. The clean room make-up air handling unit

and the recirculation air-handling units shut down, and the scrubbed exhaust system increases exhaust velocity to obtain a negative clean room pressure with respect to the rest of the building. This air handling procedure reduces the chance of the spread of gas throughout the building and evacuates gas from the clean room out the scrubbed exhaust. Audible alarms activate throughout the building notifying all occupants to evacuate.

f. Chemical Spills

- i. A small acid or base spill (<500ml) can be neutralized using available neutralizing powders located near the acid and base wet benches. Quick action can reduce the spread of hazardous fumes and reduce property damage.
- ii. If a chemical spill is too large to handle on your own, block off the area to keep other clean room users away, evacuate the clean room through the nearest exit and inform staff.
- iii. Report all chemical spills, no matter how small to the cleanroom manager.
- iv. If bodily exposure of acids or bases occurs first aid must be administered immediately.
- v. Rinse the affected area with large amounts of water at a sink away from the spill area; use the safety shower or the eye wash station, if possible.
- vi. Discard of all clothing that has been exposed to the chemical. Do not let modesty turn a minor chemical exposure into a more serious one.
- vii. If you spill Hydrofluoric Acid on yourself, or if you are not sure what chemical exposure occurred, apply magnesium oxide cream to the effected area after rinsing with water. Hydrofluoric acid (HF) will not burn upon exposure like with other acids. Water does not neutralize the effects of HF. HF will migrate to the bone and destroy all tissue in its path. You probably won't feel pain until major tissue damage has occurred. HF can cause a chemical imbalance in your body that disrupts your heartbeat. **Seek medical attention immediately after all Hydrofluoric Acid exposures.**
- viii. For other chemical exposures, follow the MSDS guidelines and notify emergency personnel.

- g. CPR training is available twice a year. It is strongly recommended that all clean room personnel receive this training and maintain certification. CPR training is required to use the clean room outside of normal working hours.

5. Gowning

- a. Proper gowning can drastically reduce the contamination you impart to your samples and the clean room environment. It is your responsibility to learn and practice proper gowning techniques.
- b. About the Bunny Suits
 - i. The bunny suit does not offer any degree of chemical protection.

- ii. You are entering a class 100 clean room which is certified to have less than 100 particles of a 0.5 micron cross-section or larger per cubic foot of air. This level of cleanliness is necessary for the manufacture of high-density microstructures. The human body is constantly replacing skin cells, which are shed through normal processes. The bunny suit acts as a filter to prevent these particles from entering the clean room. In essence, the bunny suit protects the clean room from you.
 - iii. Human skin oils and sweat contain large amounts of ionic materials such as sodium that can be deadly to semiconductor devices. The bunny suit and gloves help protect the manufactured devices from these substances.
 - iv. Bunny suits are collected weekly for laundering and a clean suit will be put in your locker. In the event you do not have a bunny suit in your locker or you have a defective suit, obtain a replacement through a clean room staff member. Yellow defect tags are available in the gowning area; use them to indicate tears, missing snaps, etc.
 - v. Some individuals are sensitive to chemicals used in laundering. See the clean room manager if you experience any rashes or other symptoms of discomfort from wearing a suit.
- c. Gowning Procedure:
 - i. Put on a bouffant cap containing as much hair as possible. Bouffant caps are disposable.
 - ii. Put on a bunny suit hood, snap side out, elastic on the inside. The hoods are packaged inside out.
 - iii. Put on a bunny suit coverall zipping the hood inside the coverall.
 - iv. Put on bunny suit boots over the coverall.
 - v. Put on eye protection. Prescription glasses are acceptable as eye protection.
 - vi. Put on gloves. These are not chemical resistant gloves!
- d. Gloves
 - i. Latex gloves are tighter fitting than vinyl and do not allow moisture to evaporate as easily. In addition, some individuals may be allergic to the natural rubber latex of which these gloves are produced. Some symptoms of latex allergy may be: hives, runny nose, facial swelling, difficulty breathing, sudden drop in blood pressure, diarrhea, itching, watery eyes, abdominal cramps, nausea, rapid heart rate, dizziness, anaphylactic shock. If any of these symptoms occur that you believe may be related to the use of latex gloves, discontinue use immediately and consult a physician if necessary.
 - ii. Vinyl gloves are loose fitting and can be worn. Some individuals like to switch between latex and vinyl gloves. However, vinyl gloves will dissolve in acetone and other solvents; they rip easily, and make it difficult to handle small parts.

- iii. Nitrile gloves are replacing the vinyl gloves. They are only slightly more resistant to solvents than vinyl. They provide a tighter fit than vinyl gloves, although they are not as stretchy as latex.
- iv. Under-gloves are also available. These are optional and can be worn under either latex or vinyl gloves. They help keep your hands dry under the gloves. If you choose to wear the cotton gloves, please take them home, launder them weekly, and replace as necessary.
- v. **In addition to the normal clean room entrance gloves, special chemical resistant gloves must be worn when working with acids and bases.** Several sizes are kept across from the acid bench.

6. Cleanroom Equipment

Going through a clean room orientation allows a person access to the clean room to receive training before becoming qualified to use any equipment. You should receive training on the necessary equipment from people in your research group or from other clean room users who are familiar with that piece of equipment (look in the log books or at the qualified user lists posted near the equipment to find out who that might be).

- a. PlasmaTherm ICP
 - i. Inductively Coupled Plasma, reactive ion-etch with RF power applied to both the substrate and the plasma.
- b. Electron Cyclotron Reactive Ion Deposition chamber.
 - i. Both 13.56 MHz RF and microwave 2.46 GHz.
- c. Samco PECVD (Plasma Enhanced Chemical Vapor Deposition)
 - i. 300° C silicon nitride from silane and ammonia at 50 W of RF.
- d. Gaertner Ellipsometer is used to measure thin film thickness and refractive index.
 - i. 3-d thickness and refractive index mapping available.
- e. Silicon Only Oxidation and Diffusion Furnaces.
- f. Metal Electron Beam Evaporators are used to deposit a variety of metals onto a sample, up to four metals in one session.
- g. Ion Tech Ion Beam Etch
 - i. Physical etching of materials through high velocity impact.
- h. Thermal Evaporator- resistive heating of low melting temperature metals for metal film deposition.
- i. Modular Process Technology Rapid Thermal Processor (RTP) is used to heat substrates in a controlled fashion up to 450degC.

- j. Process Products Rapid Thermal Annealer (RTA) is used for fast annealing of ohmic contacts.
- k. Tegal Plasmaline uses oxygen plasma to remove photoresist or it uses Freon 14, CF_4 , to isotropically (non-directional) etch silicon nitride.
- l. Technics RIE (Reactive Ion Etch)
 - i. Oxygen and Freon 12 are available.
- m. Tencor Alpha-Step 100 is used to measure vertical heights on substances.
- n. Acid and Base Benches (Corrosive Wet Benches)
 - i. No solvents allowed because of possibility of strong exothermic reaction.
 - ii. Cascade rinse on acid bench only, make sure to use after finishing working with acids.
 - iii. Flush the plenum with water after use.
- o. Corrosive Materials Cabinets contains acids, bases, etc.
- p. Dry Chemical Cabinet is for storing solid chemicals.
- q. First Aid and Spill Station contain acid aid as well as other first aid items.
- r. Safety Shower and Eye Wash stand.
- s. Photolithography Bay is for putting masks onto your samples. The lighting is yellow because photoresist does not absorb at these wavelengths.
 - i. The spinners are used to spin photoresist onto a sample. They are located in an exhausted hood.
 - ii. Ovens are used to bake solvents from photoresist or other materials.
 - iii. Karl Suss MJB-3 Contact Aligners use 365nm and 405nm near UV bands from a mercury light source to expose photoresist. It is also used to align a photomask to a previous layer.
- t. Refrigerator is used to store photoresist and other temperature sensitive materials.
- u. Solvent Benches
 - i. No corrosives.
 - ii. Do not use a solvent bottle from another bench or remove it from its bench because of contamination from the outside of the bottle.
 - iii. Do not empty solvents down the drain, put in proper waste container.
 - iv. Solvent benches are labeled as to what metal processes can be used in each one.
- v. Develop Sink

- i. Develop solutions.
 - ii. Cascade rinse.
 - iii. All water in the clean room is deionized water.
- w. Blue M Ovens are used for parts bake out.
- x. Nikon Microscope
 - i. Verniers for measuring geometries.
 - ii. Polaroid and 35 mm camera mounts.
 - iii. Variety of microscope tricks for looking at hard to see features.
- y. Leitz Ergolox Microscope
- z. HEPA Filters
 - i. Laminar flow.
 - ii. Return air.
 - iii. Make up air.
 - iv. Temperature control, no humidity control (yet).

Equipment Qualification Prerequisites:

People wishing to become qualified on cleanroom equipment must first go through cleanroom orientation. No exceptions allowed.

Users are not qualified until completing all the steps below, then arranging for a qualification time with a member of the cleanroom staff. If they are unavailable, they will designate an appropriate qualifier. They will qualify the user upon successful completion of a qualification process. Note that each process tool except for photolithography tools requires a separate qualification procedure.

Unqualified users are not allowed to operate a process tool unattended. If qualification requires a minimum number of process runs, a qualified user must be present at all times during all of the process runs. Unqualified users should arrange for training well in advance to accommodate everyone's schedules.

ICP

- Basic Vacuum Systems Video Tape
- Read and understand ICP operating procedure
- A minimum of 10 process runs with other users. If you need runs, volunteer to do other peoples runs.

ECR

- Basic Vacuum Systems Video Tape
- Contact Rod Devine for qualification. Additional procedures may be assigned before becoming qualified.

CHA

- Basic Vacuum Systems Video Tape

- Qualification on Metal II with at least 20 process runs since qualification
- Read and understand operating procedure.
- A minimum of 10 process runs with other users. If you need runs, volunteer to do other people's runs.
- Correctly answering all qualification questions

SAMCO

- Basic Vacuum Systems Video Tape
- Read and understand operating procedure.
- Read and understand MSDS of silane and ammonia as the system is not interlocked and users can flow either of these gases into the cleanroom while the chamber is open.

Tube Furnace

- Read and understand operating procedure
- Answer qualification questions concerning proper materials to put in the furnace.

Ellipsometer

- Read and understand operating procedure

Metal II

- Read and understand operating procedure
- Watch video tape for Metal II and Basic Vacuum Systems.
- Answer qualification questions correctly

Metal I

- Read and understand operating procedure
- Be qualified on Metal II
- Watch video tape for Metal I and Basic Vacuum Systems
- Answer qualification questions correctly.

Thermal Evaporator

- Read and understand the operating procedure
- Watch video tape for Basic Vacuum Systems
- Answer qualification questions correctly.

Zia Laser oxidation furnace

- Contact Zia Laser for qualification. Be prepared to explain why you need the system.

RIBE

- Read and understand the operating procedure
- Watch video tape for basic vacuum systems
- Answer qualification questions correctly

Alpha step

- Read and understand the operating procedure

Technics RIE I & II

- Read and understand the operating procedure
- Watch video tape for basic vacuum systems
- Answer qualification questions correctly.

RTA & RTP

- Read and understand the operating procedure.
- Read and understand the MSDS for hydrogen

Plasmaline

- Read and understand the operating procedure.

JEOL SEM

- Watch the SEM video tape
- Read and understand the operating procedure
- Multiple practice runs to learn proper imaging techniques.
- Contact Rick Bradley for qualification.

Wet benches

- Safety overview as covered in cleanroom orientation
- Answering qualification questions about chemical safety and handling.

Spinners

- Read and understand operating procedure for spinners.
- Watch the photolithography video tape (although it deals with photolithography, it does show the spinning of photoresist).
- Answer the photolithography qualifying questions for the spinners.

Aligners

- Read and understand operating procedure for the photolithography bay.
- Watch Karl Suss and Photolithography video tapes
- A minimum of 10 photolithography steps under the supervision of a qualified user.
- Answer the photolithography qualifying questions.