EECS 143
Microfabrication
Technology

Safety, Cleaning, and Chemical Disposal Procedures

1. Using Acids

At many points in the fabrication process strong acids are used as etchants. These cause severe burns if kept in contact with your skin for more than a few seconds, and will cause blindness if splashed in your eyes. Especially dangerous is HF, a component of virtually all oxide etchants. HF burns do not hurt immediately on contact, but by the time they do start to hurt, it is too late. The result is a severe burn which is very painful over prolonged periods and is slow to heal, sometimes taking several weeks. Some precautions to observe are:

1. Always wear protective clothing, including a face mask, rubber gloves, and apron when handling corrosive chemicals. Check gloves for pinholes before putting them on. The protective wear should be stored according to the following rules to avoid contamination:
   a) Aprons should be returned to the hanging posts with the "front side" (clearly marked) facing into the wall. This is noted by a sticker on the wall. This procedure prevents the potential of chemicals being spilled onto an apron, and then the contaminated side being used as the inside of the apron inadvertently.
   b) Gloves should be stored in plastic bags. Only ONE pair of gloves belongs in each bag. Please dry the gloves as much as possible prior to storing them following each use.

2. In preparing a solution involving an acid, <u>always add the acid last</u>. The exception to this rule is Piranha, in which case you add hydrogen peroxide (H_2O_2), a very strong base, to sulfuric acid (H_2SO_4), a very strong acid. Why? Because it is potentially explosive and at the very least will cause the solution to become **very warm**. For example, a fresh mixture of Piranha can easily reach temperatures above 100°C! Picking up a beaker that is this hot will be very painful, might melt your gloves, and may cause you to spill it! We want **none** of these things to happen!

   *For this reason always use **pyrex beakers** for **Piranha**. Piranha can melt and even attack plastic containers.*

3. Use the chemicals only in the designated area; do not transport chemicals around the room in beakers. Never pour chemicals back into the original container.

   *Special Note: Always use **plastic beakers** for etchants containing **HF**. Why? Because HF etches glass (pyrex)!*

   Always seek help if you have any questions.

4. Discarding acids:
    1. **Aspirate** buffered HF (10:1 H_2O:HF).
    2. **Aspirate** silicon etchant.
    3. **Aspirate** Piranha (H_2O_2 & H_2SO_4).

2. Organic Solvents

1. Solvents used in the lab are: 2-propanol, trichloroethane, and acetone. These are harmful when inhaled -- use only in an appropriately **vented area**.

2. Discarding solvents:

    1. **DO NOT Aspirate** trichloroethane. Instead, pour it into the large brown jug labeled "Organic Waste".
    2. **Aspirate** propanol.
    3. **Aspirate** acetone.

     *Do not mix Piranha and organic waste. The mixture is explosive!*

3. Photoresist Developer

1. The developer contains tetramethylammonium hydroxide (TMAH), which is very basic. It will blind you if you get it in your eyes and leave it there.

2. Discarding developer:

    - **Aspirate** photoresist developer.

    ALWAYS ASK WHEN UNSURE OF PROCEDURE! This is the only way to maintain a safe laboratory for yourself and your fellow students.

Chemical Exposure

If you are splashed with a dangerous chemical, it is imperative that you rinse the area immediately to remove and dilute it before it soaks very far into your body tissue. If you are unsure of whether you contacted a chemical (e.g., unsure whether a wet spot is acid or just sweat), it is better to play it safe.

For chemical contact with your eyes, immediately rinse your eyes with water at the eyewash for 15 minutes. Have someone contact emergency services.

For the chemical contact with your skin, rinse at the sink (either in the clean area or at the sink behind the clean area) for 15 minutes. If needed, use the safety shower behind the clean area. Have someone contact emergency services.

Chemical Information

Students should be aware that the Office of Environment Health and Safety has safety information for all chemicals in the lab (and for any other lab on campus). This information is contained in the Material Safety Data Sheets (MSDS) and is available to any student or employee of the University who works with chemicals. Sample MSDS are posted in the lab for your perusal.

In the near future MSDS sheets for all the chemicals used in the lab will be available in the lab itself (218 Cory).

General Rules

Contamination can be divided into two classes: Chemical and particulate. Examples of chemical contamination are sodium ions and oils from your skin. Examples of particulate contamination are dust from the air, exfoliated skin, hair, and dandruff. Humans are usually the dirtiest objects in a clean room.

Never touch semiconductor specimens, the insides of beakers, the wafer-handling end of tweezers, or photolithographic masks with your fingers. This also applies to furnace boats (especially) or any other equipment which can transfer particles from your skin to the semiconductor devices. Obviously, contaminating a furnace (for example, by touching the boat and then inserting it into the furnace where any contaminants are vaporized) will ruin not only your attempts at device fabrication, but those of all who follow.

Cleaning Procedures

General cleaning procedures for preparing your sample follow. They fall primarily into three categories: (1) removal of gross contaminants; (2) removal of organic contaminants; and (3) removal of light and heavy metallic ion contaminants. All instruments used, i.e., beakers, tweezers, etc., must be cleaned before being used to clean wafers.

1. Cleaning Tweezers, Wafer Boxes and Plastic Wafer Holders

Scrub parts in DI water containing several drops of the liquid detergent, "Nova Clean". Rinse well in DI water. Blow dry.
Note: Nova Clean liquid is available in microlab.

2. Cleaning Glass and Teflon Beakers

1. Scrub with Nova Clean diluted in DI water.

2. Rinse in DI water. Perform the "water break" test to determine if the item is clean: submerge the item in DI water for several seconds and then lift out. Observe the film of water as it drains off the item. On a clean surface, this film will remain unbroken and fairly uniform. Contaminants will cause breaks or sharp irregularities such as "islands" to appear in the color fringes and droplets that remain on the surface.

3. If necessary, glassware can be further cleaned in dilute (10:1) HF. This removes the outer layer of glass.

4. Rinse in DI water for 5 minutes.

5. Let dry top down, on lint-free paper.

3. Correct Wafer Handling Technique

1. Contamination:

   To minimize contamination from tweezers, plastic "holders" are available for handling wafers in solutions, and should be used in lieu of tweezers. Wafer drying is accomplished by drying with the nitrogen guns, or by spinning in special spinner so designated.

2. Avoiding Wafer Breakage:

   Wafers can be both quite strong and yet quite brittle. If a wafer is in a typical wafer boat, it is standing on edge in a pair of slots cut into the boat. After processing wafers in this position, they often become lodged tightly into these grooves. To remove the wafer you can use tweezers to pull directly up on the wafer. This is most easily done by looking down on the top edge of the wafer. From this vantage point you can be sure that you are not applying a torque that can **easily shatter the wafer**. A common mistake is to look at the side of the wafer while you do pull on the wafer. From this vantage point it is difficult to tell whether or not you are pulling directly up on the wafer and so often an excessive amount of torque is generated which breaks the wafer.

   You also want to avoid torque when you attempt to remove a wafer from a flat vacuum chuck, such as that in the spinner we use when applying photoresist. If the vacuum is on or if there is a film of liquid beneath the wafer, it may be difficult to get the wafer off the chuck. Using a pair of tweezers to pry and lift up the wafer from an edge will exert torque on the wafer and care must be taken to avoid applying an excessive amount.

4. Cleaning Furnace Apparatus after Contamination

1. 5% HF:H_2O for 20 seconds.
2. Rinse, blow dry.
3. Bake for 30 minutes.

5. Cleaning Photomasks

This procedure should be performed at least 30 minutes before photo step.

1. Dip in acetone for 15 minutes.
2. Rinse.
3. Scrub with cotton ball dipped in EKC Mask Cleaner.
4. Rinse well.

5. Soak in 1:1 2-propanol:water for 15 seconds.
6. Soak in 100% 2-propanol for 15 seconds.
7. Blow dry.

Last modified by Paul Friedberg, Fall 2002.