BROWN

STANDARD OPERATING PROCEDURES

DEVELOPED TO SUPPLEMENT THE BROWN UNIVERSITY CHEMICAL HYGIENE PLAN & LABORATORY SAFETY MANUAL

General Instructions - All Standard Operating Procedures (SOP) must include a cover page that lists specific, departmental information, room information and the names of ALL occupants authorized to work in the laboratory. Fill out this cover page by utilizing the options provided, print a copy to insert into Section 3 of the Brown University Chemical Hygiene Plan & Laboratory Safety Manual located within the laboratory and send an electronic copy to the University Chemical Hygiene Officer by email at Linda_Olmsted@brown.edu. The goal of this SOP is to provide specific safety information relevant to each room.

BUILDING & CONTACT INFORMATION

Building Name: Engineering Research Center

Specific Room Covered By Plan: 010

24-Hour Emergency Telephone Number: (626) 354-4919

Non-Emergency Telephone Number: (401) 426-0867

LABORATORY SUPERVISOR INFORMATION

Name: Prof. Domenico Pacifici

Date SOP Prepared (mm/dd/yyyy): 01/11/2019

Signature Required: William R Patterson for D.P personnel 1-10-2019

PERSONNEL AUTHORIZED TO USE THIS LABORATORY

First Name	Last Name	Start Date	Title	Signature
1. Michael	Jibitsky	01/02/200	Staff	MJ
2. William	Patterson	02/01/197	Staff	WRP
3. Domenico	Pacifici	09/04/201	Faculty	WRP FOR D.P, PER EMAIL 1-10-2019
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DEPARTMENTAL INFORMATION:

Department: Engineering

Department Chair: Lawrence Larson

Signature of Department Chair _____ Date: _____

Chemical Hygiene Plan Section 3: Laboratory Standard Operating Procedures

A. Laboratory Specific Information and Signatures

This plan is for the IMNI Microelectronics Facility in the School of Engineering
Building: Barus and Holley
Rooms covered by plan 703, 705, 707

The Laboratory Director for this laboratory is:

Prof. Alexander Zaslavsky

The Technical Managers for this laboratory are:

Mr. Michael Jibitsky, Senior Research Engineer
Mr. William R. Patterson, Senior Research Engineer and Senior Lecturer

As a large number of people use this facility, the signature list of those who have acknowledged receipt of this section of the manual is maintained as a separate list in the Office of the Institute for Molecular and Nanoscale Innovation (IMNI), B. H. room 633. There are regular additions to the list of users and all new users are given copies of the laboratory-specific parts of the document and are required to sign this list before receiving permission to use the facility.

B. Preparation, Approval, Annual Review and Update

The Laboratory Director is responsible for seeing that the plan meets the regulatory requirements set forth in 29 CFR 1910.1450. He or she shall assure that the Chemical Hygiene Plan (CHP) is updated on a timely basis to include procedures for new hazards and processes as they are introduced. The CHP shall be reviewed on an annual basis and updated to accommodate changes in the 29 CFR 1910.1450, departmental procedures, Brown personnel policies and other pertinent materials. Assistance in creating the Chemical Hygiene Plan will be provided by the University Chemical Hygiene Officer in Office of Environmental Health and Safety (OEHS - x3-1737).

The Laboratory Director will see that the Chemical Hygiene Plan and updates are distributed to or made available to those who are affected by it. A copy of the entire plan is kept in the laboratory so it is available during all working hours.

The **Chemical Hygiene Plan: Laboratory Standard Operating Procedures** and annual updates, after being reviewed and signed by the Laboratory Supervisor and the Dean of Engineering, are sent to OEHS.

C. Standard Operating Procedures and Work Practices for Chemicals, Equipment, and Cleanroom Practice, Including Personal Protective Equipment

All users of this facility must be familiar with the general recommendations and requirements of the University's Chemical Hygiene Plan. This section of the plan lists the particular procedures and work practices for the IMNI Microelectronics Central Facility as opposed to the standard procedures that apply to all University laboratories.

General Conditions of Use:

1. Access to the Facility is controlled by card access with your University ID card and you may not use another person's card or have someone else let you in. Access is a privilege and the Laboratory Director reserves the right to revoke that privilege at any time for any action that in his or her sole discretion creates a hazardous condition in the laboratory or possible damage to the equipment in or cleanliness of the Facility.

2. Access to the Facility is conditional on completing training offered by OEHS on handling Hazardous Waste, on Laboratory Safety, and on the Use of Hydrofluoric Acid. The records of course completion maintained by OEHS are used to control card access and you must remain in compliance with training requirements or you will automatically lose access. In addition access will be revoked for loss of financial support or separation from the University.

3. Users shall familiarize themselves with the locations of all emergency features of the laboratory including where the eyewash and shower, fire extinguishers, telephones, safety glasses, chemical and waste storage cabinets, first aid kit and HF treatment materials are located. (See floorplan below.)

4. To maintain low particulate count in air in the Facility, all users must wear appropriate cleanroom clothing, including shoe covers, cleanroom suit, boots, and hair covers. Users receive instruction on how to put on, take off, and store garments as part of initial training. Regular users of the Facility will receive their own gowns and should NOT SHARE gowns. Occasional users may use the gowns marked for Visitors**. EXAMINE garments as you put them on or take them off for signs of wear and tear, particularly looking at the boots. REPLACE WORN GARMENTS!**

5. This facility is a cleanroom in which the air pressure is maintained above the pressure in the rest of the building. **DO NOT OPEN THE DOORS FROM THE WORKING SPACES TO THE HALLWA**Y. These doors are for emergency use only and should be kept closed and sealed. In emergency use they should normally be closed behind you immediately. In the event of the spill of a volatile or hazardous compound, warn other occupants of the facility and leave the room but do not allow any more air from the lab than necessary to reach the halls. Then, if possible, return to the main door to the Facility and in that entryway press the **RED BUTTON** on the air control box. This turns off the fans that recirculate air in the lab, protecting the air filters from corrosion and turning the

air pressure in the lab negative relative to the building. The latter limits the amount of contaminant that will get into the Barus and Holley air system.

Chemical and Compressed Gas Handling (See also additional sections on Hydrofluoric Acid and "Piranha Etch."):

1. Llightweight disposable nitrile and vinyl gloves are used for most purposes. Typically the vinyl gloves are worn over the nitrile. **These are NOT intended as protection against chemical exposure.** They protect your samples and our equipment from the oils and alkali salts that can rub off your hands. They **DO NOT PROTECT** you in any substantial way. Use care in handling chemicals with them and do not use any large quantity of chemical or any dangerous material relying on them for protection. Some heavier gloves are available for communal use, but users who use large quantities of chemicals should acquire their own appropriate gloves. Gloves must be suitable for the chemicals you are using. A separate section of this plan and most laboratory supply catalogs including those of Fisher Scientific and VWR have more information on glove selection. Facility personnel will be happy to assist you in making this choice.

2. There is a supply of safety glasses kept in boxes next to both fume hoods for use when working with chemicals. **You must use these at all times and return them** to the storage boxes when done. You must even wear them if you are near the fume hoods when others are using chemicals.

3. Full-face shields and heavy-duty aprons are available for working with more dangerous materials. Their use is mandatory with "piranha etch" and solutions of hydrofluoric acid and recommended for use with any aggressive chemicals especially acids. Facility personnel will be glad to advise on when that extra protection is needed.

4. There are also special UV-absorbing glasses that shall be worn when working with one of the mask aligners and these are kept next to the aligners.

5. When working with chemicals in one of the fume hoods, you MUST LABEL any working containers of chemicals for what materials are in them even as you work with them. The facility has **standard yellow labels** for this situation that must be filled out with full chemical names, your name, the date and time of setup, etc. (The purpose is to assure that anyone else using the hood knows what is there and that we know when something has stayed there too long.)

6. We store supplies for dealing with SMALL spills under the right hand side of the fume hood in the main lab. These supplies include absorbents in several forms and neutralization materials. There are also several heavy-duty gloves in different materials stored there for protection of personnel cleaning up problems. There is a chart on the inside of the door to that space showing the appropriate glove for each likely type of chemical. Do not remove materiel from this area unless for an emergency. If you do use these supplies, promptly inform Mr. Jibitsky so the supplies can be replaced.

7. DO NOT ATTEMPT TO HANDLE LARGE SPILLS, but inform other users of the facility, exit the facility, and summon help, either facility staff or Brown Security by calling x3-4111. EHS on-call personnel will respond. If you can do so safely, turn off the air recirculation system by pushing the large red button on the air control panel in the entryway to the lab.

8. We store all chemical wastes in trays under the fume hoods and signs are posted there showing which trays are for each type of waste. Similarly, new chemicals are kept in specific, labeled cabinets. Chemical segregation of both new and waste chemicals is important and absolutely required. Please cooperate by following the posted rules.

9. All waste chemicals go into bottles that can be used for disposal and these bottles must be labeled with the University's **standard orange waste labels**. Also, when labeling bottles for waste storage, **YOU MUST USE FULL NAMES OF THE CHEMICALS TO BE PUT IN THEM**. Do not use abbreviations, for example, "Hydrofluoric acid" NOT "HF". (This is a requirement to avoid confusion in either disposal or emergency handling, so people unfamiliar with our usage will know what they confront.)

10. Some users store small quantities of new chemical mixtures in bottles in the new chemicals cabinets. The facility has **standard white labels** for these bottles too and failure to use those labels and to fill them out fully will result in confiscation of the bottles.

11. Users of the facility who have been trained and authorized by Mr. Jibitsky may change the nitrogen compressed gas cylinders and liquid nitrogen tanks. All other gas cylinders may only be changed by him. This policy reflects both safety concerns and the need for care in avoiding contamination when changing cylinders.

12. Safety Data Sheets are kept in a binder on the desk in the entryway to the facility. These may not be the latest versions and you should consult with web-based sources for up-to-date information. (See, for example, the MSDS link at http://brown.edu/Administration/EHS/) However, these provide good general information and are placed to be safely and quickly accessible in the event of a spill or other emergency.

Supplementary Handling Procedures for Hydrofluoric Acid:

1. **Users are required to complete the on-line training module on HF** offered by OEHS annually and being out of compliance with this requirement will result in automatic denial of access. A large amount of hydrofluoric acid is used in this facility, both as 48 % concentrated aqueous HF solution and as buffered oxide etchant (a mixture of concentrated HF and aqueous ammonium bifluoride solution). Mishandling HF has been the only source of a serious injury to any users of the Facility in its many years of operation. All users must be cognizant of the dangers of this material whether or not it is used in their work.

2. This acid is quite dangerous and yet may appear innocuous. Read the advisory placard about hydrofluoric acid posted on the wall opposite the fume hood in the main lab next to the eye-wash stand. There is a special ointment, 2.5 % calcium gluconate gel, in the first aid kit by that placard for use should your skin come in contact with HF. Even minimal exposure should be treated seriously since the acid can be absorbed through the skin and do substantial biological damage before pain will make you aware of a problem.

3. Full personal protective equipment must be worn while processing with hydrofluoric acid, including full face shield, double gloves (vinyl over nitrile), and apron over cleanroom suit. The gloves are not sufficient protection for hands – careful handling to prevent contact with hands is the first line of defense.

4. If you come in contact with HF, wash vigorously with water for 5 – 10 minutes and apply the calcium gluconate gel immediately. Then seek immediate medical attention, calling Brown Security (x3-4111) if needed for transportation. Advise Mr. Jibitsky, the Laboratory Supervisor, or Mr. Patterson. (The ointment deteriorates once opened and we need to replace it. We also want to know about incipient problems.) They will require you to inform your faculty advisor and fill out required forms for OEHS.

5. In case of a spill, DO NOT TRY TO CLEAN UP THE SPILL but seek help from facility staff and the Brown Security/Emergency Response service (x3-4111) IMMEDIATELY. They will then contact the EHS on-call personnel.

6. HF etches glass and attacks many metals so all storage containers, processing containers, tools, etc. that may come in contact with anything containing HF must be an appropriate plastic, usually Teflon or polyethylene. We keep separate plastic bottles for wastes containing HF in the secondary containment pans for acids.

Supplementary Handling Procedures for "Piranha Etch," H_2SO_4 and H_2O_2:

1. A mixture of sulfuric acid and hydrogen peroxide attacks most organic compounds and is used for removing trace organics as part of some cleaning procedures. Because it attacks so many organic materials, it must be **kept in glass or quartz containers** both for use and for disposal.

2. Full face shield and apron are required when using this etchant.

3. Disposal of spent etchant requires care in both the selection of the waste container and in mixing waste with other waste already in the bottle. We use recycled glass bottles that were used for acid delivery. The mixing is highly exothermic and heating the solution in the waste container can create pressure that must be relieved to avoid breaking the bottle. Leave the cap slightly loose to allow the bottle to vent. Work in the sink when pouring into the waste bottle and then store it in the inorganic acid waste tray.

4. We keep a separate waste bottle just for just this etchant in each waste storage area. Should you need to start a new waste bottle, label it (orange hazardous waste label) with

the full names of its constituents and the percentage of each. (Typical usage is 67% sulfuric acid and 30 % of 30% hydrogen peroxide.)

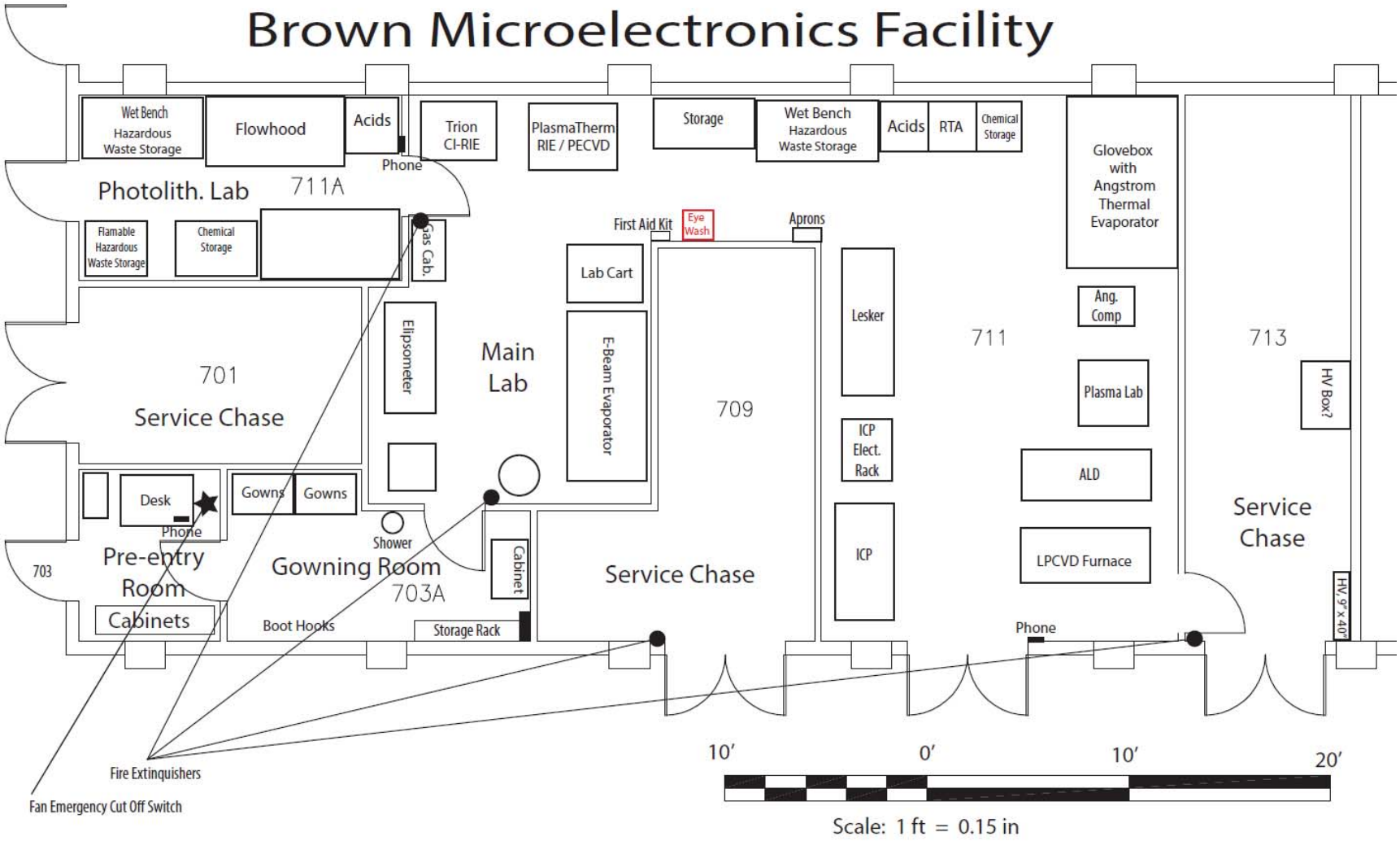
5. Even the vapors of this etchant can attack gloves so be careful not to allow your hands to linger over a beaker of hot piranha etch.

Work Restrictions:

1. No new chemicals (polymers, developers, organic compounds, gases, etc.) may be brought into the facility without approval of facility staff and the Laboartory Director. When such materials are brought in, **you MUST SUPPLY Mr. Jibitsky with hard-copies of the Safety Data Sheet** and with the quantity of material you are using. We are required to maintain a current inventory list and we want a printed SDS for consultation in emergency.

2. Most of the instruments in the facility have paper logbooks and you MUST fill out an appropriate form for each instrument run you make. While billing is based on entry to the facility, these logs let us track the equipment usage and help with maintenance.

3. All user tools and containers must be kept in closed polyethylene or similar plastic boxes. Rack space for these boxes in the gowning area is allocated to each user.


Brown Microelectronics Facility
Wet Bench
Hazardous
Waste Storage
Flowhood
Acids
Phone
Trion
CI-RIE
PlasmaTherm
RIE / PECVD
Storage
Wet Bench
Hazardous
Waste Storage
Acids
RTA
Chemical
Storage
Glovebox
with
Angstrom
Thermal
Evaporator
Photolith. Lab
711A
Flamable
Hazardous
Waste Storage
Chemical
Storage
Gas Cab.
First Aid Kit
Eye
Wash
Aprons
Lab Cart
Lesker
Ang.
Comp
711
713
701
Service Chase
Elipsometer
Main
Lab
E-Beam Evaporator
709
Plasma Lab
HV Box?
ICP
Elect.
Rack
ALD
Desk
Phone
Gowns
Gowns
Shower
Pre-entry
Room
Cabinets
703
Gowning Room
703A
Cabinet
Service Chase
ICP
LPCVD Furnace
Service
Chase
Boot Hooks
Storage Rack
Phone
HV, 9" x 40"
Fire Extinquishers
Fan Emergency Cut Off Switch
10′
0′
10′
20′
Scale: 1 ft = 0.15 in