

Clean Room Protocol and Safety Procedure for the Kostas Nanotechnology Center at Northeastern University

**EVERYONE MUST READ THIS DOCUMENT.
FAILURE TO DO SO IS NOT ACCEPTABLE.**

SAFETY AND CLEANROOM PRACTICE

Part of the material in this section has been compiled from Digital Equipment Corporation's Orientation Manual, a set of Material Safety Data Sheets from several manufacturers, and information from the University of Massachusetts.

Additional material safety information is available as a set of Material Safety Data Sheets. They are available in the lab, or from your instructor. They are available online at <http://www.hazard.com/msds/index.php>. You can also find them on the Northeastern University EH&S web site at www.ehs.neu.edu.

Semiconductor processing requires the use of hazardous chemicals and high temperatures, so certain safety guidelines must be followed. Keep in mind that although every effort has been made to reduce the risk of accidents in this lab, it is ultimately up to you to use common sense while working in the facility.

Every lab user must make themselves knowledgeable about the chemicals they will be using by reading the MSDS sheet for that chemical. This is especially important in case of an accident or a spill.

CHEMICAL HANDLING PROCEDURES

- Always make sure you are familiar with the properties of the chemical(s) that you are about to use. The following is only a guide. Complete detailed information is available from the Material Data Safety Sheets.
- When mixing dilute acid solutions, the common rule is **AAA**. Always Add Acid.
- Adding water to some acids, particularly sulfuric can cause a violent reaction.
- Take care not to spill drops of acid onto the outside of the bottle. Always rinse and dry the bottle before putting it back into storage.
- This rule also applies to beakers and graduated cylinders.
- All empty bottles and their caps should be thoroughly rinsed before discarding.

- Do **not** dispose of any waste solvents by aspiration or by pouring down the drain.
- Store this waste in bottles clearly marked with Hazardous Waste labels and place them in the large blue bin for future pick-up.
- Solutions containing metals, such as plating baths and ferric chloride should also be disposed of by this method.
- Small acid spills (drops) may be cleaned up by applying a wet wipe to the area.
- Always rinse the wipe before discarding it.
- Large spills (such as a dropped bottle) should be neutralized using the material available in the spill kits located There are separate kits for acids, HF, and solvents.
- Always wear goggles and gloves when unpacking and storing chemicals.
- Bottles of hydrogen peroxide have a small vent in the cap, so they are shipped in plastic bags to contain spills. Keep these bottles in the bags until ready for use.

Material Safety Information

Special Note:

Hydrofluoric Acid:

HF is a colorless liquid or gas with a sharp, penetrating odor. HF does not burn immediately on contact with the skin or eyes, but is more subtle, quietly penetrating deep under exposed areas, even affecting the bone. It must be rinsed off **immediately** with water (at least 15 minutes), and the area of contact should be leached with a basic salve. By the time a HF burn is felt (up to 24 hours after contact), **it is too late!** Its effects will have spread internally and inaccessibly, far out of proportion to the area first affected. If you think you might have possibly come in contact with HF, wash the affected area immediately, then report at once to the TA, instructor, or health center. When in doubt, **rinse**. Fumes are also harmful, so never remove HF or any acid from the wet bench. Buffered HF has the same dangers and procedures.

<u>Name</u>	<u>Hazards</u>	<u>Safety Note/First Aid</u>
HCL Hydrochloric Acid	Causes burns to eyes and skin Irritation nose and throat	Wear rubber gloves, safety goggles and face shield. IN case of contact immediately flush eyes or skin with water for at least 125 minutes, with clothing removed for exposed area Notify Lab Manager Immediately
HNO ₃ Nitric	Causes severe Burns to skin or eyes Inhalation of vapor is injurious to lungs. Symptoms may be delayed	Same as above
H ₂ SO ₄ Sulfuric Acid	Causes dehydration and is rapidly damaging to all tissues. Ingestion	Same as above

	may cause severe injury or death	
Phosphoric Acid H ₃ PO ₄	Weaker than Nitric or Sulfuric acids, corrosive and causes burns on contact	Same as above
Acetone	Low Toxicity solvent. Irritation of mucous membranes, headache and dizziness may result from exposure to vapors	Same as above
Developer	The hazardous component is a weak base(Tetramethylammonium hydroxide) Contact with eyes may cause Irritation or burns. May irritate on contact with skin and mucous membranes	Same as above
Resist Stripper Type 1165	A solvent. Liquid may be an irritant to skin eyes and mucous membranes	same as above
Hydrogen Peroxide H ₂ O ₂	Causes severe damage to possibly delays, possible blindness. Bleaching, blistering of skin on contact	Same as procedure for acids
Positive Photo Resist	Red liquid with a slightly sweet odor. Vapors are irritation to eyes, nose, and respiratory tract. Liquid contact with eyes may cause moderate burning , tearing redness and swelling. Liquid contact with skin may cause irritation	Wear goggles and vinyl gloves incase of skin or eye contact flush with water for at least 15 minutes, with clothing removed from exposed area Notify Lab Manager
TCA 1,1,1-Trichloro ethane	Skin, eye and mucous membrane irritation. May cause central nervous system depression	In furnace, same procedures as for acids. Normally not handled
Philtec dressing sol.	Solvent based. Flammable, Irritation to skin and eyes	Wear goggles, clean room gloves Follow solvent procedures
Philtec	Low toxicity solution	Wear goggles, clean room gloves

Safe-t-Stains		Flush Skin, eyes with water if contact occurs
HMDS	Xxxx	xxxx
SU-8	xxxx	xxxxxx
PMMA	xxxx	xxxxxx

Table 1 (Acids/Bases) . This table is not a substitute for the users reading the MSDS sheets

Safety Practices for Acids/Solvents

General

- In the event of chemical contact, begin rinsing immediately, then contact TA, lab manager or lab engineer.
- Always wear safety goggles in the lab.
- When using wet benches, put on face shield, acid gloves, and apron as described in the safety lecture.
- Never assume that any liquid is "just water". Treat it as HF. (Hydrofluoric Acid).
- Assume your hands are dangerous and dirty. Never touch your face, eyes, or skin!
- Use **extreme** caution with HF solutions. If you are in doubt about contact, rinse.
- Use insulated thermal gloves when handling hot quartz ware.
- **If you are not sure of a procedure, ask the TA or the lab engineer.**
- No open toe, open heel, high heel shoes or clogs are permitted in the lab.
- Absolutely no shorts or skirts allowed.
- Concentrate on your work; most accidents occur as a result of carelessness or complacency.

Chemicals/Materials in the Clean Room

General

Never bring any new Chemicals in the clean room that are not approved without permission

- MSDS must be provided for any unapproved chemical agent or material
- MSDS sheets for all chemicals are located in the vestibule of the clean room or can be viewed online at <http://www.hazard.com/msds/index.php>.
- You should be familiar with the MSDS sheets for the chemicals you are using.

Chemical Storage

- All chemicals must be stored in their proper Storage Cabinets –Do not MIX!
- Solvent cabinets are provided for bulk solvents.
- Acid storage cabinets are provided for acid storage
- Storage is provided in the lithography area for photo resist and developer
- Solvent squirt bottles left in the open should be returned to their “home positions” when done
- All solvent bottle labels must be approved according to the *Hazmet* description.
 - Check the following web site <http://www.hazard.com/msds/index.php>
- Use only bottles approved by the Fab for solvent distribution.
- Any bottles containing chemical for projects use must be clearly labeled with owners name and dated

Chemical Transportation

- Only transport bulk chemical acids, solvents in appropriate transportation i.e. carts and carriers.

Chemical Spills

- For small solvent spills use available clean wipes and put in the red hazmat containers located throughout the lab
- For small acid spills use the acid spill kits located throughout the lab. There is one in the acid etch bay in one in lithography
- For large spills of acids and solvents immediately inform others in the lab and call the fab supervisor and or emergency response –see below.

Note for Emergency Spill response. John Price and Steven Brehio (x2769 - day or x3333 - 24 hour coverage) are Emergency Coordinators for the University and must be contacted in the event of a major (a threat to public health, safety or the environment) spill or other emergency. The Boston Fire Department can be reached by calling the Northeastern University Public Safety Division emergency number at x3333. Laboratories or departments should have spill kits available to handle small routine spills. Any large or dangerous spills that are beyond the laboratory workers ability to handle it,

or is a hazard to health, safety or the environment must not be handled by untrained personnel. In such a situation, the University's emergency number (x3333) should be called, so appropriate emergency spill response can be made. If it appears necessary that the building should be evacuated because of the extent of the spill, then the fire alarm should also be pulled.

Fire/Safety Evacuation

Response to Building Fire Alarm

- Notify everyone in the lab.
- Pull fire alarm if necessary.
- Immediately shut down any equipment and follow the nearest exit from the building
- If the equipment has an EMO switch, engage that and proceed to the nearest building exit,
- Exit the lab by any of the doors. Do not stop to remove clean room apparel.
- Do not block exits.

Response to Local Fab Alarms

- The lab does not have local machine alarms as of yet.

Important Emergency Phone Numbers

To dial any internal phone number, just dial the extension. To dial an outside line dial “9” then “1” then the number...

Kostas Center- Lab Director

Rich DeVito: 617-373-4690 / Cell 781-632-6886

Kostas Center- Lab Manager

Scott McNamara: 671- 373-7728 / Cell 774-282-0534

After Hours

Northeastern University Police: 617-373-3333

Northeastern University Emergency Coordinators: (617) 373-2769

- Steven R. Brehio, Emergency Coordinator
- John M. Price, Alternate Emergency Coordinator

University Offices

- Northeastern University Office of Environmental Health and Safety: (617) 373-2769
- Web Site: <http://www.ehs.neu.edu>
- Northeastern University Physical Plant: (617) 373-2754
 - Water leaks , electrical issues after hours

Clean Room Practice: Basics

A significant fraction of the effort in semiconductor processing goes toward elimination of contaminants. These include metals, organic compounds, and dust (particulates, in the current jargon). One of the most pervasive of these is sodium, from NaCl, and a primary source is people. Certain procedures are effective in reducing contamination, and some of the most important are summarized below. The room itself is clean, and is rated by the number and size of particles in the air. The Northeastern laboratory in the Dana building has been designed for class 10,000 conditions, with class 1,000 conditions in the lithography room. Measurements have shown that the facility exceeds these standards.

The new Kostas Center in the Egan Building has been designed for class 1,000 conditions, and class 100 conditions in the photolithography room with 100% HEPA coverage, and it exceeds these standards. The imaging lab is designed for class 100,000.

Clean Room Gowning

Basic Fab Gowning



Figure 1. A Properly Gowned Individual for Clean Room Work

- Always don clean room apparel before entering the lab.
- You will be issued the following:
 - hood
 - goggles
 - booties
 - Jump suite
 - A hanger with your name on it
- These materials will be picked up once a week for cleaning.
 - Draw new materials as required from the stores in the vestibule
- Bouffant , face masks and gloves are used one time and are disposable at the end of each session
- Step on the tacky mat when entering the lab to remove dirt from your booties.
- Change your gloves when necessary in the clean room if you're doing a "dirty" process".
 - Often, you can keep your 1st pair on and just put on a 2nd pair over them without losing much dexterity.

- Clean room attire must **not** be worn outside the lab, except in evacuation situations.

Acid Gowning

- In addition to the attire in the section above, when using acid etches in the fab for wafer cleaning and such the user must wear the following:
 - Plastic full face mask
 - a purple plastic acid robe
 - Special acid gloves.
- All these items are kept at the Fab acid etch bay.



Figure 2 Properly gowned individual in the Acid etch Bay

Imaging Lab Gowning

- Gowning for the imaging lab in Kostas involves less drastic attire than in the fab.
- All gowning materials are available from the vestibule in the imaging lab
- Always don clean room apparel before entering the lab.
- Keep your re-usable attire in the bin assigned to you with your name on it in the vestibule
- Step on the tacky mat when entering the lab to remove dirt from your booties.
- Clean room attire must **not** be worn outside the lab, except in evacuation

situations.

- Tyvex lab coats are to be used for at least 3-4 weeks or until frayed or ripped.
- Disposable blue booties can be re-used until frayed or at users discretion.
- Gloves and bouffant should not be re-used.



Figure 3. Properly gowned individual in the Imaging Lab

Clean Room Protocols

- **No paper, pencils, felt-tip pens, erasers, food, drinks, cardboard, or unpainted wood inside lab.**
- **Lab notes should be taken on special lint-free clean room paper.**
 - Available from Kostas facility
- **Use pens only.**
- Assume gloved hands are dirty.
- Do not handle wafers or quartz boats with gloved hands.
- Always use tweezers to handle wafers.
- The utensils (tweezers, cassettes, etc.) in the lithography room should be kept segregated from those in the furnace area.
- Photoresist is an organic compound and can have an adverse effect on high temperature steps.
- Take care not to breathe over wafers and wafer work areas. **No gum chewing.**

- Clean room attire must **not** be worn outside the lab, except in evacuation situations.

Clean Room House Keeping

- Clean Up after Your Self. There are trash bins in the Clean room for throwing out wipes broken wafer etc. If the mess extends beyond this we have clean room sticky mops at clean stations in the chase for you to access. At one of these station is also a clean room vacuum.
- If someone else has left a mess please bring this or the individual to the Lab Managers or Directors attention.
- All samples, note books, wafers etc. should not be stored loose on a shelf. These must be stored in clear plastic bins available from the clean room stock. Just ask the clean room facilities for one. Put your name on it in Sharpie
- Every person will have a shelf space for his or her experiments in the clean room or in the chase area. The clean room and chase are not storage areas. After 12 months you will be asked to store your own samples else where.

Clean Room Lab Etiquette.

- The above rules are meant to create a structured, safe and pleasant working environment for all who use the facility. Please be respectful of other peoples work space / experiments as you would want them to respect yours.
- If there is a disagreement or argument about any issue in the clean room don't take it upon yourself to settle it. Take it to the clean room manager or director.
- Never take or borrow equipment from someone else's work space /experiment without permission.
- Violation of these safety rules and protocols rules could result in temporary suspension from the Kostas Facility clean rooms.
- If you're going to use the Web computer in the clean room to play music please be respectful of others. Ask about the volume. Don't let them come to you!
- Leave room for others at acid hoods
- Label unattended setup with: your name, chemicals in beaker, phone #, time and date started, time and date you will finish Remember: Special permission required for more than 24 hours unattended.

- Volunteer to help clean up in the lab when requested.
- Put things back when you are done.... for example, tools...
- Report broken equipment, safety issues or any suggestions that would make the lab more user friendly.

Clean Room Equipment Usage

- Every person qualified to use the equipment must sign up prior to use, either online or in the log book if no online booking is available
- If a person fails to show up within 30 minutes of the reservation time, the machine will be kicked back to general usage. If this is for a fee based machine the user will be charged for the ½ hour unless he calls to cancel prior to the ½ hour time limit
- For equipment that is fee based you are required to sign out at the end of your reservation period so charges may be established. Use the log book at the machines for this
- For equipment that is not charged no sign in is required- see the equipment charges sheet to see what equipment is fee based.

Violation of Kostas Center Clean Room Safety and Protocols

General

Kostas has a 3-strike policy in a calendar year, which proceeds as follows:

For a first time violation

There is a written warning by email informing the Fab director and Manager, the individual, and his professor of the incident.

Second time violation.

The individual will have his privileges suspended.

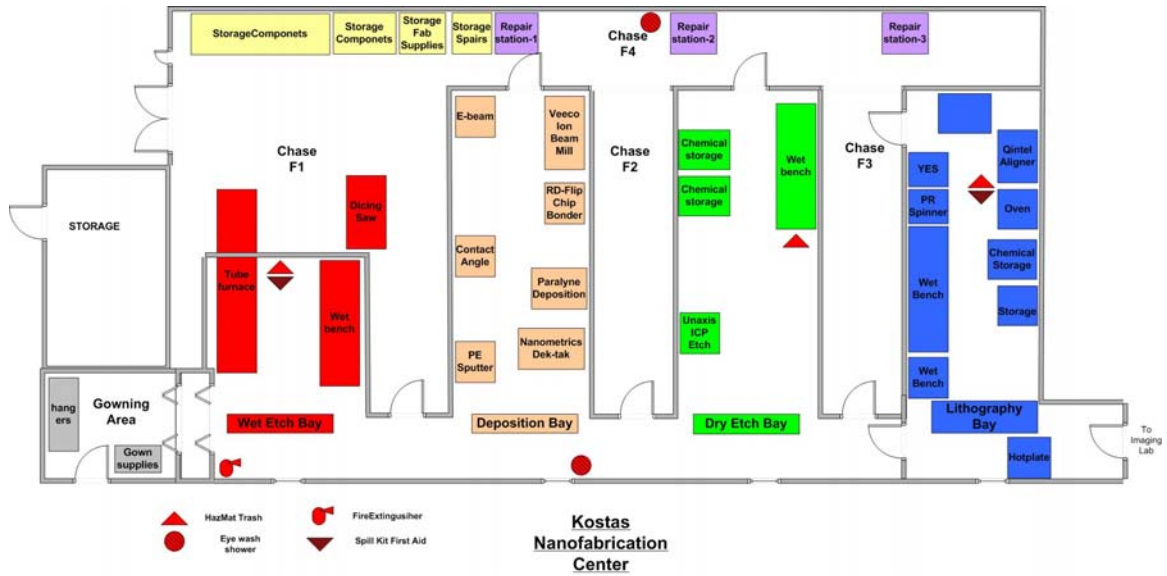
A meeting will be held with the Fab Director, the student's advisor and the student to determine appropriate steps for re-instatement. The individual will be expected to be retrained and re-certified in this protocol. He must again sign that he understands it.

Third time violation.

The student will be suspended indefinitely until the Fab Director and the advisor can work out details of re-instatement.

Appendix

Kostas Facility Layout



Kostas Nanofabrication Center Imaging and Characterization Lab

