

Yale West Campus Cleanroom SOP



Yale West Campus
Materials Characterization Core
ywccleanroom.yale.edu

100 Cleanroom Core Facility
750 West Campus Drive
West Haven, CT 06516

Version 1.1 May 2019

Table of Contents

1. Introduction	2
2. General Cleanroom Regulations.....	3
3. Personal Actions Prohibited in Cleanrooms	4
4. Entry	4
5. Gowning	4
6. Exit.....	5
7. Chemicals Storage	5
8. Safety	6
9. Chemicals transporting	6
10. Chemicals in-use	7
11. Chemical Waste.....	7
12. Protocols	8

1. Introduction

Yale west campus cleanroom started to establish at 2017 and open to users at 02/01/2018. Our cleanroom is class 100 environment. A class 100 cleanroom never allow more than 100 particles (0.5 micrometer or larger) per cubic foot of air. In a typical office building, it contains from 500,000 to 1,000,000 particles (0.5 micrometer or larger) in a cubic foot of air. The contaminants are generated from five basic sources. The facilities, people, tools, fluids and product being manufactured can all contribute to contamination. Proper contaminant control must be taken.

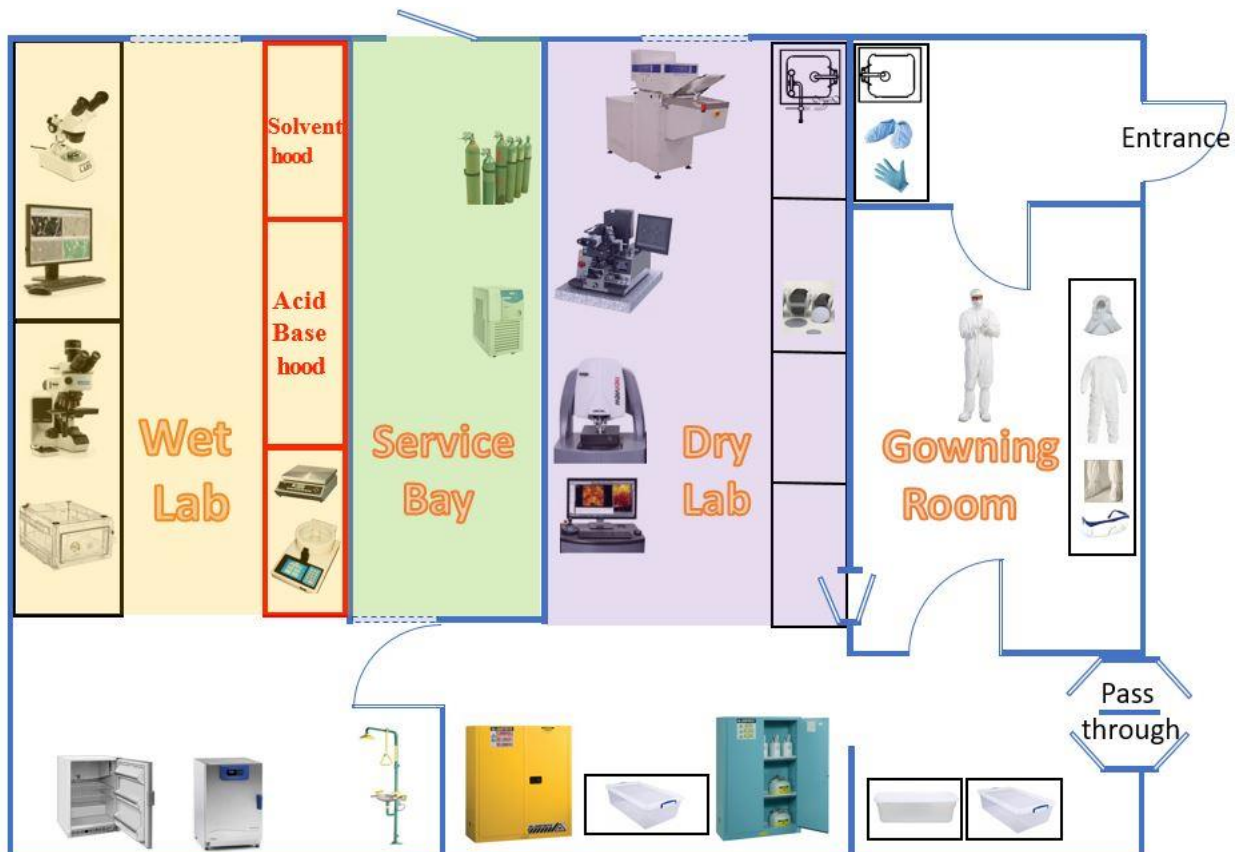
Environment of our cleanroom:

Temperature $68 \pm 4^{\circ}\text{F}$

Humidity $40 \pm 5\%$

The facilities in our west campus cleanroom include Suss MJB4 Mask Aligner, Zygo Nexview 3D Optical Profiler, Spin coaters, Olympus BX53MRF optical microscope, programmable hotplates, oven, refrigerator, and desiccator. We have Acid/Base hood, Solvent hood and Spinner hood.

Usage fee for west campus cleanroom is 47 \$/hour, which covers disposal coverall, hood, boots and general acids, bases, solvents and photo resists. The Suss MJB4 mask aligner and Zygo optical profiler is also covered by this user fee.



Version 1.1 May 2019

2. General Cleanroom Regulations

Below is a list of general regulations for west campus cleanroom.

1. All personal items such as keys, watches, rings, matches, lighters and cigarettes should be stored in the personal locker outside the gowning room.
2. Valuable personal items such as wallets may be permitted in the cleanroom provided they are NEVER removed from beneath the cleanroom garments.
3. Make sure you are suitably attired: long pants/trousers, full-coverage shoes. No shorts, no sandals/flip-flops, no high heels. Your shirt must be at least a short sleeve shirt that is long enough to reach your pants (no bare midriffs) and it must not have a deep neckline.
4. NO eating, smoking or gum chewing inside the cleanroom.
5. Only garments approved for the cleanroom should be worn when entering.
6. NO cosmetics shall be worn in the cleanrooms. This includes: rouge, lipstick, eye shadow, eyebrow pencil, mascara, eye liner, false eye lashes, fingernail polish, hair spray, mousse, or the heavy use of aerosols, after shaves and perfumes.
7. Only approved cleanroom paper shall be allowed in the cleanroom.
8. Approved ball point pens shall be the only writing tool used.
9. Use of paper or fabric towels is prohibited. Use of hand dryers equipped with HEPA filters is suggested.
10. Gloves or finger cots should not be allowed to touch any item or surface that has not been thoroughly cleaned.
11. Only approved gloves, finger cots (powder-free), pliers, tweezers should be used to handle product. Finger prints can be a major source of contamination on some products.
12. Solvent contact with the bare skin should be avoided. They can remove skin oils and increase skin flaking.
13. Approved skin lotions or lanolin based soaps are sometimes allowed. These can reduce skin flaking.
14. All tools, containers and fixtures used in the cleaning process should be cleaned to the same degree as the cleanroom surfaces. All of these items are a source of contamination.
15. NO tool should be allowed to rest on the surface of a bench or table. It should be place on a cleanroom wiper.
16. Only cleanroom approved wipers are allowed to be used. The wipers must be approved for the Class of cleanroom being cleaned.
17. ALL equipment, materials and containers introduced into a sterile facility must be subjected to stringent sterilization prior to entrance.
18. NO one who is physically ill, especially with respiratory or stomach disorders, may enter a sterile room.

3. Personal Actions Prohibited in Cleanrooms

1. Fast motions such as running, walking fast or horseplay.
2. Sitting or leaning on equipment or work surfaces.
3. Writing on equipment or garments.
4. Removal of items from beneath the cleanroom garments.
5. Wearing the cleanroom garment outside the cleanroom.
6. Wearing torn or soiled garments.

4. Entry

1. Before entering the cleanroom, ensure that you are suitably attired (long pants/trousers, full-coverage shoes, no sandals/flip-flops, no high heels).
2. Open the door using your Yale ID card. If you are entering while other people are entering or leaving, be sure to prox your card even if the door is already open, as this “logs” you in to the cleanroom.
3. The first thing you’ll do is walk over a sticky mat. If the mat is getting dirty, don’t hesitate to pull up the next sheet.
4. In the entry room, please wash your hands if dirty.
5. Put on shoe covers. Make sure your shoes are clean. Use shoe cleaner to remove the dirt on your shoes. Then Put on shoe covers.
6. Put on bouffant cap (hair net) if you have long hair.
7. Select the appropriate gloves for your intended activity in the cleanroom.
8. Clean the items you want to bring to cleanroom. You will find a supply of cleanroom wipes, and a spray bottle of IPA on the table. Use the spray and the wipes to clean the item before placing it in the passthrough. At this point, think about your cell phone – if you are going to need it in the cleanroom, wipe it down. Once you are gowned up, you won’t be able to pull it out of your pocket if it rings.
9. Enter the gowning room.
10. Put the items or samples you cleaned in the passthrough.

5. Gowning

We gown up in “top-down” fashion.

1. Put on the face mask first.
2. Put on the hood, ensuring the snaps face outward. Tuck in your hair. Fasten the hood closure, and adjust the fit snaps as needed. A full-length mirror is available in the gowning room to help you make sure you have the hood on right, all your hair is tucked in properly, etc.

3. Step into the coverall, and prevent the coverall from contacting the floor as much as possible. This takes some practice to do well. Fasten the coverall with the front zipper, ensuring the hood tails are completely tucked in to the neck of the coverall.
4. Put on the boots. Tuck the coverall into the top part of the boot, fasten the boot with the shoelace provided.
5. Choose the suitable safety glasses.
6. Finally, recheck your gowning in the full-length mirror. If you notice anything amiss, fix it now before stepping onto the last sticky mat and into the cleanroom.
7. Push the button of the automatic door to enter the cleanroom. Step on the tacky mat again.

6. Exit

Clean up the work place and hoods you used. Put your items you want to bring out in the passthrough.

The degowning procedure is essentially the reverse of the gowning procedure. While still gloved, remove your garments in “bottom-up” fashion.

1. Remove the safety glasses.
2. Remove the boots.
3. Remove the coverall, again being careful to not let it contact the floor. Hang up the coverall on your hangar, or drop it to the recycle trash bin for the disposal coverall. You can now snap your boots to the bottoms of the coverall legs to keep all your garments together.
4. Remove the hood, and snap it to the coverall as well. Or put it into the recycle trash bin if the disposal hood is dirty.
5. Remove your face mask and dispose into trash bin.
6. Don't forget your items in the passthrough.
7. Enter the entry room
8. Remove the hair net, shove covers and then gloves.
9. To operate the hallway door, prox your ID card on the pad adjacent to the door. This “logs” you out of the cleanroom. Do not follow other users to walk out the cleanroom, you must use your own ID to open the door so that the usage time can be stopped.

7. Chemicals Storage

1. Acids

Fresh acids should be stored in the trays on the 1st shelf of the corrosives cabinet. There is also room for ~ 4 bottles of acid under the *Acid Hood*.

2. Bases/Caustics

Fresh bases and caustic-based chemicals should be stored in the trays on the 2nd shelf of the corrosives cabinet. This includes developers as well as strong bases.

3. Solvents

Fresh solvents should be stored on the top two shelves of the flammables cabinet.

4. Photoresists, E-beam resists, Primers

Fresh bottles of photoresist should be stored in the explosion- proof refrigerator to preserve their lifetime. They may also be stored temporarily on the 2nd shelf of the flammables cabinet. Small bottles in-use may be stored on the bench top of Spinner Hood. Photoresist primer should be stored on the second shelf of the flammables cabinet.

8. Safety

Users are required to wear safety glasses at all times when they are in the cleanroom. Nitrile or vinyl gloves are also mandatory.

1. Acid/Base hood

All users working or observing at the acid/base hood are required to wear safety glasses, a face shield, a chemical apron, and the heavy green nitrile gloves. Even if you are using what you believe are “less-dangerous” chemicals you must still use the full PPE because of the possibility that someone else has left “more dangerous” chemicals in the hood and the likelihood that the surfaces of the bench are contaminated with these chemicals.

The apron should be put on first with the side labeled “Chemical side” facing the bench, followed by the face shield, and finally the thick gloves to avoid touching the apron and face shield with contaminated gloves. Thick gloves should be removed before removing shield or apron. Rinse and dry any contaminated gloves before removing them.

2. Solvent Hood

Users at the solvent benches must wear at least safety glasses and regular nitrile gloves. Thick nitrile gloves and face shield are strongly recommended when using heated solvents.

3. Spinner Hood

Users at the spinner benches must wear at least safety glasses and regular nitrile gloves.

9. Chemicals transporting

Users are required to wear safety glasses at all times when they are in the cleanroom. Nitrile or vinyl gloves are also mandatory.

For solvent and developer transporting, you must be wearing regular nitrile gloves and safety glasses at a minimum. These may be safely transported without the rubber buckets.

Bottles of fresh acid or caustic chemicals other than developer should be transported from

the cabinet to the hoods using a rubber bucket and one heavy nitrile glove.

- Make sure you are wearing safety glass.
- Users should get a heavy nitrile glove and a rubber bucket.
- Wearing the glove, place the chemical into the bucket and carry it using the gloved hand.
- The ungloved hand should be used for opening the door to avoid contaminating the button.

Bottles should be returned to the proper storage location immediately after use. Rubber buckets should be left near the cabinets.

10. Chemicals in-use

All chemicals in the benches must be always properly labeled. The information includes your name, chemical's name, time and date. **The chemicals should be covered whenever you are not actively using them.** This is not optional. It is a rule in all labs at Yale and complies with federal and state regulations. Label your glassware and find something to cover it with before you pour your chemicals so you don't forget. Be sure that there is a proper waste bottle available before you pour your chemicals. If there is not, this may indicate that you are using chemicals that have not been approved in the cleanroom or a mixture that has not been approved so ask the staff before you proceed. If there is no waste bottle for your chemicals but you are sure it is an approved chemical or mixture, start a new waste bottle.

The procedure to start the work at fume hood is

- Check list of allowed chemicals posted on the hood.
- Find the glassware that is suitable for your sample and make a label.
- Check waste bottle, if it is not available, make a new one.
- Transport the chemical from cabinet to benchtop, remember using rubber bucket and single heavy glove for acid and caustic chemicals.
- Put on PPE if needed.
- Pour your chemical to container.

Empty bottles

When you empty a bottle of fresh chemical, it is your responsibility to dispose of the empty bottle. You must rinse the bottle with DI water at least 3 times. The rinsate should be poured down the drain. After rinsing you must deface the label of the bottle. If possible you should peel off the label. If not, cross it out with a permanent marker. Then you may place the bottle in the small cabinet under the Acid Hood and Solvent Hood to be reused as a waste bottle.

11. Chemical Waste

We generate a significant amount of chemical waste in the cleanroom. It is important to ensure that this waste is properly handled, labeled and stored to avoid injury and to comply with state and federal regulations. ***Do not start using chemicals until you know that a waste bottle is available.***

Never leave a waste bottle un-labeled. Never write directly on the bottle.

Pouring out Waste

When you are finished with your chemicals you must pour them into the proper waste container.

- Make sure you have PPE if working with Acid and caustic chemicals.
- Place the waste bottle next to the sink and put the funnel in the mouth of the container.
- Carefully pour the waste into the funnel making sure you don't overfill the bottle.
- Once your container is empty, remove the funnel from the waste container making sure you don't drip the residue from the funnel onto the bench-top or the outside of the bottle.
- Thoroughly rinse the funnel in the sink to remove chemical residue. If you dripped chemical on the outside of the bottle, put on the cap then put the bottle in the sink, rinse it off and dry it with a wiper.
- Clean any spills from the bench-top using water and a wiper.
- Rinse the contaminated wiper in the sink and squeeze out the water before disposing of it in the trash.
- Finally, rinse out your glassware 3 times thoroughly and set to one side.
- Rinse off the heavy gloves in the sink and blow or wipe them dry before removing them.
- Remove PPE.
- If the waste bottle is not full and is one of the bottles stored in the hood you may leave it in the back of the hood.
- If it is full, or it is not to be left in the hood, transport it to the cabinet using the rubber bucket and glove as described previously.
- Dry your glassware and return to storage.

12. Protocols

Resist dispense protocol

For photo resist transfer, the "aliquot" bottle will be refilled from the "mother" bottle ONLY after the mother bottle is allowed to come to room temperature, thus avoiding the introduction of water vapor from the room air. After being used to refill the aliquot, the mother bottle can be tightly recapped and returned to the refrigerator immediately.

Remember: one person's resist is another's contaminant.

Resist will be dispensed using a disposable plastic pipette.

Pipettes will not be reused - once the dispense and spin are completed, the pipette will be disposed of in a ziplock bag, which will then be placed in the cleanroom trash.

It is ESSENTIAL that the spinner be cleaned immediately after use, as the materials used in this tool are known to harden up in a short period of time, and will surely foul the spinner, necessitating downtime and potentially expensive repairs.

It is traditional to protect the inside of the spinner with filter paper, lab wipes, or aluminum foil prior to spinning. This has the disadvantage that it is messy to clean up and dispose of the trash. The advantage is that it does help prevent contact of the fluid with the spinner inner surfaces.

Spinner cleaning procedure

For AZ-type resists, the cleaning solvent of choice is Microchem EBR, DO NOT SQUIRT ACETONE INTO THE SPINNERS, internal components are not compatible with acetone and will damage the spinner. For LOR resist, NMP seems to do a better job.

Place a 3” dummy silicon wafer, properly centered, on the spinner chuck. Switch on the vacuum, and close the lid. Program the spinner to use a speed of 1000 rpm for two minutes (120 seconds). Start the spinner. While the wafer is spinning, use the squirt bottle to spray the solvent of choice onto the center of the wafer, through the hole in the lid of the spinner. Do this for about 15 seconds, then pause, then again for about 15 seconds. If more cleaning is required, continue to spray for another 15 to 30 seconds. Now stop the spinner, open the lid, take out the dummy wafer, and use a lab wiper to wipe off all of the interior surfaces of the spinner. Dispose of the wipers in a Ziplock bag before disposing of them in the trash.

SU-8

SU-8 is a flammable and toxic substance.

SU-8 and PDMS are generally too viscous for the disposable pipettes. Other dispense methods will have to be employed.

SU-8 and SU-8 developer should be transported in a metal cart. Return these items to refrigerator or the flammable chemical storage bin in which they are kept as soon as you are done using them. Do not leave them out unattended.

Before working with SU-8, make sure that you are double-gloved.

Hot plate protocol

Hot plates in this process bench are for wafers and samples only – no beakers, etc.

In order to keep the hot plate clean, please put Aluminum foil first before heat, especially for SU-8 baking.

Set the hot plate temperature(s) to the desired value(s) before spinning your sample.

It is essential that the back of the wafer be clean and free of any resist residue! Use your tweezers and inspect the back of your sample before placing it on this hot plate. If it's not clean, don't bake it – strip it and recoat.

When baking is completed, remove the aluminum foil from the hot plates and place it in a plastic bag. Dispose of the bag properly.

SU-8 development

Development of wafers coated with SU-8 must be done in personal glassware in a solvent wet bench. Remember that this dish must be labeled as SU-8 contaminated and has your name on it.

SU-8 developer is very volatile. To prevent its fumes from reaching the common lab environment, the developer dish should be placed in the rear of the fume hood.

When you are done, you must clean the glassware using acetone and IPA and dry it using N₂.

All spent developer must go in the carboy in solvent bench.