NNFC Safety training

National nanofabrication centre
Indian Institute of Science
Bangalore
Outline

• Emergency Response
  – Fire, Smoke and Gas leak alarms
  – Tool break down

• Chemical safety training
  – protocols
  – Chemical handling
  – Disposal of chemical
  – Chemical spill
  – First aid
General Instruction during Emergency situation

- Stop the process by pressing the emergency stop buttons of the equipments (if known)
- When facility emergency alarms ring, please evacuate through the nearest exit immediately, DO NOT wait for any announcements
- Immediately alert the staff concerned (phone numbers are near the door) or call BMS: “115” if you need any emergency assistance
- Do not wait to remove the gown and PPE during evacuation

NOTE: Detailed Fire, Smoke and Gas leak alarm emergency procedure is there in the following slide
• **Common Alarms: Fire and Smoke**
  – In the cleanroom corridor, outside Films room

  *Emergency Action:*
  – Evacuate through the nearest exit and wait near the Assembly for the head count

• **Gas alarms**
  – Specific to equipments, mainly LPCVD and Diffusion furnace,
  – NEED TO INFORM BMS SINCE IT IS ONLY A TOOL ALARAM AND NOT CONNECTED WITH BMS

  *Emergency Action:*
  – Evacuate immediately through emergency exit
  – Inform BMS by calling 115 from the cleanroom outside corridor phones

• Evacuate cleanroom if power does not restore in 2 min
Emergency response in case of an incident

- 2 BMS personnel to be there at all times
- BMS personnel trained on tool
- Emergency shutdown
- Posters kept in each bay detailing emergency evacuation procedure and panic button clearly marked
- Document detailing emergency shut down of tools – one copy in BMS, one at the bay
What user need to do?

• Know emergency evacuation protocols thoroughly
• Please inform BMS at 115 immediately in case of any emergency
• Call someone if you cannot get BMS - COO/Technology manager, Bay-in charge, tool owner (Phone numbers available in the bay near the phone)
• Press panic button, present at each bay
• Evacuate through nearest exit, without ungowning and wait near the Assembly points near the front car park or badminton court for the head count
Responsibilities: Independent user

• Independent user is responsible for the tool during non-office hours
• Has enough presence of mind to save lives and the facility
• Undergo orientation every 3 months
In case of tool break down

- Stop the process by pressing the emergency stop buttons of the equipments
- Inform BMS immediately
- Concerned facility technologist during fab working hours or if it is a safety issue (phone numbers available in Bay emergency contact list/ FOM)
  - Call from outside the fab incase of network problem
- Send ‘Instrument problem report’ to the instrument managers using FOM
  - Log off and press the “something wrong” button
- If unable to contact FT’s, please put the tool down notice and send an email to the FT and technology manager, after letting the BMS know
- Send an email in the user group so that the next user is aware
- **DO NOT TRY TO REPAIR BY YOURSELF**
Buddy System: *One rule not to be forgotten*

- *Buddy system* need to be followed strictly at all times
  - Someone needs to know where you are and what your process is
  - *This is for your safety and this is the law*
  - *In the wet bay, the buddy need to be in the bay itself, if you are handling HF or HF based etchants*
LASER SAFETY*

- Exposure to laser light can cause significant damage to the skin and eyes – typically in the form of burns and direct damage to the retina.

Lasers are present in PLD tool at Equipment development bay. Please use caution when entering and using tools in that bay.

*By Roopa prakash/Sushobhan Avasthi
<table>
<thead>
<tr>
<th>Class</th>
<th>Procedure</th>
<th>Training</th>
<th>Eye Exam</th>
<th>Energy</th>
<th>Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td></td>
<td>Non-hazardous to eye</td>
</tr>
<tr>
<td>1M</td>
<td>Not Required*</td>
<td>Not Required*</td>
<td>Not Required</td>
<td></td>
<td>Hazardous with collecting optics</td>
</tr>
<tr>
<td>2</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>&lt; 1mW</td>
<td>Hazardous only when person overcomes aversion response</td>
</tr>
<tr>
<td>2M</td>
<td>Not Required*</td>
<td>Not Required*</td>
<td>Not Required</td>
<td></td>
<td>Hazardous with collecting optics and/ Class 2 hazard</td>
</tr>
<tr>
<td>3R</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
<td>1 - 5mW</td>
<td>Hazardous when person overcomes aversion response or uses optics</td>
</tr>
<tr>
<td>3B</td>
<td>Required</td>
<td>Required</td>
<td>Suggested</td>
<td>5 - 500mW</td>
<td>Direct beam eye hazard. No serious injury from diffuse reflection to eye or to skin</td>
</tr>
<tr>
<td>4</td>
<td>Required</td>
<td>Required</td>
<td>Suggested</td>
<td>&gt; 500mW</td>
<td>Hazard to eye &amp; skin from direct, specular or diffuse reflection. Fire hazard</td>
</tr>
</tbody>
</table>
WARNING LABELS

CAUTION
LASER RADIATION WHEN OPEN
DO NOT STARE INTO BEAM OR VIEW WITH OPTICAL INSTRUMENTS
CLASS I LASER PRODUCT

DANGER
CLASS 2 LASER PRODUCT
Do not stare into beam

DANGER
CLASS 3B LASER RADIATION.
AVOID DIRECT EXPOSURE TO THE BEAM.
DO NOT DISCONNECT WHILE SYSTEM IS ACTIVE.

DANGER
CLASS 4 LASER PRODUCT
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED LASER LIGHT
NEVER AIM AT AIRCRAFT - IT IS UNSAFE AND ILLEGAL
RESPONSE OF HUMAN EYE TO DIFFERENT WAVELENGTHS OF LIGHT

Retina damage is often permanent and irreparable.

Cornea and lens damage can heal, although the injury is incredibly painful.
PERSONAL PROTECTIVE EQUIPMENT

EYE PROTECTION

• Appropriate eye protection devices must be worn when working with Class 3B and Class 4 lasers or laser systems.
• Eyewear must be specifically selected to withstand either direct or diffusely scattered beams.
• Goggles are marked with the wavelength range over which protection is afforded and the minimum optical density within that range.
Chemical Safety Training

• To ensure a safe environment for learning and research

• To prevent fatal injuries and accidents

Wet benches are the only safe places for chemicals
While working on wet bench, it is mandatory to:
- Wear lab shoes
- Wear aprons
- Wear safety glasses & face shield
- Wear appropriate gloves
- Make sure exhaust is functioning
Gowning protocol for Hydrofluoric acid
Use of gloves

- **PVC**
  - Are used to protect wafers from particles generated by humans
  - *No resistance to chemicals*

- **NITRILLE**
  - Thin chemical resistant gloves
  - Strong material: used for protection against dilute acids

- **LATEX/RUBBER**
  - Gloves with good organic solvent protection
  - Could cause a skin allergy

- **TRIONIC (MAPA)**
  - Thick chemical resistant gloves: used for cleaning up leaks
  - Nevertheless don’t put your hands in liquid chemicals!
F-telon gloves (Teflon incorporated)

Chemical spill pads for acids (pink) and organic solvents (grey)

TRIONIC (MAPA)

Chemical spill pillows
Protocols

• All chemicals in the fab are hazardous. Ensure that you have read the MSDS of the chemical before use. MSDS sheets are available with BMS or at the cleanroom corridor or the respective bay.

• **Never rub in your eyes or face with your hands or gloves.**

• **Never touch the phone or the taps wearing contaminated gloves.**

• **AAA principle: Always Add Acid to Water**

SOMEBODY WORKING AFTER YOU IN A LAB HAS TO TRUST EVERYTHING IS CLEAN!
What is an MSDS?

• What is an **Material Safety Data Sheet**
  – Tells what chemicals are in the product,
  – What the hazards of the chemicals are
  – How to protect yourself from the hazards.

• Where to get M.S.D.S
  – Manufacturer websites, or
  – Google search “MSDS + name of chemical product” MUST READ !!

The label on the bottle also will contain some relevant information.
Hazard Symbols

- Carcinogen
- Mutagenicity
- Reproductive Toxicity
- Respiratory Sensitizer
- Target Organ Toxicity
- Aspiration Toxicity

- Flammables
- Pyrophorics
- Self-Heating
- Emits Flammable Gas
- Self-Reactives
- Organic Peroxides

- Irritant (skin and eye)
- Skin Sensitizer
- Acute Toxicity
- Narcotic Effects
- Respiratory Tract Irritant
- Hazardous to Ozone Layer

- Skin Corrosion/Burns
- Eye Damage
- Corrosive to Metals

- Explosives
- Self-Reactives
- Organic Peroxides

- Gases Under Pressure

- Oxidizers

- Acute Toxicity (fatal or toxic)

- Aquatic Toxicity
Chemical handling

• Chemicals should be used only in the fume hoods

• All chemicals in the bay need to be labeled
  – Solutions left for cooling/later use need to be identified using identification chit

• Do not randomly mix chemicals since this may result in an explosion / evolution of hazardous gases

• **Appropriate face masks/ goggles and gloves have to be worn before starting the expt.** Please note that latex gloves used for clean room entry has no chemical resistance. Wear nitrile / acid resistant glove depending on your experiment.
Use of glassware

- Fluoride solutions to be used only in plastic beakers / petridishes / measuring cylinders
  - Fluoride etches glass!

- Other acids to be used only in glass beakers

- Exchange of glassware between benches strictly not allowed
  - Glassware is labeled and belongs to particular benches as per contamination policy
Disposal of Chemicals

- Alkali’s and Acids can be poured down the drain after cooling!
- HF and BHF solutions to be disposed in a single plastic bottle
- Chrome etch to be disposed into the designated plastic bottle
- Organic solvents (Acetone, IPA, Methanol) in a separate bottle, separate bench provided, should not be poured down the drain
- Do not leave anything on the wet bench uncleaned/unclaimed after use
- Si wafer/glass pieces to be discarded in the designated bin at the wet etch/dry etch
Why is disposal procedure important?

• Improper disposal can cause major accidents

• Severe accidents can result from mixing of incompatible chemicals, for eg:
  
  – Nitric acid with acetone/ ethanol/ acetic acid
    • Results in fire and explosion
  
  – Hydrogen peroxide with organic solvents
    • Results in fire and explosion
Chemical spill On person

- Remove contaminated clothing and get under safety shower
- Use eye wash for minimum of 15 min if splashed into eyes
- Inform BMS and seek medical attention
- Please note the location of safety showers and eye showers in the layout slide
Chemical spill on the Floor

- **Small**
  - Contain the spill using chemical spill pillows
  - Dilute the spill with water and put spill blankets
  - Discard spill blankets and pillows in the plastic dustbin

- **Big**
  - Come out and close the door to the wet etch
  - Pull the red tape across the door to prevent further entry
  - Inform BMS immediately
  - Take precautions not to breathe in the fumes
Fluoride Solutions

- **Hydrofluoric acid and Buffered HF solution**
  - Equally hazardous
  - Highly dangerous due to the internal tissue and bone damage (Decalcification) caused by contact with the *colourless* liquid!
  - Painful treatment in hospital (death possible)

HF/BHF burns
First Aid

- Wash with large amounts of water (minimum 5min)
- Rub in Calcium gluconate gel (make sure your hand is not contaminated) and cover the burn with plastic foil
- Seek medical attention
  - Calcium Gluconate Gel is in the First aid box at the wet etch
- If the spill on the eye, please wash with large amounts of water and rush to the hospital

Most of the harm from HF exposure can be minimized if washed within minutes
Other Acids and Bases

- **Strong acids used:**
  - Sulfuric, Nitric, Hydrochloric, Phosphoric
- **Weak acid used**
  - Acetic acid
- **Bases used**
  - Potassium hydroxide, TMAH

- **The strong acids & bases are poisonous, corrosive, and will cause severe burns to body tissue.**
  - Long term exposure will cause lung and tooth damage.
  - The weak acids will cause eye, skin and mucous membrane irritation and burns.
  - Some are even carcinogenic or teratogenic.
  - TMAH and KOH causes severe eye damage and blindness
  - Exposure to 25% TMAH might cause respiratory failure

- **Acetone, Isopropyl Alcohol (IPA) and Methanol:**
  - All solvents may cause skin and eye irritation. They are colorless & combustible, should NEVER be heated for use. Solvent vapors are toxic, use only in ventilated hoods.
Photoresists

• Photoresists are organic polymers which change their chemical structure when exposed to ultraviolet light.
  ➢ They are generally flammable and should be kept away from any source of heat and ignition.
  ➢ Could be carcinogenic / irritant/ harmful / cause depression of central nervous system and damage to liver and kidneys
  ➢ Protective gear has to be used at all times when dealing with Photoresists

Photoresist Developers

• Mostly use TMAH (Tetra methyl ammonium hydroxide)
  ➢ Severe eye damage might effect from exposure to TMAH
  ➢ Could cause chemical burns on skin contact
  ➢ Dermal exposure might also cause respiratory failure/ cardiac arrest
On skin contact, wash with large amounts of water (minimum 15 minutes) and contact BMS. PPE’s mandatory at developing stations
Penalty points at the wet benches
(nx times for second violation)

• Using without booking slots: 15 points
• Not wearing proper PPE (gloves/ goggles): 15 points
• Exchanging glassware: 15 points
• Leaving solutions without identification chit: 15 points
• Leaving bench unclean: 30 points
• Using cellphones near the bench: 30 points
• Using BHF/HF/ Vaporizer carelessly: 100 points (immediate suspension of cleanroom access)
• Bringing external chemicals without permission (across all the bays): 100 points
Chemical spill

- **On person**
  - Remove clothing and get under safety shower
  - Inform BMS immediately at 115

- **On bench/floor**
  - Dilute with water and absorb the spill using chemical spill blankets/pillows
  - Dispose the spill blankets in the plastic dustbin
  - Evacuate and put red tape across the door preventing user entry
  - Call BMS immediately at 115

**Minor Spill Criteria**
- √ Not in immediate danger of an explosion, fire or a health issue
- √ Not spreading further (is only on small area (<2x2 ft) and is not HF)
- √ Dangerous only by direct contact
- √ Can be managed by existing PPE
HF exposure

Wash with large amounts of water (min 5 min)

Apply calcium gluconate gel using uncontaminated gloves

Call BMS immediately at 115

Continue applying Calcium gluconate gel till you get to the doctor
Thank you