



# **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**



# Emergency: Call 115



## 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**

# Alarm Response



- **If you hear Fire and Smoke alarm**

- 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 ALARM 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

***Note: Panic Button are to be pressed only for Facility Emergency and not for personnel emergency. Call BMs for personnel emergency***



# Emergency response in case of an incident



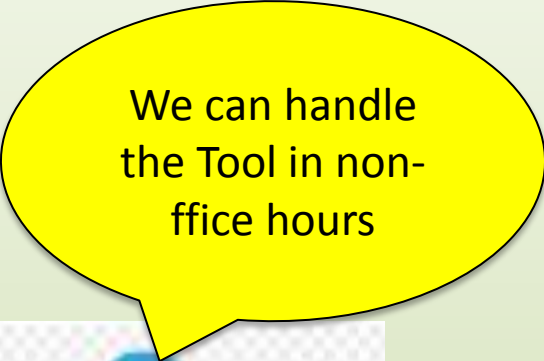
- **During Non-office Hours, if you see fire or smoke inside the cleanroom**
  - Press the Panic button nearby
  - Evacuate through the nearest exit and wait near the Assembly for the head count
- **During Non-office Hours, if you see fire or smoke in the Tool.**
  - Press the EMO of the Tool.
  - Press Panic button nearby
  - Evacuate through the nearest exit and wait near the Assembly for the head count
  - Inform BMS.
  - Inform FT/ Technology Manager.
  - Update Tool down message in user group.

## Emergency :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

A yellow speech bubble with a black outline, containing the text "We can handle the Tool in non-office hours".

We can handle the Tool in non-office hours





# In case of tool break down



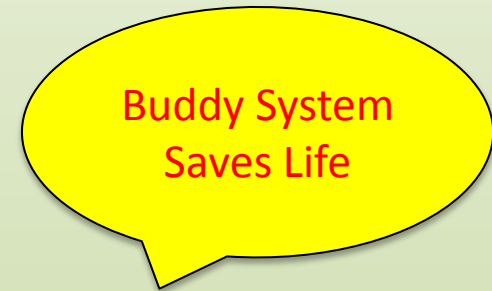
- Stop the process by pressing the emergency stop buttons of the equipments
- Inform BMS immediately
- Concerned facility technologist during fab working hours or if it is a safety issue (phone numbers available in Bay emergency contact list/ FOM)
  - Call from outside the fab incase of network problem
- 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*



# 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**

# Wet Bench Protocol

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

## ■ NITRILE

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

## ■ TRIONIC (MAPA)

- Thick chemical resistant gloves : used for cleaning up leaks
- Nevertheless don't put your hands in liquid chemicals!





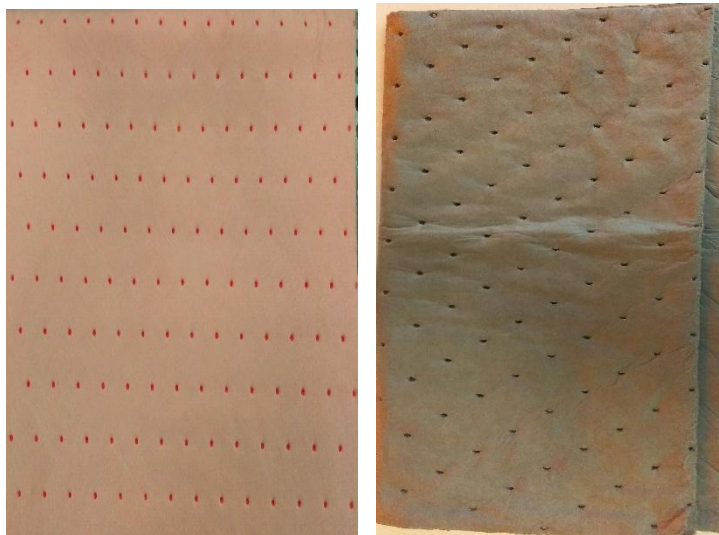
# Use of gloves



**F-telon gloves (Teflon incorporated)**



**TRIONIC (MAPA)**



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



**Chemical spill pillows**

## **PPE sequence**

- **Nitrile gloves on top of the gowning gloves**
- **Aprons**
- **Sleeves**
- **Goggles/Face-shield**
- **MAPA/ F-telon Gloves**

**Please note : F-telon gloves need to be worn when using HF/BHF**



## While wearing PPE

- Do not touch with your contaminated gloves,
  - Face shield/Apron/sleeves
  - Cleanroom Gown
  - Mobile
  - Taps
  - Phone
  - Wet etch computer

**“No walking around the Fab wearing wet etch PPE”**

## Removing PPE

### ➤ Removal in the order

- Contaminated gloves, wash and keep in its place
  - Sleeves, fold and keep
  - Face shield
  - Goggles
  - Apron
- 
- **ACCESS TO THE WET ETCH WILL BE DENIED IF PPE RULES ARE VIOLATED**

# 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
- *Always use appropriate amount of chemicals...Do not waste the expensive MOS grade chemicals...!*
- *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 **M**aterial **S**afety **D**ata **S**heet
  - 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 !!**
  - In Every bay with peticular chemical details...you can ask cleanroom staff.

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

# NNFC Disposal Protocol



- 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**



Eye Shower



Safety Shower

# 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 **colour less liquid!**
  - Painful treatment in hospital (death possible)



HF/BHF burns

## Symptoms HF injury: HF 50%

- *Almost immediate deep throbbing pain, burning feeling, (especially at hands and finger tips)*
- Red discoloration with whitish blister, tissue under skin starts dying off, bone de-mineralises
- Need only 1% body surface area to be exposed
- Systemic fluoride intoxication
- **Painful treatment in hospital (death possible)**

## Symptoms of HF injury: Diluted HF solution $\leq 20\%$

- Sometimes it can take upto 24 hours before symptoms appear (pain, rash)
- Might result in deeper penetration and more painful burn (especially at hands and finger tips )
- The surface symptoms are minimal or may be absent
- Can cause white discolored skin, blisters seldom form
- HF solution  $>20\% < 49\%$ :
- Symptoms sometimes just noticeable after a few hours!
- Treat all unlabelled, water-like solutions as HF solutions



# First Aid



- Wash with large amounts of running water (minimum 15min)
- 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.



# 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 BHF/HF/ Vaporizer carelessly: 100 points (immediate suspension of cleanroom access)
- Bringing external chemicals without permission (across all the bays): 100 points

# 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 running water (minimum 15 minutes) and contact BMS. PPE's mandatory at developing stations



# Photoresist /Developer Handling Protocols

- *Its mandatory to wear two set of gloves inside the Litho Bay.*
- *Ensure photoresist/developer contaminated gloves and wipes are disposed in the dedicated bin, which is located inside the spin coater work station under exhaust.*
- *Do not touch the tools, computer, face shield or any other object or document with photo resist contaminated glove, failing which lead to penalty.*
- ***Never keep the PR containers near the HOT Plate!!!***
- ***Never displace the resist from its designated place.***
- ***Do not leave developer/Resist bottle open....!!!!***



# Chemical spill

## 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

On person

On bench/  
floor

Minor spill | Major spill

Remove clothing and get under safety shower

Dilute with water and absorb the spill using chemical spill blankets/ pillows

Try not to breathe the fumes

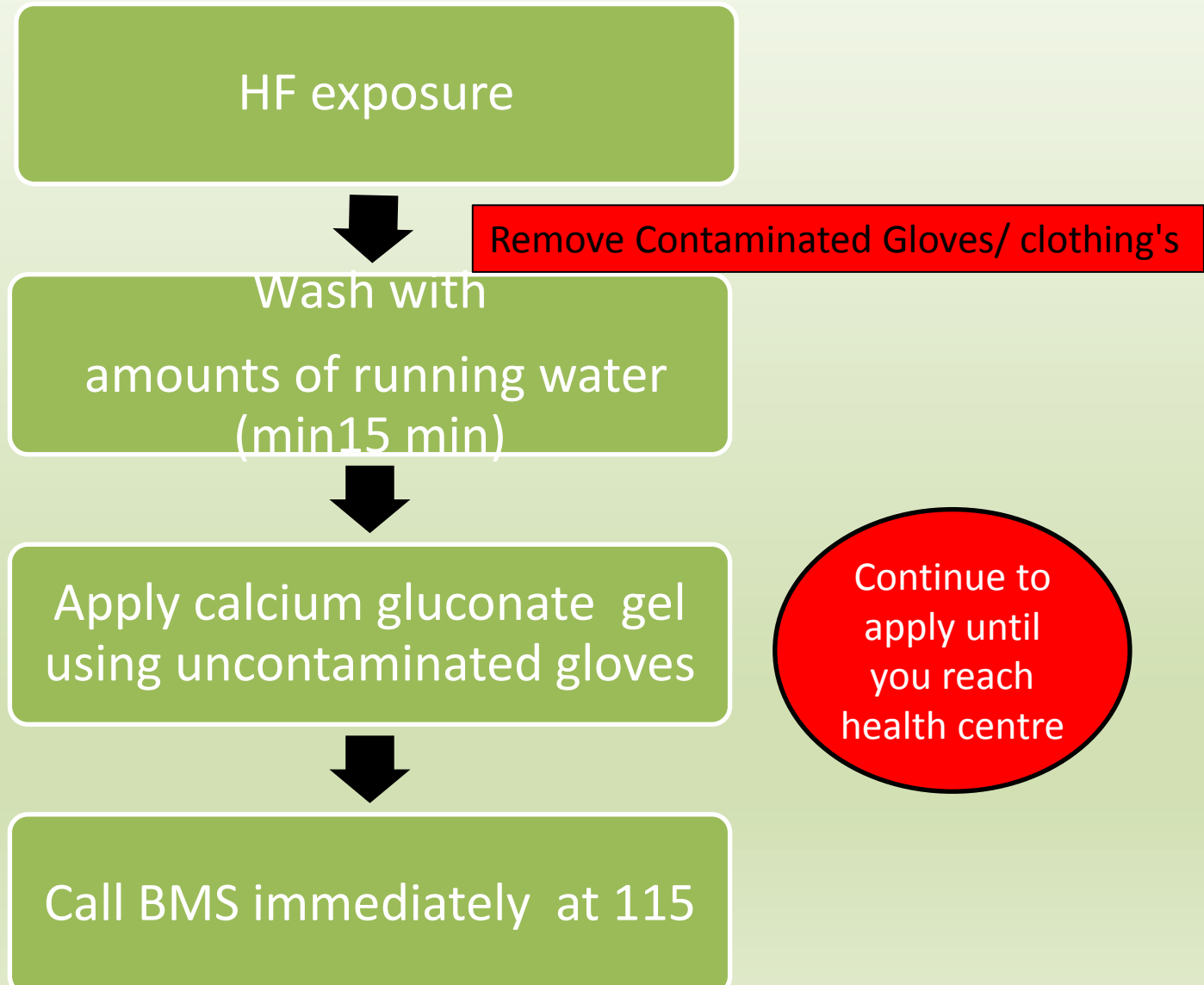
Inform BMS immediately at 115

Dispose the spill blankets in the plastic dustbin

Evacuate and put red tape across the door preventing user entry

Call BMS immediately at 115

## HF spill on Body



## Emergency Contact Numbers

Contact Name	Contact Number
IISc health Centre or Ambulance	2227/2234
Sadashiv Nagar Police station	22942589
IISc Security	2400/2225
IISc Emergency Contact Number	5555
ICU on Wheels	6366914617

