

**MICROFABRICATION LABORATORY  
SAFETY AND CLEANROOM PROCEDURES**

**JANUARY 2001**

**EVERYONE MUST READ THIS.  
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, available in the lab, or from your instructor.

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.

## **Fire/Safety Evacuation**

1. Notify everyone in the lab.
2. Exit the lab by any of the doors. Do not stop to remove cleanroom apparel. Do not block doorways.

## 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 on the storage shelves in the maintenance area. 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. Irritating to 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 15 minutes, with clothing removed from exposed area. <b>Notify LAB MANAGER</b>
HNO <sub>3</sub> Nitric Acid	Causes severe burns to skin or eyes. Inhalation of vapor is injurious to lungs. Symptoms may be delayed.	Same as above.
H <sub>2</sub> SO <sub>4</sub> Sulfuric Acid	Causes dehydration and is rapidly damaging to all tissue. Ingestion may cause severe injury or death.	Same as above.
Phosphoric Acid H <sub>3</sub> PO <sub>4</sub>	Weaker than Nitric or Sulfuric acids, corrosive and causes burns on contact.	Same as above.
Acetone	Low toxicity solvent. Irritation of mucous membrane, headache and dizziness may result from exposure to vapors.	Same as above.

<b>Name</b>	<b>Hazards</b>	<b>Safety Note/First Aid</b>
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	A solvent. Liquid may be irritating to skin, eyes, and mucous membranes.	Same as above
Aluminum Etch	A mixture of phosphoric, nitric and acetic acids. Contact with common metals produces H <sub>2</sub> .	Same as procedures for individual acids.
Hydrogen Peroxide H <sub>2</sub> O <sub>2</sub>	Causes severe damage to eyes, possibly delayed, possible blindness. Bleaching, blistering of skin on contact.	Same as procedures for acids.
Positive Photoresist	Red liquid with a slightly sweet odor. Vapors are irritating 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. In case of skin or eye contact, flush with water for at least 15 minutes, with clothing removed from exposed area. <b>Notify LAB MANAGER.</b>
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, irritating to skin and eyes.	Wear goggles, cleanroom gloves. Follow solvent procedures.
Philtec	Low toxicity solution.	Wear goggles, cleanroom gloves.
Safe-T-Stains		Flush skin, eyes with water if contact occurs.

<b>Name</b>	<b>Hazards</b>	<b>Safety Note/First Aid</b>
N <sub>2</sub>	Can produce hazardous atmospheres through displacement of O <sub>2</sub> . Burns from cold liquid or gas.	If skin is exposed to cold N <sub>2</sub> , flush with tepid water ≈105°F. Wear goggles when handling liquid.
SF <sub>6</sub>	Same as N <sub>2</sub>	
O <sub>2</sub>	Promotes combustion.	

### **Safety Practices**

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

## Cleanroom Practice

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 Microfabrication Laboratory 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.

### Procedures

1. Always don clean room apparel before entering the lab. You will be issued a lab coat, a hood, and goggles. Keep these rolled up in a bin in the storage cabinet for use during the quarter. Put on booties, a facemask, and vinyl gloves. Dispose of the gloves and facemasks at the end of each session. Step on the tacky mat when entering the lab to remove dirt from your booties.
2. Change your gloves when necessary. Often, you can keep your 1st pair on and just put on a 2nd pair over them without losing much dexterity.
3. **No paper, pencils, felt-tip pens, erasers, food, drinks, cardboard, or unpainted wood inside lab. Lab notes should be taken on special lint-free cleanroom paper. Use pens only.**
4. Assume gloved hands are dirty. Do not handle wafers or quartz boats with gloved hands. Always use tweezers to handle wafers.
5. 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.
6. Take care not to breathe over wafers and wafer work areas. **No gum chewing.**
7. Clean room attire must **not** be worn outside the lab, except in evacuation situations.