AggieFab Manual

(Updated 07/2019)

Contents

1. Accessing the AggieFab

1.1. AggieFab Access Protocol

- AggieFab uses the iLab system to handle all services (membership, training, etc).
- To begin the process of becoming a user, please visit the following web address: https://aggiefab.tamu.edu/become-a-user/
- Safety Training

  All users must receive basic safety training through safety training courses offered by TAMU as well as various AggieFab specific trainings. For more details, see Section 2.
- Authorization request and receiving card key access.

  Upon finishing all safety training, the advisor should request AggieFab access by sending an email to admin@aggiefab.tamu.edu. The user will be asked to submit all safety training documents and the signature page in Section 3 as a PDF through the iLab system. Upon confirmation and approval, the user will receive card key access to GERB. To receive card key access to AggieFab, the user needs to be qualified for at least one instrument in AggieFab (see Section 4).
- Personal protection equipment (PPE)

  User will receive cleanroom garments (hood, coverall, boots, safety glasses) from AggieFab staff. Other PPE, such as acid gloves, acid aprons, and face shields are available inside the cleanroom.

All users are required to follow the AggieFab Rules outlined in this document. Failure to do so may result in losing access to AggieFab.

1.2. Operation hours

Normal Operating Hours: Monday – Friday, 8AM – 5PM

After Hour Operation: After-hours access is granted on a subjective basis to users who have been working in the lab for at least one (1) semester and have demonstrated they can handle tools and processes responsibly. There must be at least one other user in the lab with you while you are working after-hours. This is to ensure the safety of both users. It is also strongly recommended that users finish their work during 8AM to 11PM. Please limit the use of the AggieFab outside of these hours to minimize the safety risk. If the need to work after 11PM arises, prior approval should be obtained by providing a detailed account and explanation.

Furnace usage after 11PM (such as having to take out samples due to long run times) is excluded from the approval requirements outlined above, but notification should still be sent to admin@aggiefab.tamu.edu.

1.3. Internal Visitor Access Guidelines

- Current AggieFab PI's bringing a visitor for a lab tour will not need to get approval.*
- Cleanroom users (students, postdoctoral researchers, technicians) bringing a visitor for a lab tour on behalf of their PI must have the PI submit a written request (email) to the AggieFab Manager for approval prior to the tour.*
- No other personnel will be allowed to enter the facility.
- If exception is needed for special circumstances, the PI will have to submit a written request (email) to the AggieFab Director, the case will be discussed by the AggieFab Committee, and will require final approval by the Director.
- All visitors to the AggieFab must sign the Liability Waiver prior to entry. See page 23.

All other visitors not affiliated with Texas A&M will need to contact Chelsey Michalsky (cmichalsky@tamu.edu) for more details on access

2. AggieFab Safety

Safety is extremely important during the conducting of experiments and any blatant disregard of safety guidelines will result in immediate expulsion from AggieFab.

2.1. General Safety Information

- No eating or drinking is allowed in the lab.
- Proper attire to enter the lab is close-toed shoes, long pants, and a sleeved top. While in the lab, you must wear a hairnet, nitrile gloves, and shoe covers under your cleanroom coverall, hood, and boots.
- This is a shared user space. Keep your work area neat and orderly upon finishing your experiment by cleaning up any mess you may have made.
- Put all chemicals or tools back where you found them.

2.2. Safety Precautions

- If you are unsure or don't know, call the lab manager or equipment trainer.
- Know the locations of emergency showers, eyewash fountains, fire extinguishers, respirator masks, first aid kits, and safety data sheets (SDS) (*See* Appendix I).
- If an acid or base splashes into a person's eye, flush the eye profusely with cold water for 15 to 20 minutes using the eyewash station. It is imperative that the eye be held open during the rinse. After rinsing, seek immediate medical treatment.
- If an acid or base splashes onto your skin, rinse immediately in cold water for 15 to 20 minutes. Then notify the lab manager.
- If an acid or base spills on your clothing, remove the clothing immediately.
- For Hydrofluoric Acid (HF) burns, apply Calcium Gluconate gel immediately (*See* Appendix II).

2.3. Training Requirements

Complete the following training by visiting https://ehs.tamu.edu/programs/laboratory-safety/

Introduction to Laboratory Safety (classroom, course number: 211126)

On-line Hazard Communication Training (online, course number: 211138)

Visit 'Single Sign On' (**https://sso.tamu.edu/**) via HR Connect to complete other certified general safety Trainings via TrainTraq.

If you do not receive a certificate, contact David Breeding of the Engineering College Safety Office at **safety@tees.tamus.edu** with following information to receive the training certificates.

- Student's full names as registered
- UIN number
- Affiliation
- Laboratory assignment by building & room number
- Name (s) of actual safety courses completed
- Name & email of their professor or supervisor
- Their statement under the *Aggie Honor Code*, that they have thoroughly studied and completed the course materials and their pledge to apply this knowledge to reduce risk for themselves and others.

2.4. General Handling of Laboratory Chemicals

A number of strong acids, solvents, and bases are used in the lab. Users should be aware of the characteristics of each chemical used in the laboratory as well as the general handling and safety guidelines listed below. For more detailed information on the chemicals and materials used, the SDS is available through the AggieFab website (aggiefab.tamu.edu) under the "Training" tab.

Bringing New Chemicals or Materials into the AggieFab

- If you don't see the chemical you want to use in the cleanroom in the MSDS folder, you are not allowed to bring it in.
- If you would like to bring any new chemicals or materials, the user or PI must submit a written (e-mail) request to the AggieFab manager or administrator. Describe the process steps needed for this new chemical or material. The request is then reviewed by the Materials Review Board for approval.

Safety Precautions

- Always wear proper protective clothing, including rubber gloves and safety goggles.
- Always check rubber gloves before using them. Never touch your face or body while wearing rubber gloves and always rinse gloves off before removing them. To check for leaks, inflate the glove using the N2 nozzle and see if the glove can hold the inflated state.
- All chemicals, especially acids, bases, and strong solvents, should always be used in an exhausted fume hood.
- Photoresist-related chemicals should be used in well-ventilated areas.
- Always label beakers and do not let beakers of unused chemicals accumulate.
- Rinse empty beakers thoroughly by placing them under a running water faucet for several rinses and then placing them top down in the drying oven.
- Always start with clean beakers that have been placed top down in the drying oven or on the storage shelves.
- Never pour excess chemicals back into the containers. Pour excess chemicals into the appropriate waste container. When finished, return containers to their storage locations immediately.
- All chemicals should be disposed of according to the guidelines set forth by the lab. See Appendix VI.
- Chemicals such as solvents, some acid mixtures, etchants, developers, strippers, and bases must be poured into their designated waste containers for later pickup.
- Always assume unknown liquid spills and beakers with unknown substances are dangerous and treat them accordingly.
- When in doubt about the proper procedure, always ask a staff member.

Handling Solvents

- Solvents are volatile, and their fumes are highly flammable. Clearly, flames should not be allowed in the lab. If fumes from solvent in a beaker should happen to ignite, cover the top of the beaker with another larger beaker or container to extinguish the flames.

Handling Acids and Bases

- When working with strong acids, a face shield, acid apron, and acids gloves should be worn for maximum protection. Never pour water into acids as this can cause a reaction, which will splash acid everywhere. Always pour acids slowly into water.

- Always pour acids carefully to avoid splashing. Wipe off any excess from the bottle and return it to its proper storage area after use.

Safety Information

- Sulfuric acid is extremely corrosive and toxic to body tissues. It will rapidly attack the skin and can cause severe burns and blistering.
- Nitric acid can also destroy tissue and cause burns, but is not quite as destructive as sulfuric acid. Nitric acid leaves a characteristic yellow stain on the skin.
- Phosphoric acid should not be heated to the boiling point since the fumes are toxic. It will cause burns if it contacts the skin.
- Ammonium hydroxide is a powerful base that can cause severe burns. It should always be used with adequate ventilation.

Handling Hydrofluoric acid (HF)

- Hydrofluoric acid can produce severe skin and deep tissue burns that are slow in healing. It is more dangerous in that burns may not be noticed until sometime after the exposure and the burns can be extremely painful. Please see *Appendix II* for detailed handling information.

Handling Piranha Solution

- Piranha solution is a mixture of sulfuric acid (H_2SO_4) and hydrogen peroxide (H_2O_2), used to clean organic residues off substrates. Please see *Appendix III* for detailed handling information.

Handling TMAH

- The use of TMAH is only permitted with prior approval of the AggieFab Lab Manager. The request must be in writing (email), and all safety equipment must be provided and on hand during use. TMAH may only be used during normal business hours and when the technical staff is present.
- Note that most photoresist strippers and developers contain TMAH.
- TMAH is considered a health risk, especially for women of child bearing age

Solution Mixing Guidelines

- Use a face shield rather than goggles. Mix chemicals under an exhaust hood. Never peer into the top of a beaker - always view it from the side.
- Pour chemicals slowly and make sure you have the correct chemicals.

- Never pour excess chemicals back into the containers. Pour excess chemicals into the appropriate waste container. When finished, return containers to their storage locations immediately.

2.5. Furnace Safety

Furnace temperatures frequently exceed 1100 °C in the flat-zone of the tube. The following procedures should be observed when working with a furnace.

- The quartz tube of the furnace glows (orangish) when heated. Staring at this for long periods of time may damage your retinas.
- Keep the open end of the furnace tube covered as much as possible to prevent diffusion of atmospheric gases.
- Although the sides of the furnace are generally cool to touch, the quartz ends may be quite hot.
- When removing the end cap, use a thick cloth or glove for protection. When a push rod is removed from the furnace, the end will be too hot to touch for at least five minutes.
- Glass components on the furnace setups are actually quartz, which means they are quite expensive. Handle them carefully!
- Gases flow continuously through the furnaces.

2.6. Electrical Safety

The electrical hazards in the lab are comparable to those of other electrical engineering laboratories with a few notable exceptions.

- The probe stations can produce several hundred volts and lead to fatal shocks. Keep the curve tracer OFF while connecting leads to the device being tested.
- Always ground the Lesker Electron Beam Evaporator using the ground rod to the left of the tool. See the tool's Standard Operating Procedure for detailed information.

Equipment such as furnaces and mask aligners may have high-voltage circuitry behind protective panels. Do not attempt to work on this circuitry!

3. Signature Page

- I **have completed all required safety trainings as outlined in this AggieFab manual.**
- **I have read all safety instructions, including the appendices, and agree to observe all safe lab practices.**

Name of Student (print): _____

Supervisor (Name): _____

Student's Address:

Phone:

Email:

Person(s) to be notified in the event of an accident of emergency:

Name (print): _____ **Relationship:** _____

Phone (home): _____**Phone (work):** _____

Address:

Signature: _____

Date: _____

UIN: **NetID:**

Expected Graduation Date:

4. AggieFab Equipment Training

In order to become eligible to use equipment in the AggieFab, the user must go through the following training procedures prior to usage.

4.1. Trainer

- Each cleanroom equipment has at least one or more designated trainer. The list can be found on the AggieFab website under the "Training" tab.
- Trainers are authorized to check-off trainees on that particular equipment upon completion of required training sessions.
- The name and contact info for authorized users and trainers are posted next to the equipment.

4.2. Equipment Training Protocol

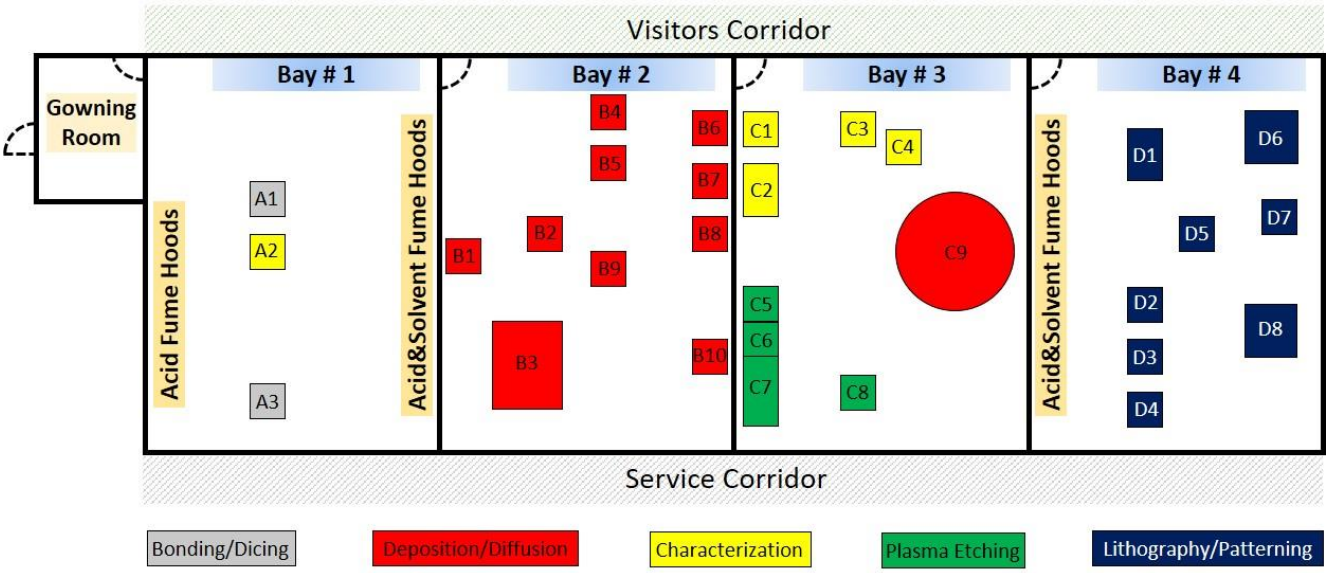
- To receive equipment training, the user has to contact trainers for that particular equipment and schedule a training session.
- The user is required to read the equipment operating manual that is available through the AggieFab website before coming to the training session.
- During the first training session, the trainer demonstrates the proper usage of the equipment and goes through an actual run using a test sample.
- During the second training session, the new user demonstrates the proper usage of the equipment to the trainer.
- If the trainer qualifies the user at the second training session, the trainer notifies the lab manager of the result. This notification has to be submitted using the Equipment Training form in Appendix VI. The lab manager makes the final decision on whether the user is authorized to operate the equipment on their own and retains the right to revoke the privilege if a cause for doing so arises.

- If the trainer fails the user during the check-off session, the user need to practice further either with the trainer or other authorized equipment users, and requests another check-off session.

4.3. Equipment Usage Protocol

- All authorized equipment users are required to fill up the equipment usage log book located next to each equipment when using the equipment. Failure to log-in, will result in suspension of access to the equipment use.
- All users are required to abide by the equipment operating manual posted on the AggieFab website. Failure to do so may result in losing equipment access.

Appendix I. AggieFab Floor Plan and Equipment List



Instruments

Lithography/Patterning	Location
Direct Laser Write Lithography	D1
Double-side Mask Aligner	D2
Quintel Mask Aligner	D3
Suss MA-6 Mask Aligner	D4
FEI Helios DualBeam FIB	D5
Canon FPA 2000-I Stepper	D6
TESCAN MIRA3 E-beam Writer	D7
Zeiss OrionPlus He Ion Microscope	D8

Characterization	Location
Micromanipulator 6100 Probe Station	A2
Veeco NT 9100 Profilometer	C1
Caltex 3D Microscope	C2
Bruker DektakXT Profilometer	C3
Ocean Optics Film Measurement	C4

Bonding-Dicing	Location
K&S Wire Bonder	A1
Micro Automation Dicing Saw	A3
EVG 501 Wafer Bonder	A4

Deposition/Diffusion	Location
MTI RTP Anneal Furnace	B1
LPCVD	B2
ASM P8200/P3000 ALD	B3
Lesker PVD 75 E-Beam Evaporator 1	B4
Lesker PVD 75 E-Beam Evaporator 2	B5
Lesker PVD 75 DC Sputtering	B6
Lesker PVD 75 RF Sputtering	B7
Edwards E-Beam Evaporatin	B8
Oxford Plasma lab 80 PECVD	B9
Minibrutes Oxidation Furnace	B10
CLUSTEX 100sp Sputtering	C9

Plasma Etching	Location
STS ICP RIE	C8
Oxford Plasma lab 100 ICP RIE	C7
Oxford Plasma lab 80 RIE	C6
Nordson March CS-1701 RIE	C5

Appendix II. Hydrofluoric acid (HF) Handling Manual

HF will penetrate the skin and attack underlying tissues. HF may produce severe ocular and dermal injury, as well as acute life threatening systemic toxicity with minimal external tissue damage. Both liquid and vapor can cause severe burns, which may not be immediately painful or visible.

1. Proper Protection Equipment

The handling of HF solution requires special protection equipment in addition to the regular clean lab coat, safety glasses and nitrile gloves for standard Yellow Room protection. The additional protective equipment includes the followings:

- Full face shield.
- Heavy duty neoprene rubber gloves (standard purple nitrile gloves used in the cleanroom will not provide sufficient protection).
- Acid apron to wear on top of the cleanroom garments.

2. Proper HF Solution Handling

- All users must thoroughly read and understood the attached Hydrogen Fluoride Emergency Protocol.
- HF is a glass etchant; only use plastic labware to contain HF, not glass beakers.
- Personal protective gear is imperative and required as noted above.
- Do not attempt an experiment if calcium gluconate cannot be found. Check calcium gluconate before commencing any experiment to ensure that they have not passed their expiration dates.

3. Waste Disposal Procedures

- (Preferred method) Use the aspirator to remove the HF from the beaker. Follow with DI water to dilute the acid and clean the aspirator's tip.
- HF can be poured down any white polypropylene wet bench with DI water and a sink with an acid drain. Slowly and carefully pour the HF while following with DI water to dilute.

4. Accident / Injury Response

- Apply first aid as required.
- Notify clean room staff immediately.

- In the case of skin contact first aid must be started within seconds. If the skin contact is local, immediately remove any contaminated clothing and wash the area with water for 15 minutes, then apply generous amounts of calcium gluconate gel to the area. Gently massage the gel into the contaminated areas while using gloves. White specks appearing around the burned region indicates the formation of calcium flouride and that the gel is working. Gently apply the gel for 15 minutes and reapply when the pain flares up.
- If larger amounts of HF are spilled, or if HF is spilled in a difficult area to wash, remove clothing and proceed immediately to the nearest safety shower. After showering apply the calcium gluconate gel. It is important to realize that calcium gluconate gel WILL NOT adequately neutralize the effect of HF on tissue by itself. Rinsing with water prior to application of the gel is critical. In case of eye contact, rinse the eyes with large amounts of water for a minimum of 5 minutes and seek medical attention. Do not apply calcium gluconate gel to the eyes.
- If HF is ingested, contact medical help. Do not induce vomiting. If vomiting occurs naturally, help the person so they do not choke on the vomit. If HF vapor is inhaled, move the person to fresh air and seek medical attention at once.

5. Spills

- HF spill kit is located in the chemical storage area. **Note:** Spill kits that contain Floor-dri, kitty litter, or sand should NOT be used because HF reacts with silica to produce a toxic gas.
- If HF is spilled outside a chemical fume hood, evacuate the area, close the doors, post the area to prevent others from entering, and call staff.
- Small spills inside a fume hood can be cleaned by lab staff if they have had proper training on HF cleanup and waste disposal.

6. Supply and Storage

- HF acid and BOE are stored under the wet bench in Bay 4 labeled “Acids/Etchants”.
- SDS is located on the AggieFab website under the “Training” tab.

TEXAS A&M UNIVERSITY ENVIRONMENTAL HEALTH & SAFETY
CHEMICAL FACT SHEET

HYDROFLUORIC ACID

HEALTH RATING 4 = EXTREME  CONTACT RATING 4 = EXTREME 

HYDROGEN FLORIDE; HF; FLUOROHYDRIC ACID; FLUORIC ACID; HF IN AQUEOUS SOLUTION

Hydrofluoric acid (HF) is an extremely corrosive acid used for many purposes including mineral digestion, surface cleaning, etching, and biological staining. The unique properties of HF make it significantly more hazardous than many of the other acids used on campus.

SAFETY PRECAUTIONS

- **Ventilation**
Concentrations of HF greater than 5% should always be handled inside a properly functioning chemical fume hood.
- **Eye Protection**
Always use chemical goggles together with a face shield when handling concentrated HF.
- **Body Protection**
Wear a laboratory coat with a chemical splash apron made out of natural rubber, neoprene, or viton. Never wear open-toed shoes or shorts when handling HF.
- **Gloves**
Wear medium or heavy-weight vitron, nitrile, or natural rubber gloves with a pair of nitrile gloves underneath to protect against leaks.
- **Eyewash/Shower Combination**
Required to be nearby and accessible.

EYE AND SKIN EXPOSURE

- Contact with eyes may result in blindness or permanent eye damage.
- HF readily penetrates human skin, allowing it to destroy soft tissues and decalcify bone.
- Chemical burns from HF are typically very painful and slow to heal.
- Skin exposure to highly concentrated HF (approximately 50% or greater) immediately results in serious and painful destruction of tissue.
- In concentrations of 20-50%, the burn becomes apparent 1-8 hours following the exposure; and in concentrations of less than 20%, symptoms may be delayed for as long as 24 hours.
- Not only can skin contact with HF cause burns, but systemic fluoride poisoning may also result.

INHALATION OF VAPOR

- Inhaling HF vapors can cause severe respiratory damage, including severe irritation of the nose, throat, and lungs.
- Delayed reactions up to and including fatal pulmonary edema (fluid build-up in the lungs) may not be apparent for hours after the initial exposure.
- Employees' exposure to airborne concentrations of HF should be limited to an average of 3 ppm over an 8-hour work day.
- Concentrations of 10 to 15 ppm will irritate the eyes, skin, and respiratory tract. At concentrations of 30 ppm HF is immediately dangerous to life and health, and may have irreversible health effects.
- At concentrations above 50 ppm, even brief exposure may be fatal.

CHRONIC EXPOSURE

- The chronic inhalation of hydrofluoric acid can cause irritation and congestion of the nose and throat, and bronchitis.
- Studies have found that HF inhalation may also damage the liver and kidneys.
- Fingertip injuries from HF may result in persistent pain, bone loss, and injury to the nail bed.
- Occupational studies of women exposed to fluoride have identified HF as a possible teratogen (reproductive hazard).
- Long-term or chronic exposure to hydrofluoric acid may result in fluorosis; a syndrome characterized by weight loss, bone embrittlement, anemia, and general ill health.

Because of the ability of HF to produce severe delayed tissue damage without necessarily producing pain, all skin, eye, or tissue contact with HF should receive immediate first aid and medical evaluation, even if the injury appears minor or no pain is felt.

TRAINING

- Employees who handle HF MUST receive documented training on the hazards of HF and what to do in the event of an exposure or a spill.
- A Material Safety Data Sheet (MSDS) on HF should be kept in the immediate work area where HF is used.

SPILLS

- If HF is spilled outside a chemical fume hood, evacuate the area, close the doors, post the area to prevent others from entering, and call 911 (9-911).
- Small spills inside a fume hood can be cleaned by lab staff if they have had proper training on HF cleanup and waste disposal.
- Note: spill kits that contain Floor-dri, kitty litter, or sand should NOT be used because HF reacts with silica to produce a toxic gas.

STORAGE

- Glass, metal, and ceramic containers are NOT compatible with HF. Store in polyethylene or Teflon containers.
- Never store HF with incompatibles such as strong bases (i.e. Sodium Hydroxide and Potassium Hydroxide), or ammonia and other alkaline materials.

WASTE

All HF waste, including contaminated clothing and gloves used to apply calcium gluconate gel should be labeled and disposed of as "Hazardous Waste".

FIRST AID

- **Skin contact** - Immediately (within seconds) wash affected area for a minimum of 5 minutes. Have someone call 911 (9-911 from a campus phone). Remove all contaminated clothing. Using gloves, massage calcium gluconate gel into the affected area. Re-apply gel every 15 minutes until assistance arrives or pain completely stops. If calcium gluconate gel is not available, wash affected area for at least 15 minutes or until medical assistance arrives.
- **Eye contact** - Immediately (within seconds) rinse eyes for a minimum of 30 minutes. Do NOT apply calcium gluconate gel to eyes. Have someone call 911 (9-911).
- **Ingestion of HF** - Dilute the acid by drinking large quantities of milk (preferable) or water. Have someone call 911 (9-911). Do NOT induce vomiting.
- **Inhalation** - Immediately move to an area with fresh air. Call 911 (9-911).

Note: Provide medical personnel with an MSDS sheet for HF.

If you work with HF, please contact EHS Occupational Health Program for a pre-exposure medical consultation.
ehsd.occ.health@tamu.edu

Appendix III. Piranha Solution Handling Manual

NOTE: Piranha cleaning is used to remove organic residues from substrates. Acid piranha is a self-starting reaction which is extremely exothermic.

1. Proper Protection Equipment

The handling of Piranha solutions requires special protection equipment in addition to the regular clean room gown, safety glasses and nitrile gloves for standard Yellow Room protection. The additional protective equipment includes the following:

- Full face shield.
- Heavy duty neoprene rubber gloves (standard purple Nitrile gloves used in the Yellow Room will not provide sufficient protection).
- Acid apron to wear on top of the cleanroom garments.

2. Proper Piranha Solution Handling

- Whenever handling Piranha, only use glass containers (preferably Pyrex). Containers used during the experiment must be very clearly labeled. All work must be done under the fume hood.
- Mix the solution in the chemical hood with the sash between you and the solution. Wear full protection gear (face shield, acid apron, acid gloves) as described above.
- When preparing the piranha solution, always add the peroxide to the acid. The H_2O_2 is added immediately before the etching process because it immediately produces an exothermic reaction with gas (pressure) release. If the H_2O_2 concentration is at 50% or greater, an explosion could occur. The H_2O_2 currently in use in AggieFab is 35%.
- A 3:1 H_2SO_4:H_2O_2 is generally used. Ask your trainer for more information on different mixture ratios.
- Piranha solution is very energetic and potentially explosive. It is very likely to become hot, more than 100 °C.
- Substrates should be rinsed and thoroughly dried before placing them in a piranha bath.
- Piranha etch is used to remove photoresist, acetone residue, and native oxides, not the compounds themselves.
- Adding any acids or bases to piranha or spraying it with water will accelerate the reaction. This includes photoresist, which is a strong base.

- Mixing hot piranha with organic compounds may cause an explosion. This includes acetone, photoresist, isopropyl alcohol, and nylon.

3. Piranha Waste Disposal

- The primary hazard from storage of piranha etch waste is the potential for gas generation and over pressurization of the container when the solution is still hot. Never store any piranha solutions. Piranha stored in a closed container will likely explode.
- After complete cool down of the solution (1-2 hours after adding the H_2O_2), use the aspirator to dispose of the piranha and follow the DI water down the drain.

4. Emergency Procedure

- Any exposure to Piranha or its vapor is severe and dangerous. The victim should be removed from the contaminated area, placed under a safety shower while the cleanroom staff are contacted.
- All contaminated clothing should be removed immediately with appropriate gloves and safely discarded.
- In case of contact with the skin, the affected area must be immediately rinsed with large amounts of water from the emergency shower for at least 15 minutes.
- In case of contact with the eye, irrigate the eye for at least 15 minutes at the eyewash, keeping the eyelids apart and away from eyeballs during irrigation. Place ice pack on eyes until reaching emergency room.
- Inhalation of hot or cold Piranha vapors will severely burn the upper respiratory tract.
- Conscious persons should be assisted to an area with fresh, uncontaminated air. Seek medical attention in the event of inhalation; coughing or tightness in the chest may result. Symptoms may be delayed.

5. Supply and Storage

- Sulfuric acid is stored under the wet bench labeled “Acids/Etchants” and hydrogen peroxide is stored under the wet bench labeled “Oxidizers”.
- SDS is available online on the AggieFab website

Appendix IV. Liability Waiver Form

To be used for visitors doing lab tour.

ACCIDENT WAIVER AND RELEASE OF LIABILITY AND HOLD HARMLESS FORM

Aggie Fab Laboratory Tour

Date of Activity or Event: _____

Check One:

On Campus Visitor _____
Off Campus Visitor _____
Other _____

I HEREBY ASSUME ALL OF THE RISKS OF PARTICIPATING AND/OR VOLUNTEERING IN THIS ACTIVITY OR EVENT, including by way of example and not limitation, any risks that may arise from negligence or carelessness on the part of the persons or entities being released, from dangerous or defective equipment or property owned, maintained, or controlled by them, or because of their possible **liability** without fault.

I certify that I am physically fit, have sufficiently prepared or trained for participation in the activity or event, and have not been advised to not participate by a qualified medical professional. I certify that there are no health-related
reasons or problems which preclude my participation in this activity or event.

I acknowledge that this Accident **Waiver** and **Release** of **Liability Form** will be used by the event holders, sponsors, and organizers of the activity or event in which I may participate, and that it will govern my actions and responsibilities at said activity or event.

In consideration of my application and permitting me to participate in this event, I hereby take action for myself, my executors, administrators, heirs, next of kin, successors, and assigns as follows:

(A) I WAIVE, **RELEASE**, AND DISCHARGE from any and all **liability**, including but not limited to, **liability** arising from the negligence or fault of the entities or persons released, for my death, disability, personal injury, property damage, property theft, or actions of any kind which may hereafter occur to me including my traveling to and from this event, THE FOLLOWING ENTITIES OR PERSONS:

> The AggieFab Laboratory and/or The Texas Engineering Experiment Station and/or their directors, officers, employees , faculty, researchers, volunteers, representatives, and agents, the activity or event holders, activity or event sponsors, activity or event volunteers;

(B) I INDEMNIFY, HOLD HARMLESS, AND PROMISE NOT TO SUE the entities or persons mentioned in this paragraph from any and all liabilities or claims made as a result of participation

in this activity or event, whether caused by the negligence of **release** or otherwise.

I acknowledge that the AggieFab Lab and their directors, officers, employees, faculty, researchers, volunteers, representatives, and agents are NOT responsible for the errors, omissions, acts, or failures to act of any party or entity conducting a specific event or activity on behalf of the AggieFab Lab.

I acknowledge that this activity or event may carry with it the potential for death, serious injury, and property loss. The risks may include, but are not limited to, those caused by being in the proximity of toxic chemicals, toxic gases, sensitive instruments and high voltage instruments. These risks are not only inherent to participants, but are also present for volunteers.

I hereby consent to receive medical treatment, which may be deemed advisable in the event of injury, accident, and/or illness during this activity or event.

I understand that at this event or related activities, I may be photographed. I agree to allow my photo, video, or film likeness to be used for any legitimate purpose by the event holders, producers, sponsors, organizers, and assigns.

The accident **waiver** and **release** of **liability** shall be construed broadly to provide a **release** and **waiver** to the maximum extent permissible under applicable law.

I CERTIFY THAT I HAVE READ THIS DOCUMENT, AND I FULLY UNDERSTAND ITS CONTENT. I AM AWARE THAT THIS IS A **RELEASE** OF **LIABILITY** AND A CONTRACT AND I SIGN IT OF MY OWN FREE WILL.

_____

Print Participant's Name

_____ _____

Signature Date

_____

Print Tour Leader's Name

Appendix V – Equipment Training Form

To be used for each piece of equipment requiring checked off training.

Equipment Training Form

Equipment Name: _____

Student Name: _____

Training 1:

Trainer: _____ Date: _____

Trainer sent email to admin@aggiefab.tamu.edu Date:

Training 2:

Trainer: _____ Date: _____

Trainer sent email to admin@aggiefab.tamu.edu Date: _____

Student Name	Checkoff Trainer Name
Student Signature	Checkoff Trainer Signature

Turn in this hardcopy to the AggieFab Program Specialist.

Appendix VI – Chemical Disposal Procedure

AggieFab uses a variety of solid, liquid and gas phase chemicals and materials. Please consult the website for a list of chemicals provided by AggieFab and to find DS safety sheets. Gases for processing are provided by AggieFab in high pressure cylinders. Please ask a staff member for help to handle any gas cylinders. Solids used in processing are mostly in the form of sputtering targets in the RF and DC sputter tools. Ask a staff member for assistance if you have any question in the handling of these targets, or other solid materials that may need special care for safe handling.

Chemicals in liquid form will generally be used under wet benches with fans to exhaust dangerous fumes. The white polypropylene benches are designed primarily for safe handling of acids and bases, and for developing and stripping of photoresist. These benches are set up with Deionized (DI) water, aspirators, and drains that connect to the acid neutralization system for the building.

The gray metal hoods are designed primarily for safe handling of solvents. These do not have water or drains set up. Any chemicals used under these hoods must be captured in waste containers after use.

In general, any chemical that cannot be disposed of using the aspirator or pouring down the acid drains must be collected into their respective waste containers after use. For example, solvent waste must go into the solvent waste bottle, AZ 1:1 waste must go into the AZ 1:1 waste bottle, etc. When a bottle is completely empty, please rinse thoroughly with water and mark with marker on the outside that it is a waste bottle for that specific chemical, as we do reuse empty bottle for waste. Waste bottles are stored underneath the wet benches alongside the normal chemicals. Waste bottles are considered full when the top of the waste is 4 inches from the bottle's cap. Please notify staff if there is a build up of waste bottles or more waste bottles are needed.

Acid Bench Aspirators:

- The aspirators are a much safer way to empty acids from containers after completing wet etch or cleaning operations. Note that ONLY acids that can be disposed into the acid drain system can use the aspirators. The aspirators dilute acids with water which then flows directly into the acid drains where it is processed by the GERB acid neutralization system.
- **DO USE** the aspirators for:
    - Disposal of piranha etch – in addition, be sure to allow piranha etch to cool for a few hours before disposal down the drain
    - HCl, HF, BOE, nitric or sulfuric acids.
- **DO NOT USE** the aspirators for:
    - Solvents.
    - Any metal etchant mixtures, such as aluminum or chrome etch.
    - Any acid that contains metals must be disposed into waste containers.
    - See below for complete list.

List of chemicals that **CANNOT be aspirated and must go into their respective waste containers**. For example, AZ 726 must go into the AZ 726 waste, NOT AZ 1:1 waste, etc.

- Solvents (acetone, methanol, isopropyl alcohol) can all go into a single solvent waste container
    - If performing lift off, use separate solvent bottle and label that there is Cr/Ni/Ti in the solution.
- Photoresist developers (AZ 1:1, AZ 300, AZ 726, MF 319, MIBK)
- Photoresist strippers (AZ 400T)

- Metal etchants (copper, chromium, aluminum)

Notes on chemical disposal:

- HF can be disposed of by using the aspirator next to the wet bench sink or by pouring the acid down the drain with the sink water running. AggieFab's wet benches have CPVC lines that are acid compatible and connect to the building's neutralization system.
- Piranha needs to cool down sufficiently to minimize excessive reaction. This time can range from one hour for smaller amounts to several hours for larger amounts. Never leave piranha solution out overnight. The aspirators in AggieFab automatically provide 10:1 water to acid dilution for disposal. Use the aspirators if they are available, while also allowing the sink DI water to flow for further dilution. Rinse the aspirator tip by aspirating a large beaker of DI water. This also rinses the aspirator's tubes.
- Acid mixtures designed to etch metals should NOT be aspirated nor poured down the drain. These mixtures must be collected into their respective waste bottles. Other acids or bases that are used for cleaning organic contaminations or resist can generally be disposed of by using the aspirator or pouring down the drains.
- The acid neutralization system consists of three tanks that process acids: one receives the water acid mixture, one changes the pH of the acid waste via base rock, and the third test the pH to ensure its value is safe before entering the waste stream.

Appendix VII – AggieFab-Provided Chemicals

Please see the SDS page on AggieFab's website for specific safety information on each of the following chemicals.

Acids:

- Hydrofluoric (HF)
- Sulfuric (H_2SO_4)
- Hydrochloric (HCl)

Solvents:

- Isopropyl alcohol (IPA)
- Acetone
- Methanol

Developers:

- AZ 726 MIF
- AZ Developer 1:1
- Microposit MF-319
- AZ 300 MIF
- MIBK:IPA

Photoresist:

- AZ 5214 EIR
- S1818

Strippers:

- AZ 400T stripper

Etchants:

- Chromium etch
- Copper etch
- Aluminum etch
- Buffered Oxide Etch (BOE, contains HF acid)

Oxidizers:

- Hydrogen peroxide (H_2O_2)