

Buffered Hydrofluoric Acid

BHF is going to be used as native oxide etchant prior to do Au electroplating process. The required precautions, personal protective equipment, First Aid treatments, and working procedure are all addressed in the following sections.

Required Precautions:

BHF which is buffered hydrofluoric acid is a mixture of some portion of HF and DI water. The ratio of our interest is 1:10 which means 1 portion of HF with 10 portion of DI water.

HF is a weak acid (PH 3 to 5), odourless in concentrations below 50% and colourless. HF is a lipid soluble molecule; it easily penetrates into skin and travels quickly throughout the body. Dissociated F^- binds with Ca^{2+} and Mg^{2+} in tissue cells forming insoluble salts. This is not a strong acid, so there might be no pain from exposure to HF and so there is no way to know if one has been exposed to it or not. Pains start 1-8 hours after exposure which is too late to prevent major tissue damages. If affected area is more than 1% of the body, F^- in blood may kill if treatment is delayed. **More information can be found on University of Waterloo hydrofluoid acid standard (https://uwaterloo.ca/safety-office/sites/ca.safety-office/files/uploads/files/uw_hf_exposure_protocol.pdf).**

All being said, precautions are the only way to prevent dangers associated with using HF.

Some general principles involved in mitigating HF dangers are as:

- To wear PPE, and to inspect them.
- To work slowly and cautiously.
- To plan all work ahead of time.
- To rinse as much as possible (three times or more).
- To inspect fume cupboard after every action.
- To assume all unknown liquids on fume cupboard as HF.
- To clean fume cupboard after use so others will have no doubt that this is safe.
- To know first aid procedures.

Personal Protective Equipment (PPE):

In order to work with HF, the following PPE must be worn to adequately protect us from HF exposure:



1. Nitrile gloves



2. Tychem apron



3. Faceshield



4. Chem resistant gloves

This is important to notice to the order of PPEs, and they must be donned in specific order so that HF contamination of our work and PPE does not take place.

The followings need to be kept in mind:

- 1- To inspect PPE.
- 2- To never touch “hand” portion of green gloves.
- 3- To roll cuffs so no drops come down to our body.

First Aid treatments:

In the event of any exposure, we must follow these general protocols (Although, a detailed protocol following UW standard protocol can be found in the following):

- STOP!
- Remain calm! There is no reason to panic.
- Inform someone that we have been exposed to HF.
- That person will inform the lab manager.
- Remove contaminated clothing/PPE, place in some place where no one is in danger!
- **Do not** let others touch us or contaminated clothing.
- Apply antidote solution according to instructions.
- Available antidote is calcium gluconate (skin contact, old treatment).

Calcium Gluconate (skin contact)

Instructions for use:

- 1- Remove contaminated clothing and place them in a safe place so no one get contaminated.
- 2- Rinse affected area with cool water for 5 minutes.
- 3- Apply Calcium gluconate gel to affected area and massage into skin.
- 4- Seek medical attention immediately.
- 5- Re-apply gel every 15 minutes until medical assistance is given.

Notes:

- If assistance is required, the assistant should be wearing HF suitable PPE.
- All chemical exposures must be reported to staff.

However, in case of specific exposure such as skin or eye exposure, we must follow the UW protocol as follow:

Skin Contact:

1. Ensure scene is safe.
2. Protect yourself from exposure with PPE (gloves, labcoat, and goggles).
3. Direct individual to safety shower, remove clothing, and flood affect area thoroughly with large amounts of water (can remove clothing while under shower).
4. Apply calcium gluconate to affected area (can be applied while being showered down).
5. Call 911 and inform of the HF exposure
6. Call ext 22222 (UW Police) and inform them that 911 has been called. Ask them to meet and direct the paramedics to the incident location
7. Call ext 33587 and notify the safety office
8. Apply calcium gluconate every 15 minutes and continue while transporting to the hospital.
9. One first aider or co-worker should accompany the victim to the hospital.
10. Provide responders with "MSDS".

Eye Contact:

1. Ensure scene is safe.
2. Protect yourself from exposure with PPE (gloves, labcoat, and goggles).
3. Direct individual to eye wash and flush eyes with water for at least 15 minutes. Hold eyelids open and away from the eye during irrigation. If contact lenses are worn, they should be removed (if possible).
4. Do not apply calcium gluconate or benzylalkonium chloride to eyes.

5. Call 911 and inform of the HF exposure.
6. Call ext 22222 (UW Police) and inform them that 911 has been called. Ask them to meet and direct the paramedics to the incident location.
7. Call ext 33587 and notify the safety office.
8. Ice water compresses may be used while being transported to hospital.
9. Provide responders with "MSDS".

Inhalation:

1. Ensure scene is safe.
2. Protect yourself from exposure with PPE (gloves, labcoat, and goggles).
3. Remove victim from exposure.
4. If victim is not breathing, begin artificial respiration immediately. Mouth to mouth is not recommended, use CPR shields or preferably use an oxygen mask.
5. Call 911 and inform of the HF exposure.
6. Call ext. 22222 (UW Police) and inform them that 911 has been called. Ask them to meet and direct the paramedics to the incident location.
7. Call ext. 33587 and notify the safety office.
8. Provide responders with "MSDS".

Ingestion:

1. Ensure scene is safe.
2. Protect yourself from exposure with PPE (gloves, labcoat, and goggles).
3. Have the victim drink large amounts of water.
4. Administer 100 mL of milk of magnesia or 30 tablets of Tums or another antacid with water.
5. Call 911 and inform of the HF exposure.
6. Call ext. 22222 and inform that 911 has been called. Ask them to meet and direct the paramedics to the incident location.
7. Call ext. 33587 and notify the safety office.
8. Provide responders with "MSDS".

One can find a summary of first aid and emergency procedures for exposure to HF (copied from UW hydrofluoride acid standard protocol).

Emergency Response Plan for Hydrofluoric Acid Exposure

Inhalation	Skin	Eyes	Ingestion	PPE Only	Room
<ul style="list-style-type: none"> • Ensure scene safety • Protect yourself with PPE • Leave area with HF vapors • Call 911 • Call 22222 to notify UW Police • Call 33587 (Safety Office) • Have a paper copy of MSDS ready for paramedics 	<ul style="list-style-type: none"> • Ensure scene safety • Protect yourself with PPE • Remove contaminated clothing • Wash area with water for 2-3 minutes • Begin Applying 2.5 % Calcium Gluconate Gel with gloves on • Call 911 • Call 22222 to notify UW Police • Call 33587 (Safety Office) • Have a paper copy of MSDS ready for paramedics 	<ul style="list-style-type: none"> • Ensure scene safety • Protect yourself with PPE • Flush continuously with water • Call 911 • Call 22222 to notify UW Police • Call 33587 (Safety Office) • Have a paper copy of MSDS ready for paramedics 	<ul style="list-style-type: none"> • Ensure scene safety • Protect yourself with PPE • Get exposed individual to drink 1 glass of water • Administer 100 ml of milk of magnesia or up to 30 Tums (or other antacid tablets) • DO NOT induce vomiting • Call 911 • Call 22222 to notify UW Police • Call 33587 (Safety Office) • Have a paper copy of MSDS ready for paramedics 	<ul style="list-style-type: none"> • Remove any visible liquid with red pH sensitive towels • Remove / check / get new PPE as needed • Dispose of old PPE in a thick plastic waste bag, label, and bring to ESF with a label on it. 	<p>Small spill (< 500 mL)</p> <ul style="list-style-type: none"> • Protect yourself with PPE • Pour Soda Ash or Uni-Safe Sorbent • Call 35755 (Safety Office) for disposal instructions <p>Large spill (> 500 mL)</p> <ul style="list-style-type: none"> • Leave the area • Remotely call 22222 UW Police • Call 33587 (Safety Office) and notify

Working Procedure:

HF acids eat glass, so no glassware should be exposed to HF or BHF. Additionally, HF will tarnish steel tweezers. Glassware should be Teflon or polypropylene; Beakers should be NALGENE plastic beakers; tweezers should be Teflon/poly/nylon tipped.

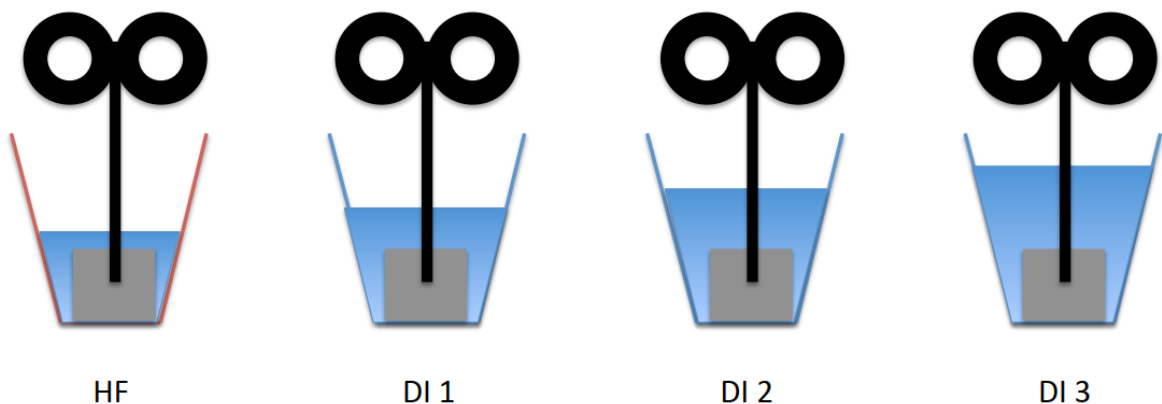
We must keep this in mind that such things as diluted HF are as dangerous as HF itself.

In order to work with HF we must follow the following steps:

- 1- Prepare the BHF in G2N on the dedicated wetbench with the ratio 1:10 with DI water using the NALGENE beakers, store it in our own bottle and label it.
- 2- We must transport the bottle using yellow polypropylene carriers located at E3-3139 and bring it to E3-3139.
- 3- Prepare our sample and place on fume cupboard. (Place in lockable tweezers for easy manipulation).
- 4- Gather one beaker for BHF etch, and three beakers for our rinse.
- 5- Don our PPE in correct order.
- 6- Pour BHF solution into first beaker.
- 7- Pour DI water into remaining three beakers. Ensure water level gets progressively higher for each rinse beaker, all water levels should be higher than the HF level

To conduct our etching:

- 1- Immerse sample in BHF beaker for 30 sec to 1 min.
- 2- Remove from HF beaker and move to DI rinse beakers (no drips!)
- 3- Sample should be left in each rinse beaker for at least 10 sec.
- 4- At the end of our third rinse, sample and tweezers should be clean. We need to dry them on fume cupboard while still wearing PPE.



After being done with BHF:

- 1- Pour the BHF to our labeled bottle, and store them under the fume cupboard in the cabinet or in the acid cabinet.
- 2- Clean the NALGENE beakers and anything came in touch with BHF by rinsing them with clean DI water at least 4 times and dispose the rinse water in the drain at the end of fume cupboard.
- 3- Dry them with Nitrogen gas.

Should any BHF spilled during conducting experiment on the ground or on fume cupboard desk:

- 1- Small spill (<500 ml):
 - a. Protect ourselves with PPE
 - b. Pour soda ash, uni-safe sorbent, or absorbing spills using spill kits located on top of the acid cabinet (the blue one)
 - c. Call 35755 (Safety Office) for disposal instructions.
- 2- Large spills (>500 ml):
 - a. Leave the area
 - b. Remotely call 22222 UW Police
 - c. Call 33587 (Safety Office) and notify them.