

Wetbench #1-5 – Organics, Acids/Bases, Developers, KOH, RCA

Standard Operating Procedure

Revision: 2.4 — Last Updated: Apr.5/2018, Revised by Chris Balicki

Overview

This document will provide a detailed operation procedure of the Wet Benches. Formal Training is required for all users prior to using the system.

Revision History

#	Revised by:	Date	Modification
1	Grace Li	2008-12-01	Initial Release
2	Grace Li	2018-02-06	Update PPE
3	Mohamad Rezaei	2018-02-28	APPENDIX A: Waste Disposal Added
4	Chris Balicki	2018-04-04	APPENDIX B: Spill Response Summary Several Revisions
5			

Document No. 4DSOP000X

Table of Contents

Overview.....	1
Revision History.....	1
Table of Contents.....	2
1. Wet Bench Rules and PPE	3
2. Wetbench Glassware	6
3. Chemical Compatibility	6
4. Wetbench Chemicals.....	6
APPENDIX A: Waste Disposal Procedures.....	11
APPENDIX B: Cleanroom Spill Response Procedure	16

1. Wet Bench Rules and PPE

- Personal protective equipment (PPE) must be worn at all times while working on the wetbenches (see table 1 below).
- Never dump chemicals into the sink.
- There is a specific wet bench for each type of processing; please ensure to choose the correct work area. For example, do not use acid/base in the solvent bench(#1), and do not use organic solvents in the acid/base bench(#2) (see table 2 below).
- Used chemicals must be transferred into their respective used/waste chemical waste bottles.
- Avoid leaving samples/chemicals on benches for extended durations.
- Any chemicals and/or work-in-progress left unattended must be labelled clearly with the user's name, chemistry present, and contact phone number.
- Clean up the wet benches after each use.

Table 1: 4D LABS **CLEANROOM** (TASC2 6060.3/5/7/13) WETBENCH AREA

PERSONAL PROTECTIVE EQUIPMENT (PPE)

		GENERAL WETBENCH WORK -IPA -acetone -etc.	PHOTORESIST & SPINCOATING	BASES -all bases -KOH -NH ₄ OH -etc.	DEVELOPERS & STRIPPERS -excl. Nanostrip	METAL ETCHANTS -Au etchant -Cr etchant -Al etchant -etc.	ACIDS -all acids -BOE / HF -Nanostrip -RCA -etc.
Category 1	Standard Cleanroom PPE (Gown + Gloves + Safety Glasses)	✓	✓	✓	✓	✓	✓
Category 2	Cleanroom Gloves (second pair)	✓	✓	✓	✓	✓	✓
Category 3	Face Shield						✓
	Apron						✓
	Green Nitrile Gloves						✓

NOTES:

- Remove category 3 PPE when finished working with acids. **DO NOT wear category 3 PPE outside of the acid bench room.**
- Remove category 2 PPE (outer glove layer) when gloves are noticeably contaminated, when moving from one wetbench room to another, or when finished working on the wetbenches.
- Category 1 PPE must be worn at all times and in all other areas within the cleanroom.
- Nitrile gloves should be rinsed regularly while working at the benches, using the DI water sprayer, sink, or glove wash. This will not only prevent cross contamination, but will decrease the chance of injury due to chemical exposure.

Table 2: 4D LABS **CLEANROOM** (TASC2 6060.3/5/7/13) WETBENCH AREA
 ALLOWABLE BENCH PROCESSES / CHEMISTRIES

	ORGANICS & STRIPPERS	BASES	DEVELOPERS	METAL ETCHANTS	ACIDS
	-IPA -acetone -excl. Nanostrip -etc.	-all bases -KOH -NH ₄ OH -etc.		-Au etchant -Cr etchant -Al etchant -etc.	-all acids -BOE / HF -Nanostrip -RCA -etc.
Wetbench #1 (Organics)	✓				
Wetbench #2 (HF/Acids/Bases)		✓		✓	✓
Wetbench #3 (Developers)			✓		
Wetbench #4 (KOH/Metal Etch)		✓		✓	
Wetbench #5 (RCA Clean)					✓

NOTES:

- Only 1 user (or team of 2) permitted on a bench when acid work is in progress.

2. Wetbench Glassware

Shared and cleaned glassware are located on the rack near each individual bench. Some of the beakers, ground cylinders, and dishes are labeled for specific use. When using the glassware, you should:

- After each use, rinse glassware 3 times with DI water and place it into the grey tray labeled “used glassware”.
- Any broken glassware must be disposed of into the sharps waste container (located in the chemical transfer bay) and reported to 4D LABS staff.

3. Chemical Compatibility

Below are some important compatibility guidelines. However, these guidelines are **not** an exhaustive list. Please make sure you have reviewed all relevant MSDS forms and are well informed in terms of what you are doing, especially prior to working with chemistry:

- Review MSDS forms in their entirety.
- Understand and anticipate chemical reactions that are likely to take place.
- Ensure that the vessel material is an appropriate choice. For most chemistry, glass is suitable, but this must be confirmed, especially prior to working with new chemistry.
- Never use glassware when using Hydrofluoric acids (HF) or any HF mixture.
- Never heat up chemicals inside Teflon containers or dishes.
- Any user who wants to bring new chemicals into 4D LABS must complete the New Chemical Approval Form and be approved by 4D LABS staff.

4. Wetbench Chemicals

4.1 Organic Solvent Bench (Wet Bench #1)

- **PPE Requirement:** Wear double gloves, gown, and safety glasses. Remove the outer glove layer when gloves are noticeably contaminated, when moving from one room to another, or when finished working on this bench.

- The Chemicals and the processes that can be used at this bench are summarized in Table 3, and how to deal with those chemicals are summarized in Table 4:

Organic Solvent Bench (#1)



Table 3

Chemicals on Bench #1	Processes on Bench #1
<ul style="list-style-type: none"> EBR Photoresist Stripper Microposit remover 1165 Remover PG Acetone IPA DI Water Anisole Any other organic solvent like Toluene 	<ul style="list-style-type: none"> Ultrasonic Bath Hot DI water Lift-off Acetone Clean 2-Propanal Clean Photoresist Dilution F-silane and HMDS coating

Table 4

Name	How to handle	Disposal <small>(Bottles are located under the solvent bench)</small>	In case of spill
- EBR (AZ EBR Solvent); - Photoresist Stripper; - Microposit remover 1165 - Remover PG	<ul style="list-style-type: none"> Transfer a suitable amount to glassware for use Do not contaminate the large bottle Do not put the remaining solvent back into the original bottle Keep container tightly closed when not in use Keep away from heat and flame 	White plastic bottle (Labeled for Acetone/ether/alcohol/ketones)	<ul style="list-style-type: none"> Collect onto inert absorbent Transfer into suitable containers for disposal. Wipe residual with water

Acetone	<ul style="list-style-type: none"> • Use squeeze bottle to rinse or pour some into the glassware to clean substrates • Keep away from heat • Keep container tightly closed 	White plastic bottle (Labeled for Acetone/ether/ alcohol/ketones)	<ul style="list-style-type: none"> • Collect onto inert absorbent
IPA	Use squeeze bottle to rinse or pour some into the glassware for clean substrates	White plastic bottle (Labeled for Acetone/ether/ alcohol/ketones)	<ul style="list-style-type: none"> • Collect onto inert absorbent

4.2 Acid/Base Processing benches (Wet Bench #2, #4, and #5)

- **PPE Requirement:** Check Tables 1 and 2 to find the proper PPE in this bench. If you plan to use strong acids make sure to wear the Green Nitrile gloves, apron, and face shield on top of your goggles. (shown in picture below)



Note: When work is complete, remove apron, face shield, green Nitrile gloves. Rinse them and return them to the original place. Remove the outer glove layer when gloves are noticeably contaminated, when moving from one room to another, or when finished working on the wet benches.

- Tables 5 and 6 summarize the chemicals and processes that can be used at these benches. It is strongly encouraged to perform RCA processes on Wetbench #5 if possible.

Acid Process Bench (#2)



Table 5

Chemicals on Benches #2, 4, and 5	Processes on Benches #2, 4, and 5
- all bases (KOH, NH ₄ OH, etc.) - all acids (BOE / HF, Nanostrip, RCA, etc.) - metal etchants, not bench #5 (Au, Cr, Al, Ti, etc.)	- All metal etching, No Metals on bench #5 - RCA-1/2, HF, and BOE bathes (bench #2 and #5)

Table 6

Name of Chemicals	How to handle	Disposal <small>(Bottles are located under the acid bench)</small>	In case of Spill
- HF - BOE	Need HF individual safety training		
- all acids - Nanostrip - RCA-2 - etc.	<ul style="list-style-type: none"> •When diluting, always slowly add acid to water, •Never use hot water, and never add water to acid •Avoid contact with skin, eyes and clothing •Avoid breathing mist or vapour 	Individual waste bottles as labeled	<ul style="list-style-type: none"> •Upon contact with skin or eyes, wash off with water •For small spills, use Spill Neutralizer for Acid to neutralize it, or call staff for help • Use PH paper checking to be neutralized •Use wipes to clean up •Use wet wipes to clean the residual (or flush by DI water, then wipe the surface)

<ul style="list-style-type: none"> - all bases - KOH - NH₄OH - RCA-1 - etc. 	<ul style="list-style-type: none"> •Do not get in eyes, on skin, or on clothing. •Keep container tightly closed after using •Do not breathe the vapor •Wash thoroughly after handling 	Individual waste bottles as labeled	Upon contact with skin or eyes, wash off with water <ul style="list-style-type: none"> •For small spills, use Spill Neutralizer for Base to neutralize it, or call staff for help • Use PH paper checking to be neutralized •Use wipes to clean up •Use wet wipes to clean the residual (or flush by DI water, then wipe the surface)
<ul style="list-style-type: none"> - Au etchant - Cr etchant - Al etchant -Ti etchant - etc 	<ul style="list-style-type: none"> •Do not mix with strong oxidants or organic materials 	Individual waste bottles as labeled	<ul style="list-style-type: none"> •Isolate or enclose the area of spill •Call staff for help

4.3 Developer Bench (Wet Bench #3)

- **PPE Requirement:** Wear double gloves, gown, and safety glasses. Remove the outer glove layer when gloves are noticeably contaminated, when moving from one room to another, or when finished working on this bench.
- The Chemicals and the process that can be used at this bench are summarized in Table 7.

Table 7

Name of Chemicals	How to handle	Disposal (Bottles are located under the acid bench)	In case of Spill
Developer (AZ 300MIF, AZ 917MIF, SU-8 developer, etc.)	<ul style="list-style-type: none"> • Transfer developer 50-60ml (depends on the size of container) to dish for developing • Close the bottle properly after use 	AZ 300 Developer Waste AZ 917 Developer Waste	<ul style="list-style-type: none"> • Ventilate area of spill or leak, remove all sparking devices or ignition sources, collect onto inert absorbent, and place in the waste container • Rinse residual with water

APPENDIX A: Waste Disposal Procedures

Minor Chemical Cleanup and Waste Disposal Procedure

While working with chemicals, it is common that minor drips or spills may occur particularly while transferring chemicals from one vessel to another, e.g. at container spouts, on glassware exteriors, or on bench tops. These minor drips or spills, roughly 2-3mL in volume, are routine and must be dealt with accordingly by the user. Chemical spills larger than 2-3mL must be treated as spill response, which require an immediate risk assessment and prompt action; users may refer to the Cleanroom Spill Response Procedure provided in the cleanroom wet bench areas for further guidance or contact 4D LABS staff for assistance.

1. Any chemical droplets or minor spills must be cleaned up by the user. If the quantity is less than 2-3mL, e.g. **smaller than the size of a loonie**, use cleanroom wipes to clean up the spill. Rinse the contaminated wipes with plenty of water and dispose of the wipes in the chemical solid waste garbage.
Note: This policy does not apply to wipes used to clean up photoresist, which should be disposed of in the designated container without rinsing.
2. If the spill is **larger than the size of a loonie but less than 50 mL**, the user may perform the minor spill response cleanup procedure to neutralize and clean up the spill. Refer to the Cleanroom Spill Response Procedure provided in the cleanroom wet bench areas.
IMPORTANT: Contact staff if you have any questions about cleaning up spills.
3. **If the spill is larger than 50 mL, the user must immediately notify nearby lab users, evacuate the area, and contact Campus Security and the 4D LABS staff.** Refer to the Cleanroom Spill Response Procedure for further information.
4. All materials used to clean up after silane compound work must be stored in a Ziploc bag, labelled, and stored with the chemical waste in the transfer bay. There is an updated silane deposition procedure that is posted inside the Cleanroom.
5. Waste made up of sharp items, which could potentially cut or pierce, or potentially hazardous contaminated items should be deposited in the yellow 'sharps' container.
6. When the user has finished working on a wet bench, all items placed on the bench by the user should be removed, including containers, wipes, thermometers, and hot plates.

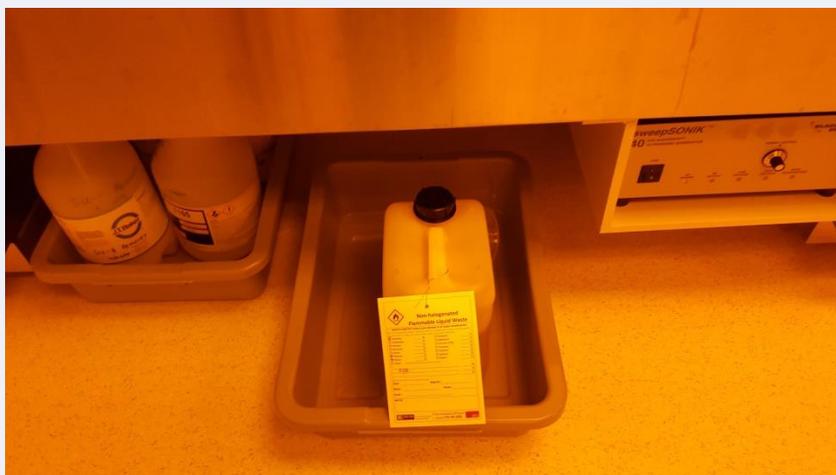
Solid Chemical Waste Disposal Procedure

When the user has finished working on a wet bench, all items placed on the bench by the user should be removed, including containers, wipes, thermometers, and hot plates.

1. Any chemicals spilled on the wet bench must be cleaned up by the user, In the case of acid or base spill; spill kit should be used to neutralize the chemicals.
2. Any wipes with water soluble chemicals **smaller than the size of a loonie** on them should be rinsed, squeezed dry, and placed in a garbage can.
3. Wipes that have been soaked with solvents should be neutralized first. Please do not put solvent soaked wipes into the garbage can.
4. **All materials used to clean up after silane work must be stored in a Ziploc bag, labelled, and stored with the chemical waste in the transfer bay.** There is an updated silane deposition procedure that is posted in the Clean Room.
5. Waste made up of sharp items, which could potentially cut or pierce, or potentially hazardous contaminated items should be deposited in the yellow 'sharps' container.

Liquid Chemical Waste Disposal Procedure

All chemical waste containing **organic solvents, acids, bases** and **developers** must be collected and put into the appropriately labeled waste solution containers. **Be very cautious to avoid accidental mixing of waste;** waste should only be added to appropriately designated and labeled waste containers. Liquid waste containers are usually located under the wet benches and each container is dedicated to a specific class of chemicals. Check the label prior to any disposal.



1. Select an appropriate waste container for the solvent you are disposing.
Note: If you cannot find an appropriate waste container or it is full, request assistance from the 4D LABS staff.
IMPORTANT: It is prohibited to dump waste solutions directly down wet bench drains.
2. Place the waste container into the sink in the bench. Then remove the container cap.
3. Use an appropriate funnel labelled "For Waste Disposal" and place it into the waste container. Glass and plastic funnels are available in the cleanroom.
4. Pour the liquid waste very slowly into the container. **Make sure the waste chemical is at room temperature before dumping it into the waste container.**



5. Put the cap back on the waste container. Make sure you do not overtighten the caps.
6. Get a cleanroom wipe and wipe the bottom of waste container. Ensure it is dry.
7. Return the waste container to its storage location.
8. Rinse the funnel into the sink with plenty of water and return the funnel to its original tray.
9. Rinse the cleanroom wipe thoroughly with water and dispose of it in the chemical solid waste garbage.

APPENDIX B: Cleanroom Spill Response Procedure

Cleanroom Spill Response Procedure

A. INITIAL RESPONSE AND RISK ASSESSMENT

If an explosion hazard, fire hazard, and/or toxicity hazard exists:

1. Pull the fire alarm and evacuate all personnel.
2. If safe to do so, turn off ignition sources and nearby equipment.
3. Do not attempt to remove injured persons if doing so risks your health and/or safety, or risks further injury to the injured.
4. If safe to do so, note the hazardous materials involved. Arrange to secure the Material Safety Data Sheet (MSDS) for the materials involved in the incident. MSDS will be needed by responding emergency personnel.
5. Evacuate the building and locate 4D LABS staff and Campus Security emergency responders to relay significant details about the emergency.
6. Submit an online EHS Incident Report at www.sfu.ca/security.

If no immediate safety risk is present, proceed to section B.

B. SPILL SIZE ASSESSMENT

A major spill is:

- a. A spill of 50mL or greater, or
- b. At risk of chemical vapours exceeding safe levels.

A minor spill is:

- c. One that does not meet the major spill criteria, and;
- d. Is assessed to pose minimal risk to lab occupants during spill cleanup.

C. SELECT APPROPRIATE RESPONSE

In the event of a major spill:

1. Alert others nearby and immediately evacuate the area. **DO NOT ATTEMPT TO CLEAN UP.**
2. Call Campus Security at 2-4500.
3. Call 4D LABS staff: Grace Li (2-8075), Mohamad (2-3790), Nathanael Sieb (2-8084).
4. Put a barrier and sign to prevent entry to the affected area.
5. Standby for emergency responders and provide information as per request.
6. Submit an online EHS Incident Report at www.sfu.ca/security.

In the event of a minor spill:

1. Alert others nearby and inform them of the potential risks.¹
2. If in need of assistance, contact the appropriate 4D LABS staff member.
3. Select the appropriate clean up procedure from the available options in Section D.²
4. After clean-up, rinse contaminated PPE with plenty of water to remove any chemical residues before reusing.
5. Notify 4D LABS staff to replenish materials used for spill response and to discuss corrective/mitigative action for future occurrences.

D. CLEANUP PROCEDURES

SOLVENTS Examples: Acetone, Isopropanol (IPA), Ethanol, Ethylene Glycol, Photoresists, PGR Remover

1. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
2. Place a sorbent pad on the spill. Ensure to catch any chemical runoff.
3. Dispose the pad(s) into a plastic bag. (Plastic bags are located on the top of the wall box.)
4. Label the plastic bag indicating the appropriate solvent(s) and place the plastic bag into **Transfer Bay 1 (OUT)**. (Stickers are located within Transfer Bay 1.)
5. Request 4D LABS staff to place a hazardous waste pick up request on your behalf.

¹ Ensure you are working in a well ventilated area.

² Ensure you are familiar with this procedure, along with the waste disposal procedure and other relevant policies which may be applicable.

HYDROFLUORIC ACID (HF)

1. Ensure that all required **Personal Protective Equipment** (PPE) is equipped as mandated.
2. Gently spray with the HF Acid Eater, working from the outside of the spill inward.³
3. Test with pH paper to confirm neutralization (the PH should be between 6 and 9).
4. Allow neutralized liquid to cool.
5. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
6. Place a sorbent pad on the neutralized spill. Ensure to catch any chemical runoff.
7. Place used sorbents into the normal garbage can for disposal.⁴
8. Clean the spill surface area with water at least two times and wipe to dry.

ACIDS Examples: Hydrochloric (HCl), Nitric (HNO₃), Sulfuric (H₂SO₄)

1. Find the acid neutralizer bottle, labelled "KOLOR-SAFE® LIQUID NEUTRALIZER for ACID SPILLS."
2. Gently spray with the acid neutralizer, working from the outside of the spill inward.
3. Test with pH paper to confirm neutralization (the PH should be between 6 and 9).
4. Allow neutralized liquid to cool.
5. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
6. Place a sorbent pad on the neutralized spill. Ensure to catch any chemical runoff.
7. Place used sorbents into the normal garbage can for disposal.⁴
8. Clean the spill surface area with water at least two times and wipe to dry.

BASES Examples: Ammonium Hydroxide (NH₄OH), Potassium Hydroxide (KOH), Sodium Hydroxide (NaOH)

1. Find the base neutralizer bottle, labelled "KOLOR-SAFE® LIQUID NEUTRALIZER for BASE SPILLS".⁵
2. Gently spray with the base neutralizer, working from the outside of the spill inward.
3. Test with pH paper to confirm neutralization (the PH should be between 6 and 9).
4. Allow neutralized liquid to cool.
5. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
6. Place a sorbent pad on the neutralized spill. Ensure to catch any chemical runoff.
7. Place used sorbents into the normal garbage can for disposal.⁴
8. Clean the spill surface area with water at least two times and wipe to dry.

³ Atomize HF Acid Eater into surrounding air to neutralize any vapors.

⁴ Follow guidelines provided in the Waste Disposal procedure.

⁵ Do NOT use Kolorsafe Base Neutralizer on any solution containing metallic nitrates, cyanides, sulfides, oxidizers, or hypochlorate solutions.