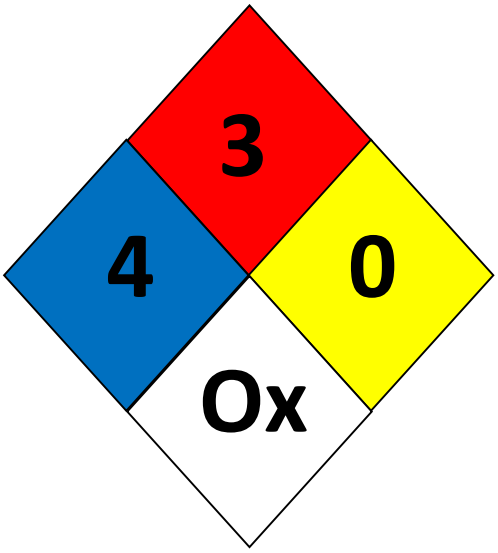
WVU Shared Research Facilities

Cleanroom Chemical Hygiene Plan

410 - 410A – 414 – 414A White Hall

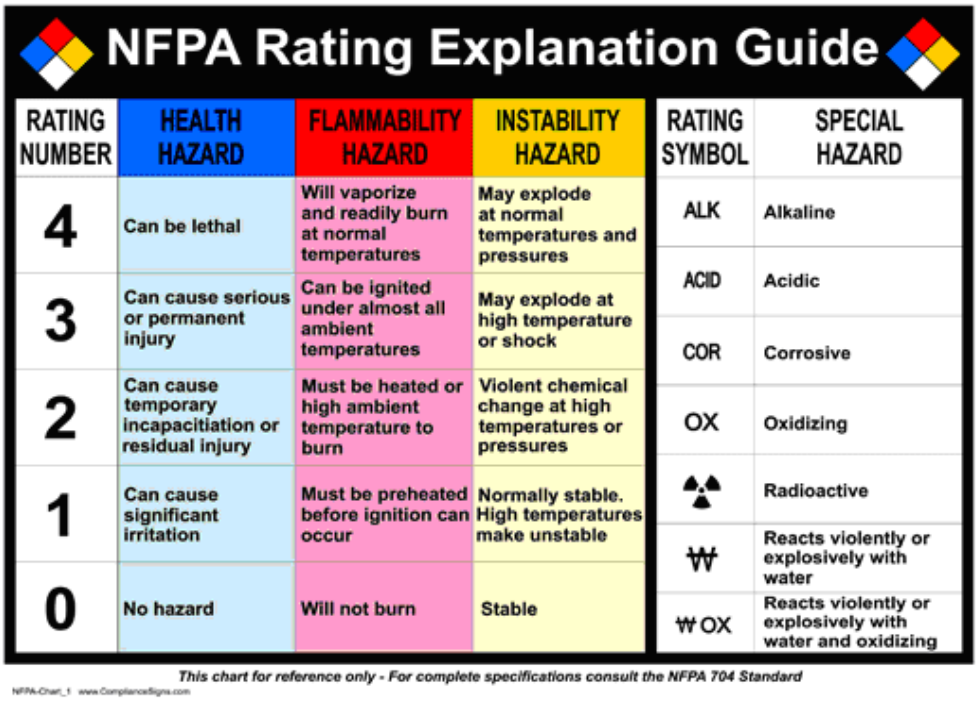


Emergency Contact:

Harley Hart
Office: 409 White Hall
G75D Engineering Sciences Building
Cell Phone: (412) 443 - 1514

Kolin S. Brown;Harley Hart;Weiqiang Ding
8/29/2013

SECTION 1.1: NFPA CHEMICAL HAZARD LABEL



NFPA Rating Explanation Guide

RATING NUMBER	HEALTH HAZARD	FLAMMABILITY HAZARD	INSTABILITY HAZARD
4	Can be lethal	Will vaporize and readily burn at normal temperatures	May explode at normal temperatures and pressures
3	Can cause serious or permanent injury	Can be ignited under almost all ambient temperatures	May explode at high temperature or shock
2	Can cause temporary incapacitiation or residual injury	Must be heated or high ambient temperature to burn	Violent chemical change at high temperatures or pressures
1	Can cause significant irritation	Must be preheated before ignition can occur	Normally stable. High temperatures make unstable
0	No hazard	Will not burn	Stable

RATING SYMBOL	SPECIAL HAZARD
ALK	Alkaline
ACID	Acidic
COR	Corrosive
OX	Oxidizing
	Radioactive
W	Reacts violently or explosively with water
W OX	Reacts violently or explosively with water and oxidizing

This chart for reference only - For complete specifications consult the NFPA 704 Standard

Figure 1: NFPA Explanation Chart

NFPA Rating - The National Fire Protection Association (NFPA) has developed a standard system (ANSI/NFPA 704) for indicating the health, flammability, and reactivity hazards of chemicals. In addition, a special precaution symbol may be used where necessary.

This system of identifying hazards associated with various materials was developed primarily for fire protection and emergency personnel but can be useful to anyone who needs to handle potentially hazardous material. As stated in NFPA 704, "This standard provides a simple system of readily recognizable and easily understood markings, which will give at a glance a general idea of the inherent hazards of any material and the order of severity of these hazards as they relate to fire prevention, exposure, and control."

General Rating Summary:

Health (Blue)

0- Hazard no greater than ordinary material
1- May cause irritation; minimal residual injury
2- Intense or prolonged exposure may cause incapacitation: residual injury may occur if not treated
3- Exposure could cause serious injury even if treated
4- Exposure may cause death

Flammability (Red)

0- Will not burn
1- Must be preheated for ignition, flashpoint above 93°C (200°F)
2- Must be moderately heated for ignition flashpoint above 83°C (100°F)
3- Ignition may occur under most ambient conditions, flashpoint below 83°C (100°F)
4- Extremely flammable and will readily disperse through air under standard conditions, flashpoint below 83°C (100°F)

Instability (Yellow)

0- Stable
1- May become unstable at elevated temperatures and pressure, may be mildly water reactive
2- Unstable; may undergo violent decomposition, but will not detonate. May form explosive mixtures with water
3- Detonates with strong ignition source
4- Readily detonates

Special Symbols (White)

OX- oxidizer
~~**W**~~- Water reactive, use no water

SECTION 1.2: EMERGENCY CONTACTS

In case of FIRE**,** INJURY, or EMERGENCY ASSISTANCE, contact in the following order:

9-911 from any campus phone
or
Campus Security
Phone: (304) 293-3136 (293-COPS)

Then Call

Harley Hart, SRF Manager
Cell Phone: **(412) 443-1514**
Room: **G75D ESB / 409 White Hall**

or

Weiqiang Ding, SRF Manager
Cell Phone: **(304) 685-1938**
Office Phone: **(304) 293-9683**
Room: **G75D ESB / 409 White Hall**

If no one responds to any numbers above, then contact:

Phillip Tucker, Lab Instrumentation Specialist for Department of Physics, Eberly College of Arts and Sciences
Cell Phone: **(304) 292-1160**
Office Phone: **(304) 293-3422 x69956**
Room**: G12 White Hall**

Dr. Earl Scime, Chairperson for Department of Physics, Eberly College of Arts Sciences
Cell Phone: **(304) 282-4473**
Office Phone: **(304) 293-5125**
Room: **111D White Hall**

For non-emergency assistance please contact:

Harley Hart, SRF Manager
Cell Phone: **(412) 443-1514**
Room: **G75D ESB / 409 White Hall**
or
Weiqiang Ding, SRF Manager
Cell Phone: **(304) 685-1938**
Office Phone: **(304) 293-9683**
Room: **G75D ESB / 409 White Hall**

SECTION 1.3: EMERGENCY EVACUATION PROCEDURES

Cleanroom Evacuation Plan

In case of Fire or Chemical Spill all users should evacuate the entire cleanroom immediately!

- Do not stop to un-gown.
- Use the shortest, unobstructed path to the exterior of the building.
- Only if it is safe to do so, users should turn off or unplug the hotplate bath before evacuating.
- Only if it is safe to do so, users should turn off or unplug the ultrasonic bath before evacuating.

WARNING: Due to the high number of air exchanges in the cleanroom to maintain positive pressure and room cleanliness, fire will travel quickly throughout the cleanroom. An individual in the cleanroom may find their emergency egress quickly blocked if they hesitate to fight the fire or un-gown.

WARNING: Due to the high number of air exchanges in the cleanroom to maintain positive pressure and room cleanliness, chemical vapors and gases will travel quickly through the

cleanroom. It is safer to evacuate all persons from the room than to try to clean up any chemical spills.

Cleanroom - WH 410 Evacuation Plan

410 White Hall

Photolithography Lab

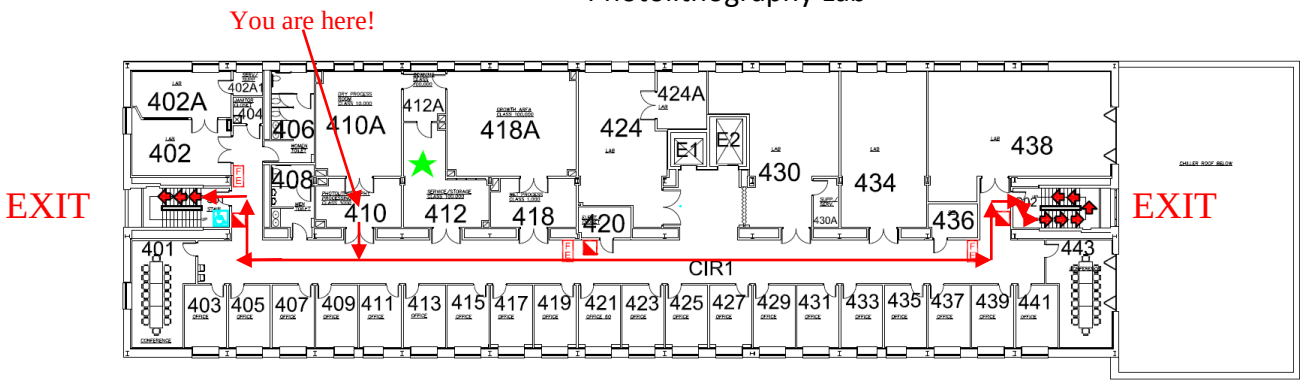


Figure 2: White Hall 410 Evacuation Plan

Cleanroom - WH 410A Evacuation Plan

410A White Hall

Dry Processing Lab

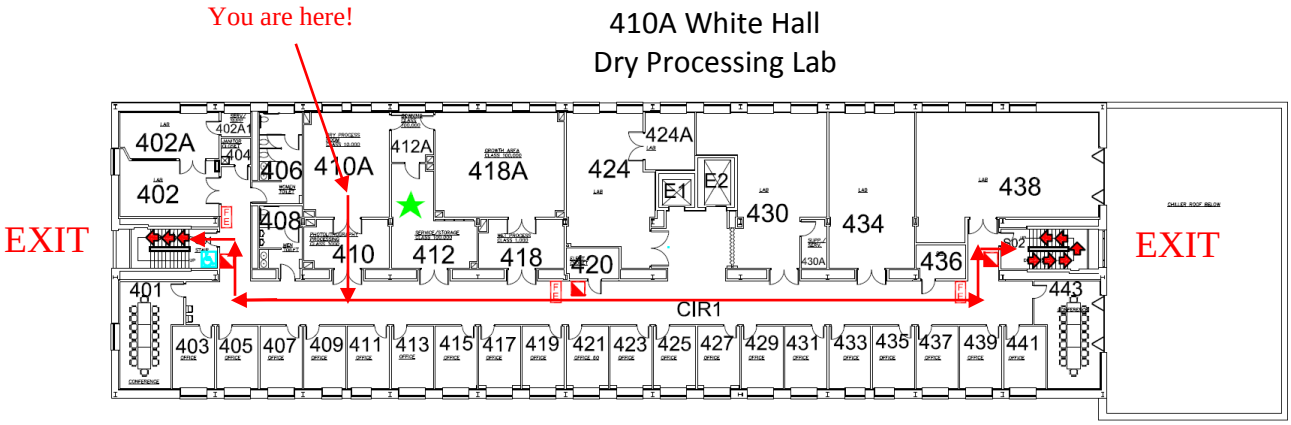


Figure 3: White Hall 410A Evacuation Plan

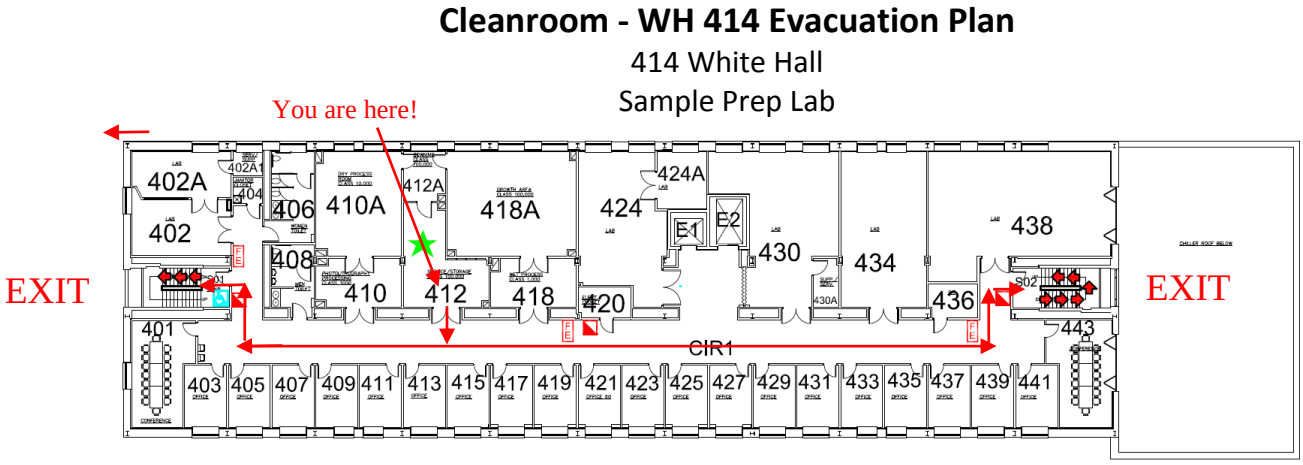


Figure 4: White Hall 414 Evacuation Plan

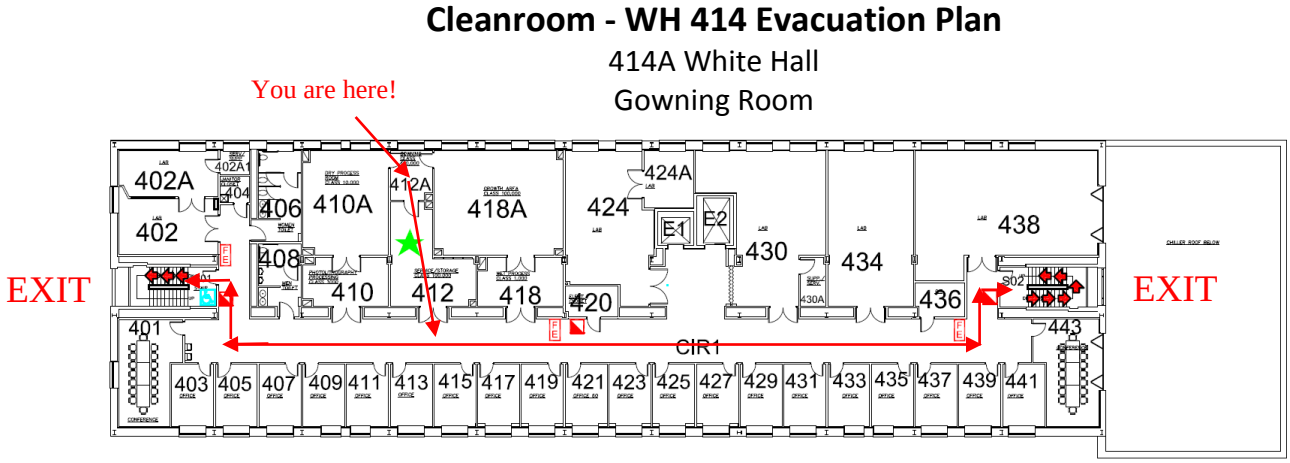


Figure 5: White Hall 414A Evacuation Plan

SECTION 1.4: EMERGENCY SHUTDOWN PROCEDURES

If a dangerous situation is evident (smoke, fire, sparks, etc.), ONLY if it is safe to do so, should a user attempt to shut down a system. The user should then notify all other persons within the cleanroom lab to evacuate immediately. After evacuation, a user should contact proper emergency personnel from a safe place.

If the tool is not acting as expected then the user should attempt to put the tool in its default mode; do not leave the tool running in an abnormal state! If the tool cannot be placed in its default mode, the user should stay by the tool and contact one of the WVU Shared Facilities staff members. If it becomes necessary to leave the tool then the user should leave a large, legible

note on the tool stating that the tool is down. The user should also report this through the FOM by entering the details of the issues in the PROBLEM REPORT section of the FOM before logging out.

Listed below are the procedures to place each tool into a safe default mode, or to shut down each tool. Detailed shutdown procedures may be found on the cover of each tool logbook or in the Standard Operating Procedures found in Appendix C.

PLD:

Emergency shut-down:

- **Press the STOP LASER icon on the Laser Control screen**
- **Press the STOP AUTO MASS FLOW CONTROL icon on the Mass Flow Control screen**
- **Press the ABORT icon on the Heater Control screen**
- **Turn off the argon and oxygen gas at the gas valves behind the tool**
- **Turn off the laser by pressing the RUN/STOP button on the laser control panel**
- **Using the laser control keypad, press the F10 button on laser keypad, then ENTER and then EXE to shut down the laser**
- **On the back of the laser, turn the key switch to the OFF position**
- **On the back of the laser, turn the power switch to the OFF position**
- **Close the argon and oxygen gas bottles valves in the entry lab**

To place in default mode:

- **Decrease voltage and current on RHEED power supply and then turn-off the power supply**
- **Close the RHEED gate valve and the RHEED camera shutter**
- **Press the STOP AUTO MASS FLOW CONTROL icon on the Mass Flow Control screen**
- **Press the ABORT icon on the Heater Control screen.**
- **Verify that the main chamber turbo pump is operating at 820 Hz**
- **Verify the loadlock is under vacuum**
- **Turn off the laser and manually close the laser shutter**
- **Close all gas valves on wall behind the tool and at the bottles in the 414 Sample Prep Lab**

Sputter Station - WH:

To shut down:

- **Press the STOP button on the process screen**
- **Turn off all sputter gun power supplies**
- **Turn off the heater power supply**
- **Press OPEN on the pressure controller**
- **Turn off all gases gas controller**

- **Close all gas valves on wall behind the tool and at the bottles in the 414 Sample Prep Lab**

To place in default mode:

- **Turn off the substrate heater**
- **Turn off the DC and/or Rf power supply(s) being used**
- **Open the throttle valve**
- **Move the process gas toggle switches to the OFF position for the gases being used**
- **Verify the loadlock is under vacuum**
- **Close all gas valves on wall behind the tool and at the bottles in the 414 Sample Prep Lab**

Mask Aligner - WH:

Emergency shut-down:

- **Turn OFF the unit by pressing the POWER button on the front control panel**
- **Turn OFF the lamp by pressing the toggle switch on the front of the power supply**
- **Turn OFF the microscope power supply using the toggle switch**
- **Turn OFF the vacuum pump by located on the right-hand side of the tool**

To place in default mode:

- **Turn OFF the power supply on the front control panel**
- **Turn OFF the lamp power supply**
- **Turn OFF the microscope power supply**
- **Turn OFF vacuum pump located on the right-hand side of the tool**

Spinner - WH:

Emergency shut-down:

- **Press the STOP button on the control panel**
- **Turn off the unit by pressing the toggle switch on the back of the unit**
- **Turn off the vacuum pump located beside the solvent hood**
- **Turn off the nitrogen gas by closing the gas valve at the back of the hood**

To place in default mode:

- **Turn OFF vacuum pump located on the left-hand side of the tool**
- **Close the nitrogen line located at the back of the hood**

Optical Microscope - WH:

Emergency shut-down:

- **Move the toggle switch on the right-hand side of the microscope to the OFF position**

To place in default mode:

- **Move the toggle switch on the right-hand side of the microscope to the OFF position**

Wafer Dicer - WH:

Emergency shut-down:

- **Press the EMO button on the front of the tool**
- **Close the DI water valve located behind the tool**
- **Close the compressed air line located behind the tool**
- **Turn the power key to the OFF position**

To place in default mode:

- **Move the key on the front panel to the OFF position**
- **Close the DI Water Valve**
- **Close the Compressed Air Line Valve**

SECTION 1.5 LASER EXPOSURE RESPONSE

The PLD uses a 248 nm wavelength Class IV laser and the laser is contained in a laser safety enclosure so that during operation the system is a Class I. While the laser is in operation, laser safety googles are required for all lab personnel and the **LASER IN USE** must be illuminated. The potential for injury is most likely to occur during laser maintenance, but if laser exposure has occurred, contact the following:

Laser Safety Department
Office Phone: **(304) 293-0952**
and,
Harley Hart, SRF Manager
Cell Phone: **(412) 443-1514**
Room: **G75D ESB / 409 White Hall**
or
Weiqiang Ding, SRF Manager
Cell Phone: **(304) 685-1938**
Office Phone: **(304) 293-9683**
Room: **G75D ESB / 409 White Hall**

Then, seek immediate medical attention. Be sure to inform the physician that exposure to a Class IV laser has occurred!

SECTION 1.6: EMERGENCY RESPONSE EQUIPMENT

First Aid kits are located in the Entry Lab **414,** of **WHITE HALL**.

The nearest **AED** (Emergency Defibrillator) is located on the first floor of the Wise Library building next to White Hall to the right of the elevators.

The **safety shower and eyewash station** is located next to the solvent hood in **410A** of **WHITE HALL**.

The **Chemical Hygiene Plan** and **MSDS** are located in the Sample Prep Lab, **414,** of **WHITE HALL**.

SECTION 2: LAB OVERVIEW

The WVU Shared Research Facilities Cleanroom - WH, is a specialized laboratory environment for fabricating electrical and photonic devices. This collection of lab consists of 960 square feet of clean space and is part of a 6 lab suite of cleanroom spaces:

- Lab 410A is a class 10,000 room designed capable of sputter and pulsed laser deposition
- Lab 410 is a class 1,000 room designed for photolithography processing
- Lab 414A is a class 100,000 room and functions as the gowning area for 410 and 410A
- Lab 414 is a clean space and functions as a sample prep/storage area.

As part of the WVU Shared Research Facilities, the Cleanroom – WH provides student and postdoctoral researchers with the opportunity to learn how to use cutting-edge materials science and engineering equipment. The facility is open to all researchers, including researchers at government laboratories and industries.

SECTION 2.1: FACILITY DESCRIPTION

The WVU SRF Cleanroom – WH facility is part of a suite of 4 labs. A map of the entire facility is shown in Figure 6. WVU Shared Research Facilities are only authorized to enter the following labs highlighted in YELLOW:

- Sample Prep Lab (414)
- Gowning Room (414A White Hall)
- Photolithography Lab (410 White Hall
- Dry Processing Lab (410A White Hall)

Figure 6: Cleanroom – WH Facility Map

WARNING: WVU Shared Research Facilities CR-WH users are NOT authorized to enter 418A unless granted permission in email from the Dr. David Lederman (david.lederman@mail.wvu.edu). Any questions, concerning this should be directed to the WVUSRF CR-WH Staff.

SECTION 2.1.1: PHOTOLITHOGRAPHY LAB

Lab 410 of White Hall is a Class 1,000 lab that serves as the Photolithography lab. The purpose of this room is to create polymer process masks on substrates using standard photolithography techniques.

This lab houses a spinner hood, developer hood, optical microscope, and mask aligner.

The spinner hood is chemical wet bench where users can apply resist polymers to their substrates:

- One spinner and one hotplate are installed on the spinner hood deck.
- Resist polymers, HMDS, and waste container are stored in the cabinet under the hood.
- A waste container for contaminated wipes is kept on the hood deck.
- A waste jar for contaminated pipettes is store in storage cabinet under the hood.
- Rinse bottles of Acetone, Isopropanol, and Methanol are stored on the hood deck for ease of use.
- Supplies are stored at the hood for point of use.

The developer hood is a chemical wet bench where users can develop samples that have been patterned using UV light:

- A waste container for contaminated wipes is kept on the hood deck.
- Developers and waste jars are stored in the storage cabinet under the hood.
- Rinse bottles of Acetone, Isopropanol, and Methanol are stored on the hood deck for ease of use.
- Supplies are stored at the hood for point of use
- An ultrasonic bath is located on the hood deck

Equipment:

MJB3 Mask Aligner

- For patterning photoresist into the sub-micron range
- Front side alignment
- 365nm UV exposure source
- Hard and Soft Contact modes
- Sample chucks for 10 x 10 mm die and 2-inch substrates
- Mask holder for 4-inch mask with a 2 x 2 inch exposure area

Laurell Technologies 600 Spinner

- For solvent cleaning and spine development or spin application of resist polymers
- Located in 4 foot solvent hood with hotplate available
- Substrates from 10 mm to 6-inches
- Maximum speed of 12,000 rpm

MEI Optical microscope:

- 5x, 10x, 20x, 50x objectives

SECTION 2.1.2: DRY PROCESSING LAB

Lab 410A of White Hall is a Class 10,000 lab that serves as the Dry Processing lab. The purpose of this lab is to house equipment for deposition, thermal processing, and MBE.

This lab houses a solvent hood, sputter station, pulsed laser deposition tool, and oven.

The solvent hood is a chemical wet bench for cleaning system substrate holders, system parts and components.

- A waste container for contaminated wipes is kept on the hood deck.
- Rinse bottles of Acetone, Isopropanol, and Methanol are stored on the hood deck for ease of use.
- Supplies are stored at the hood for point of use
- Acetone, Methanol, and Isopropanol bottles are stored in the storage cabinet under the solvent hood.

The sample prep table is space dedicated to attaching substrates to holder and recording research data:

- A waste container for contaminated wipes is kept on the sample prep table
- Supplies are stored at the hood for point of use.

Equipment:

Neocera Pulsed Laser Deposition

- Thin film deposition technique that retains the composition of the material
- Uses a 248 nm wavelength Coherent laser
- Loadlock UHV system
- Argon and Oxygen source gases
- Maximum sample size of 2-inch
- Substrate heater with a maximum temperature of 950˚C
- Capable of Continuous Composition Spread capability
- Target carousel capable of holding 3 2-inch targets or 6 1-inch targets
- RHEED deposition monitoring capable

Sputter System:

- Thin film deposition of metals, oxides, or magnetic materials
- Loadlock HV system
- Argon and Oxygen source gases
- Standard targets: Platinum, Titanium, Gold, Zinc Oxide, Aluminum, Nickel, and Cobalt
- DC and Rf sputtering capable
- Rotating backside substrate heater with a maximum temperature of 850˚C

SECTION 2.1.3: SAMPLE PREP LAB

Lab 414 of White Hall is a clean space lab that serves as a Sample Prep space for the Cleanroom lab. The purpose of this lab is for preparing samples prior to entry into the cleanroom lab and to serve as a support space for the Cleanroom labs

This lab houses a sample prep table, storage cabinets, chemical storage cabinets for the Physics researchers, wafer dicer, and gas bottles for cleanroom equipment.

The sample prep table is for cleaning substrate holders for the wafer dicer and for preparing samples for dicing:

- A waste container for contaminated wipes is kept on the table.
- Rinse bottle of Isopropanol is stored on the sample prep table for ease of use.
- Supplies are stored at the hood for point of use

This space also serves as a support space for 410 and 410A.

- The waste storage container for the WVU EH&S is located in this lab.
- Storage space for spare parts
- Location of the Argon, Nitrogen, Oxygen, and Helium gas bottles which are used for the sputter station, PLD, and spinner
- Storage area for equipment gas bottles

Equipment:

Discotech Wafer Dicer

- Capable of dicing samples up to 6-inch in diameter
- Vacuum chuck or Ceramic chuck is available for use
- Chop cutting capabilities
- Auto-alignment of sample capable

SECTION 2.1.4: GOWNING ROOM

Room 414A of White Hall serves as the location where users can dress in proper cleanroom garments before entering the cleanroom suite. This room is also used as a wipe down location for any items or equipment entering the cleanroom area.

SECTION 2.1.5: SUPPORT SPACES

White Hall Penthouse (located above the Cleanroom – WH):

- DI water system for the entire cleanroom
- Cleanroom HVAC unit

SECTION 2.2: LABORATORY ACCESS

Access to the WVU Shared Research Facilities is controlled through the WVU ONITY Lock system. The three Cleanroom Lab locks of White Hall are located on the doors to 414, 414A, 410A.

WVU Shared Research Facilities and ECAS have identified the Cleanroom Lab locks, 414, 414A, and 410A as restricted locks. Access to these locks is only given to lock shop personnel, campus security, emergency services, appropriate ECAS Administration, Shared Research Facilities staff, and cleanroom users. Please contact Harley Hart at harley.hart@mail.wvu.edu for questions related to these restrictions.

The following persons are the official operators of these locks:

Kolin S. Brown
Lisa Sharpe
Harley Hart
Chris Tarabrella

In addition the WVU Lock Shop and WVU Card Services also have capabilities to give students, staff and faculty access in these locks.

CR-WH users are only given access to the Cleanroom Lab during normal working hours after they have completed all required safety trainings, have a signed user agreement on file with the SRF CR-WH Manager, and have completed training on desired equipment.

The normal working hours of the Cleanroom - WH are 8AM-5PM, Monday–Friday and the after-hours are 5PM-8AM, Monday-Friday; weekends and holidays are all hours.

CR-WH users reserve the time on the instruments via online reservation system (FOM). http://fom.wvu.edu/fom

SECTION 2.2.1: REQUIRED SAFETY TRAINING

All CR-WH users must complete the following the following safety training to receive access to the facility during normal working hours.

- WVU SRF General Lab Safety Training
- WVU SRF Chemical Safety Training
- Cleanroom Protocols Safety Training (including tour of the cleanroom)
- View Coherent Laser Safety Video
- Read and sign the WVUSRF Cleanroom Lab Chemical Hygiene Plan sign-in sheet in Appendix B

Copies of the WVU SRF safety presentation slides and CHP are located on the Shared Research Facilities website:
http://sharedresearchfacilities.wvu.edu/safety/srfSafetyMain.html

SECTION 2.2.2: REQUIRED SYSTEM TRAINING

All CR-WH users must complete the following safety training to receive access to the facility during normal working hours.

- Users will attend a minimum of two instrument operation trainings and then be observed using the tools before being granted day-time access to the lab.
- Experienced users will receive additional trainings and be evaluated before granted unlimited access to the cleanroom.

SECTION 2.2.3: USER AGREEMENTS

All cleanroom-WH users must have a user agreement on file with the WVU SRF. User agreements must be signed by the user, the user's advisor and the user's department chair, when appropriate.

Copies of the User Agreements are located on the Shared Research Facilities website:
http://sharedresearchfacilities.wvu.edu/forms/srfForms.html

SECTION 2.2.4: RADIATION BADGE

This section is not applicable to this lab.

SECTION 2.2.5: DRESS CODE REQUIREMENTS

The following dress code is required for all users entering the Cleanroom - WH Labs:

1. No contact lenses
2. No shorts, legs must be fully covered
3. No sandals or open toed shoes, feet must be fully covered
4. No make-up or perfume

Users entering the cleanroom must wear the following cleanroom attire:

- Blue boot covers
- Cleanroom suit that is free of rips and tears
- A bonnet
- Nitrile gloves
- Cleanroom boot covers

- A beard guard is required if a male user has facial hair or if he did not the shave the morning of entry.
- A facemask is required when working in the Class 1000 area.
- Laser Safety goggles are required for users present in the Cleanroom – WH 410 and 410A labs if the PLD is going to be used or if the **LASER IN USE** light is illuminated.

SECTION 2.2.6: AFTER HOUR ACCESS

After hour access to the Cleanroom - WH Lab is given upon request by the WVU Shared Research Facilities CR-WH Manager. The CR-WH manager will use their own discretion to grant access when a user has demonstrated he or she can work alone safely and handle an emergency.

SECTION 2.2.7: TEMPORARY USER SUPERVISION

Temporary users in the Cleanroom - WH Lab must be accompanied by a trained system user or staff member at all times and must follow all safety protocols while present in the lab. Temporary users may include summer research participants, visitors or class participants.

WARNING: Temporary users or users who have not been fully trained are NOT permitted to enter room 410 and 410A if the PLD laser is energized unless the user has been trained on the equipment and has viewed the Coherent Laser Safety Video.

SECTION 3: CHEMICAL SAFETY

The following chemicals are always available in the Cleanroom - WH Labs:

- Isopropanol
- Methanol
- Acetone
- Vacuum Grease
- Silver Paint

In addition several types of photoresists and developers are kept in the 410 lab. The following list represents the types of resists that are typically kept inside the cleanroom, however, the exact formulations will change periodically based on current projects:

- HMDS
- AZ 5214 Photoresist
- SU – 8 Photoresist
- AZ 300 MIF Developer
- SU – 8 Developer

These list represents the standard process chemicals used inside the Cleanroom - WH Labs by WVUSRF users. A current chemical inventory may be found in Appendix B. This inventory is updated each semester. The cleanroom is a multiuser facility that supports a wide variety of research projects.

In addition to process chemicals, hydrocarbon based oils are stored and used by the Cleanroom – WH Lab equipment.

SECTION 3.1: CHEMICAL STORAGE

Chemicals are stored in the point of use areas under the solvent hoods in 410 and 410A.

When a chemical order arrives, an approval chemical label that is dated and signed by a SRF staff member is applied to each chemical container. The chemical is then placed in the appropriate solvent hood storage cabinet for use.

WVUSRF users are NOT authorized to store chemicals in lab 414 of White Hall. If a user needs to store chemicals in 414, then the user must contact the Chemical Hygiene Officer and Physics Lab Manager:

> **Phillip Tucker,** Lab Instrumentation Specialist for Department of Physics, Eberly College of Arts and Sciences

Cell Phone: **(304) 292-1160**
Office Phone: **(304) 293-3422 x69956**

SECTION 3.2: AUTHORIZING CHEMICAL USAGE

The WVU Shared Research Facilities CR-WH staff only purchases chemicals that are for general use. Often, research projects require the use of chemicals that are specific to a project. Any user, who wishes to bring a new chemical into the cleanroom, must first obtain permission before bringing a new chemical into the lab. The user must submit a signed material tracking form and a material safety data sheet(s) (MSDS) for each chemical container to the CR-WH manager for approval. A copy of this form can be found on the shared research facilities website (http://sharedresearchfacilities.wvu.edu/forms/srfForms.html). This form identifies the chemical, proper storage, and proper disposal methods. Material tracking forms are kept in a binder in the SRF CR-WH manager's office. The MSDS are added to the MSDS file kept in 414 of White Hall.

All containers must be brought to a SRF staff member to receive an approved chemical label, which is signed and dated by the SRF staff member. The chemical container must be appropriate for the chemical and it must be labeled appropriately with the full chemical name to receive an approved chemical label. Only containers with approved chemical labels may be taken into the Cleanroom - WH

A chemical must be approved before being brought or stored into the cleanroom, even if the chemical is only going to be used one time.

SECTION 3.3: CHEMICAL HANDLING

Wet chemical processing or any work with open chemical vessels must be performed in a chemical hood. The Cleanroom – WH lab has three chemical hoods, and each is designated for a specific type of process. All chemicals have adjustable sashes. Users should always be working with all chemicals at arm's length in the back of the hood for their protection.

WARNING: Acids and Bases are not able to be used in the SRF cleanroom areas.

- 410A Solvent Hood: Used for sample holder cleaning and sample prep for the PLD and Sputter Station
- 410 Developer Hood: Solvent hood used for sonication and liftoff processing
- 410 Spinner Hood: Solvent hood used for photoresist application.

A rinse bottle with isopropanol can be found on the Wafer Dicer sample prep table in 414. This is used for substrate/sample cleaning only. Nitrile gloves and safety glasses are required when using this rinse bottle.

A rinse bottle with 10% isopropanol / 90% DI Water can be found on the gowning rack shelves 414A. This is used for wiping down items prior to entering the 410 and 410A cleanroom labs.

Users working in the cleanroom must be properly gowned wearing a cleanroom suit and nitrile gloves. Cleanroom suits are splash resistant and nitrile gloves are resistance to chemicals in used in the cleanroom – WH.

When working in the chemical hoods in the Cleanroom – WH:

- Read the MSDS prior to handling a new chemical
- Keep the work area inside the hood clean and free from obstructions
- Never heat solvents in closed beakers
- Do not store items in the hood
- Do not leave unlabeled chemicals in a hood
- Always properly label beakers
- Work at arm's length
- Always wear safety glasses when working with chemicals

WARNING: Users should use designated hoods for specific chemical processing. Using acids in the solvent hood or solvents in the acid hood may result in an explosion.

SECTION 3.4: ACCIDENTAL CHEMICAL EXPOSURE

Users are required to wear appropriate personal protective equipment (PPE) for their safety, if at any piece of PPE becomes damaged or torn it should be replaced immediately. If a user has been exposed to a chemical, the following procedures should be followed immediately.

For eye exposure:

1. Remove all contaminated clothing and gloves.
2. Initiate water flow at eyewash station by either pressing on the pedal or the hand lever.
3. Hold eyes open with fingers and lower face into eyewash bowl, so that water is rinsing the eyes.
4. Keep eyes open and rotate.
5. Flush eyes for a total of 15 minutes.
6. Seek emergency medical attention.

For exposure to any part of the body:

WARNING: Do not wipe off the chemical as you will only increase area of contact! Increasing area of contact will increase absorption through the skin and may result in faster or more severe reaction or poisoning.

1. Remove all contaminated clothing and gloves.
2. Initiate water flow at safety show by pulling down ring.

3. Flush contaminated area for a total of 15 minutes.
4. Seek emergency medical attention

In case of MEDCIAL EMERGENCY contact:

9-911 from any campus phone
or
Campus Security
Phone: **(304)293-2677 (293-COPS)**

If going to the hospital for medical assistance, make sure you:

- Take a copy of the MSDS with you

SECTION 3.5: CHEMICAL SPILL RESPONSE

If at any time a user is unsure of how to clean up a spill or is uncomfortable in trying to clean up the spill they should immediately evacuate the area and seek assistance. Users should attempt to only contain the spill and then seek assistance from the SRF Cleanroom - WH staff. Personal protective equipment should be worn at all times.

A spill kit is kept in the 410 lab next to the solvent hoods. Users should only attempt to contain the spill if it is less than one gallon.

If a chemical spill occurs, contain the spill by doing the following:

1. Open the spill kit by pressing the red lever with the thumb and rotating the lid counter clockwise.
2. Put on the gloves inside the spill kit.
3. Remove a pink absorbent pad and place over the spill area. Use as many pads as necessary to contain the spill.
4. Seek SRF Cleanroom - WH staff assistance.
5. With staff assistance, place all pads in the garbage bag.
6. Remove any remaining contents from the spill kit and place the garbage bag inside the pail.
7. Close the spill kit lid.
8. Fill out the USED Spill Kit label and attach to outside of the kit.
9. The cleanroom staff will contact EH&S for pickup.

NOTE: Small spills of resists or polymers, which are less than two inches in diameter, may be wiped up with an acetone dampened cleanroom wipe. The wipes may then be disposed of in an appropriate waste container.

NOTE: ALWAYS TRY TO ATTEMPT TO KEEP SPILL FROM ENTERING DRAIN SYSTEM.

In case of an ACUTELY HAZARDOUS SPILL contact in the following order:

Environmental Health & Safety
Phone: **(304) 293-3792**

Then Call,

Harley Hart, SRF Manager
Cell Phone: **(412) 443-1514**
Room: **409 White Hall / G75D ESB**
or
Weiqiang Ding, SRF Manager
Cell Phone: **(304) 685-1938**
Office Phone: **(304) 293-9683**
Room: **409 White Hall / G75D ESB**

If no one responds to any numbers above, then contact:

Phillip Tucker, Lab Instrumentation Specialist for Department of Physics, Eberly College of Arts and Sciences
Cell Phone: **(304) 292-1160**
Office Phone: **(304) 293-3422 x69956**
Room**: G12 White Hall**

Dr. Earl Scime, Chairperson for Department of Physics, Eberly College of Arts Sciences
Cell Phone: **(304) 282-4473**
Office Phone: **(304) 293-5125**
Room: **111D White Hall**

SECTION 3.6: CHEMICAL DISPOSAL

All the chemicals inside the cleanroom must be captured in waste jars.

To dispose of all chemicals and chemical mixtures:
Used chemicals must be captured in chemical waste jars. All chemical waste is captured and stored in an appropriately chosen waste jar which is properly labeled with the word **WASTE.** The jar label should clearly list all contents of the waste jar. Ideally, the waste jar should be an

empty original container of the same chemical to be disposed of. Each chemical or mixture should have its own waste jar. The only waste jar that should be used for multiple chemicals is the alcohol waste jar; this jar may be used to dispose of, isopropanol, and ethanol.

Waste jars should be closed when not in use.

WARNING: Do not pour a hot liquid in a waste jar. Allow the hot chemical or chemical mixture to cool before adding it to a waste jar. Sealing a hot liquid in a waste jar may cause the jar to explode.

WARNING: Do not seal a waste jar if the material is highly reactive! If the waste jar heats up, or if it fumes, keep the jar open in the chemical hood deck and contact an SRF staff member immediately for assistance. Sealing a chemical reaction in a waste jar may cause the jar to explode.

SECTION 3.6.1: HAZARDOUS WASTE DISPOSAL

Waste jars are inspected weekly by the SRF Cleanroom – WH staff. When a waste jar is full, it is placed in storage area under the hood. A hazardous waste chemical disposal form is filled out and submitted to EH&S for pick-up. When EH&S arrive for pick-up the waste label is modified to show the words HAZARDOUS WASTE. The label is dated and signed by the SRF staff member.

A copy of the hazardous chemical disposal form can be found on the WVU EH7S website: http://ehs.wvu.edu/forms.

Waste jars are available for the following chemicals in lab 410:

- Acetone
- Isopropanol / Methanol
- SU – 8 Developer
- AZ 300 MIF Developer
- Photoresist pipettes

SECTION 3.6.2: CONTAMINATED MATERIAL HAZARDOUS WASTE DISPOSAL

Any wipe that has been contaminated must be disposed of as hazardous waste. **USED WIPES** waste containers with lids are kept at the following locations:

- 414 sample prep table
- 414A gowning room
- 410A sample prep table
- 410A solvent hood

- 410 spinner hood
- 410 developer hood

The contents of the **USED WIPES** containers are emptied as needed and the contents are placed in the **USED WIPES** storage containers in the solvent hood storage cabinets. The contents of these containers are collected weekly by the SRF CR-WH staff, taken to room 414, and placed in the sealed drum for **USED WIPES** collection. EH&S retrieves these wipes for disposal on Friday of each week.

A waste jar labeled **WASTE: Photoresist Contaminated Pipettes** for used pipettes is kept in the exhausted storage cabinet underneath the spinner hood. This jar is inspected monthly by the SRF Cleanroom Staff. When a waste jar is full, it is placed in storage area under the hood. A hazardous waste chemical disposal form is filled out and submitted to EH&S for pick-up. When EH&S arrive for pick-up the waste label is modified to show the words HAZARDOUS WASTE. The label is dated and signed by the SRF staff member.

A copy of the hazardous chemical disposal form can be found on the WVU EH&S website, http://ehs.wvu.edu/forms

SECTION 3.6.3: USED OIL DISPOSAL

The Sputter Station has two pumps which use hydrocarbon oil:

- Roughing Pump: KJL TKO 19 Ultra
- Turbo Pump: TL011 Pump Oil

All used oil is captured and stored in an appropriately chosen waste jar which is properly labeled with the words **USED OIL**. A hazardous chemical disposal form is filled out and submitted to EH&S for pickup and it is taken to 414 for pickup. A copy of the hazardous chemical disposal form can be found on the WVU EH&S website, http://ehs.wvu.edu/forms.

SECTION 3.6.9: WATER USAGE

PLD - 410:

- Processed chilled water is required for the system sputter guns and main chamber turbo pump.
- Processed chilled water is only required to when the laser pulse rate during deposition is above 10 Hz.

WARNING: Failure to turn on water to cool the laser for pulse rates above 10 Hz could lead to severe equipment damage.

Sputter Station - 410:

- Processed chilled water is required for the system cryopump compressor, sputter guns, sample heater, and Rf matching network.

WARNING: Failure to verify the flow meters are at set-point prior to operation could cause severe equipment damage.

Wafer Dicer:

- DI Water is required for processing.

Solvent Hoods – 410 & 410A:

- DI Water is available for user at each sink location.

SECTION 4: GAS SAFETY

The following gases are typically used by equipment inside the cleanroom:

- UHP Argon
- UHP Helium
- UHP Nitrogen
- UHP Oxygen
- Halogen Laser Gas (0.09% Fluorine)

For a full list of gases with specific information on each gas and location, please see the current chemical inventory in Appendix B. All unused, full gas cylinders, and empty gas cylinders are stored in the gas rack in the 414 lab.

All unused cylinders are stored securely to the wall with the valve caps on. All cylinders in use are mounted securely against the wall or inside a gas cabinet. All cylinders are transported using a cylinder gas hand truck. Eye protection or face shield is to be worn when changing cylinders.

When operating equipment, users should only open or close the cylinder stem valves and manifold valves inside the cleanroom. Users should not make adjustments to the regulators. Adjustments to the regulators should only be done by SRF Cleanroom staff. Cleanroom users are to follow all equipment operational procedures outlined in the Standard Operating Procedures located in Appendix C, in the equipment manual and during equipment trainings, when working with compressed gases

WARNING: Users should never bypass equipment interlocks. Bypassing a safety interlock may expose the user to toxic or flammable gases

SECTION 4.1: TOXIC GASES

The following gas in the cleanroom is toxic and presents a health hazard if exposed:

- Halogen Laser Gas (0.09% Fluorine)

This gas is used for the Neocera PLD laser and is located in the gas cabinet in 410A. This gas is used to REFILL the PLD laser monthly. When not in use the stem valve on the gas bottle is closed and the lines are purged with UHP Helium. Staff members will follow the procedures outlined in the Coherent Laser manual when refilling the laser.

Users should not attempt to open or change this gas bottle or disconnect any line connected to this cylinder. An SRF staff member will change the cylinder as needed. Staff members will follow the procedures outlined in the Coherent Laser manual when changing gas cylinders.

An HF sensor is located above the gas cabinet in 410A to detect any leak of this gas with in the cleanroom. If an audible alarm sound is heard, evacuate the lab and contact:

9-911 from any campus phone
or
Environmental Health & Safety
Phone: (304) 293-3792

Then Call

Harley Hart, SRF Manager
Cell Phone: **(412) 443-1514**
Room: **G75D ESB / 409 White Hall**
or
Weiqiang Ding, SRF Manager
Cell Phone: **(304) 685-1938**
Office Phone: **(304) 293-9683**
Room: **G75D ESB / 409 White Hall**

SECTION 4.2: FLAMMABLE GASES

This section is not applicable to the Cleanroom – WH.

SECTION 5: LABORATORY HAZARDS

Users should be aware of additional hazards when working in the Cleanroom – WH labs, these are:

- Sharps and broken glass
- High voltages
- UV Lamp hazards

SECTION 5.1: SHARPS AND BROKEN GLASS DISPOSAL

A broken glass disposal box is kept in the 414A gowning room. This box is for the disposing of broken glass or substrates. SRF staff members inspect this box monthly. When full, the box is sealed and disposed with the laboratory trash.

SECTION 5.2: HIGH VOLTAGE HAZARDS

The following instruments inside the Cleanroom - WH use High Voltages:

- Sputter Station
- PLD
- Mask Aligner
- Wafer Dicer

All Cleanroom – WH users are given proper instruction on equipment operation before given authorization to use these tools. Users must follow all operational procedures outlined in the Standard Operating Procedures located in Appendix C.

The equipment listed above utilizes high electrical voltage. Users are permitted to operate the equipment, but not to conduct service. User must follow all operation procedures outlined in the Standard Operation Procedures located in Appendix C. All equipment issues must be brought to a Cleannroom - WH staff attention. The tool must be disconnected from the power supply before being serviced.

WARNING: Users are required to use due care when entering outlined areas marked with RED/WHITE warning tape as there is a risk for potential injury due to connections to high voltage equipment.

WARNING: Any attempt to bypass any safety interlocks on any piece of equipment in the cleanroom may result in severe shock or electrocution.

SECTION 5.3: UV ARC LAMP HAZARDS

The MJB3 Mask Aligner utilizes a mercury xenon arc lamp. Improper use of this equipment can create a UV light hazard or a mercury exposure hazard.

UV Light Hazard:
The arc lamp is a source of UV light for photolithography processes. Users must follow all equipment operational procedures outlined in the Standard Operating Procedures located in Appendix B when operating the Mask Aligner. Users should not bypass any interlocks on the system.

These lamps produce intense UV light. UV protective glasses are required when operating the Mask Aligner. Prolonged, direct UV exposure may burn the sin or cause temporary or permanent blindness. Objects should not be moved in or out of the beam path during exposure. Users should not place hands or tools directly under the beam during exposure.

Mercury Exposure Hazard:
When operating the Mask Aligner, do not attempt to increase the lamp voltage to increase the output intensity. The mercury arc lamp output intensity will decrease over the lifetime of the lamp. If the optical intensity is too low, then the lamp needs to be changed. Please see an SRF Cleanroom – WH staff member for assistance. The procedures outlined in the equipment manual must be followed when changing the arc lamp.

WARNING: Over driving an arc lamp with higher voltage may cause the lamp to crack or explode, releasing mercury vapor.

When an arc lamp breaks the sound of shattering glass can be heard. If this occurs while operating the Mask Aligner

1. Immediately turn off the lamp power supply. **Do not attempt to open the lamp housing!**
2. Evacuate the cleanroom of all persons immediately.
3. Contact an SRF staff member.
4. Let the arc lamp housing cool for 30 minutes before re-entering the cleanroom. This will allow any mercury vapor to condense inside the lamp housing.
5. Clean up the mercury with a Mercury Spill Kit on the wire-rack to the right of the Mask Aligner.
6. A cleanroom staff member will properly dispose of the spill kit and broken arc lamp, by properly sealing the lamp in a labeled container and contacting EH&S for hazardous waste disposal.

To use the Mercury Spill Kit:

1. Put on the protective gloves found inside the kit.
2. Wet the mercury neutralizing sponge with water.
3. Carefully rub all mercury contaminated surfaces with the sponge, ensuring the neutralizing surface is face down.
4. Once the sponge has absorbed all the mercury, dispose of it in the plastic back and seal.
5. A cleanroom staff member will properly dispose of the spill kit and broken arc lamp, by properly sealing the lamp in a labeled container and contacting EH&S for hazardous waste disposal.

SECTION 6: RADIATION HAZARDS

This section is not applicable to the Cleanroom - WH.

SECTION 7: STANDARD OPERATING PROCEDURES

Standard Operating Procedures for the following equipment can be found in Appendix C:

- Neocera Pulsed Laser Deposition Tool
- Sputter Station
- Discotech Wafer Dicer
- MJB3 Mask Aligner
- Laurell Spinner

SECTION 8: LAB SPECIFIC EMERGENCY PROCEDURES

1. Instrument shut down procedures are to be performed only by the Cleanroom - WH staff and experienced users who are qualified to do so by the Cleanroom - WH staff.
2. In case of compressed gas emergency, exit the building and notify safety personnel immediately.
3. In case of fire, evaluate the building and call 9-911.
4. In case of unplanned power outage, the instruments will shut-down in an abnormal state. Contact SRF staff immediately
5. In case of unplanned water outage, the instruments will shut-down in an abnormal state. Contact SRF staff immediately
6. For other lab equipment:
    a. Shut off all surge protectors to the computer.
    b. Shut power off to all in-use equipment.

SECTION 9: ADDITIONAL ITEMS

1. Visitors are not permitted in the lab unless authorized by the Cleanroom - WH staff.
2. Replace wipes and gloves when their supplies are running low.
3. Clean nitrile gloves are to be worn at all times when handling samples.
4. If you use up any item (*e.g.*, gloves, wipes, sticky tabs, *etc.*), notify MFCF staff.

APPENDIX A:
SIGN - IN SHEET

APPENDIX B:
CHEMICAL INVENTORIES

APPENDIX C:
EQUIPMENT STANDARD OPERATION PROCEDURES