1 Introduction

This document is an addendum to "**HSE-RST-Chem001G_working with Corrosives**" and is offered to provide a short and concise overview of a widely used and unique hazardous corrosive material. Understanding of the parent document is a crucial prerequisite in understanding basic safety fundamentals such as 1) hazard awareness, 2) engineering controls, 3) work practices, 4) PPE and 5) emergency response for working with corrosive materials.

2 Scope

The guideline applies to lab personnel, and it has been developed to assist them in the preparation of lab specific SOPs.

3 Procedure

3.1 Introduction to Hydrofluoric Acid / Buffered Oxide Etch (BOE)

Ideal PPE: Silvershield, Neoprene, Butyl or natural rubber gloves

Hydrofluoric acid (HF) and Buffered oxide etch (BOE) are not only highly corrosive materials they are toxic as well. Hydrofluoric Acid (HF) is one of the most hazardous chemicals used at KAUST. Small exposures to HF can be fatal if not treated properly. The critical minutes immediately after an exposure can have a great effect on the chances of a victim's survival. HF is a gas that is dissolved in water to form hydrofluoric acid. The concentration can vary from very low such as in store bought products up to the most concentrated 70% form (anhydrous), with the most common lab use around 48%. The liquid is colorless, non-flammable and has a pungent odor. HF is actually a weak acid by definition and not as corrosive as strong acids such as hydrochloric acid (HCl), however, corrosivity is the least hazardous aspect of HF. HF is absorbed through the skin quickly and is a severe systemic toxin due to the nature of the fluoride ion. Hence why any fluoride salt (i.e. sodium and potassium fluoride) that is water soluble retains a high degree of toxicity. The fluoride ion binds calcium in the blood, bones and other organs and causes damage to tissues that is very painful and can be lethal. At the emergency room, the victim is often given calcium injections, but pain medication is not generally given since the pain subsiding is the only indication that the calcium injections are working.

Note: Buffered oxide etch (BOE) is an aqueous mixture composed of HF and a buffering agent such as ammonium fluoride for slower and more controllable etching. Hydrochloric acid may also be added to BOE in order to help with the dissolving of insoluble oxides. Hydrofluoric acid training is available https://lms.salutesafety.com/course/view.php?id=33.

Due to the toxic nature of HF/BOE, work with it as much as possible in a fume hood or under some adequate type of exhaust ventilation. Although HF/BOE is a weak acid it does have the ability to etch glass

due to the fluoride ions high affinity for silicon. Therefore HF/BOE should not be stored in glass containers. Polyethylene or fluorocarbon plastic material is best and commonly used for HF/BOE storage.

Key take away points for hydrofluoric acid (in addition to the already stated for Corrosive Materials)

- Before anyone uses HF they must have prior approval from their Principal Investigator. The Principal Investigator should ensure anyone working with HF is familiar with the following:
  - ✓ Has read the SDS for HF, this guideline, and any SOPs developed by the lab.
  - ✓ Is aware of the designated area for HF use.
  - ✓ Knows the first aid procedure in case of an HF exposure.
  - ✓ Knows what to do in case of an HF spill.
- All users of HF must attend the HSE Hydrofluoric Acid Safety training as well as training by their supervisor. Dates for upcoming training sessions can be found on the Lab Safety Training Calendar.
- A Standard Operating Procedure (SOP) must be written for the process in which HF is used. This SOP should be posted or readily available near the designated area where HF use will occur.
- Never work alone with HF, always have a buddy system in place.
- Keep containers of HF closed. HF can etch the glass sash and make it hard to see through (if the hood sash becomes fogged and hard to see though due to etching, then please contact the Help Desk at 959 about installing a polycarbonate sash).
- A Safety Data Sheet (SDS) for HF must be available.
- All containers of HF must be clearly labeled.
- The stock HF should be stored in plastic secondary containment and the cabinet should be labeled. HF should be stored in lower cabinets near the floor.
- Wash gloves off with water before removing them.
- Use a plastic tray while working with HF for containment in case of a spill.
- Never clean up spills of HF with spill pads or paper towels. Neutralize HF/BOE first with calcium carbonate.
- If HF/BOE is present, then an adequate supply of unexpired calcium gluconate must be maintained.
- If HF/BOE is present in a space, all personnel should then be familiar with the First Aid procedures for a possible exposure.
- Be mindful that HF/BOE etches glass. Never store HF/BOE or its waste in glass containers; use polyethylene or fluorocarbon plastic containers.
- The best gloves for HF/BOE work are Silver shield® gloves. Butyl, neoprene, or natural rubber gloves are second best.

Recommended material(s)

GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:
"Forsberg Clothing Performance Index".
The effect(s) of the following substance(s) are taken into account in the ***computer-generated*** selection:
HYDROGEN FLUORIDE

Material	CPI
BUTYL/NEOPRENE	A
NATURAL RUBBER	A
NATURAL+NEOPRENE	A
NEOPRENE	A
NEOPRENE/NATURAL	A
VITON/NEOPRENE	A
NAT+NEOPR+NITRILE	B
PE	B
PVC	B
SARANEX-23	B
NITRILE	C

* CPI - Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion
NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -
* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

3.2 Health hazards

3.2.1 Eye and skin exposure

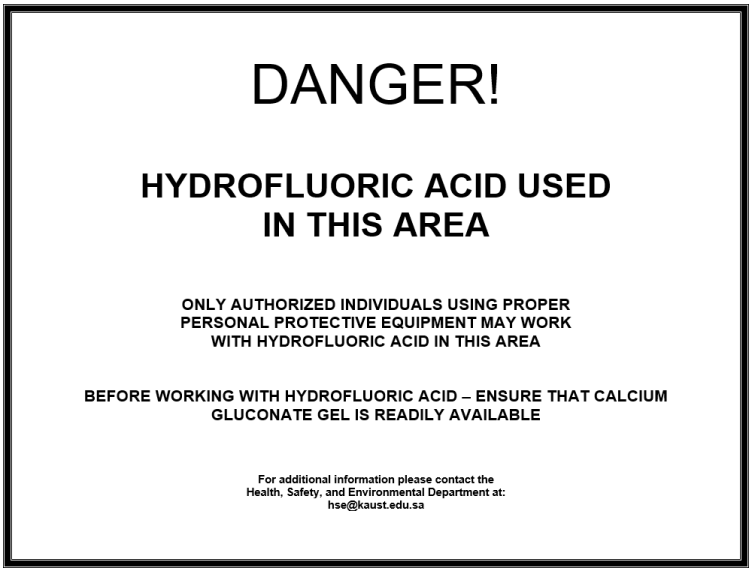
HF is corrosive and readily destroys tissue *via* its high toxicity. Exposure of the eyes to HF may result in blindness or permanent eye damage. HF readily penetrates skin, allowing it to destroy soft tissues and decalcify bone. Chemical burns from HF are typically very painful and slow to heal. Skin exposure to higher concentrations of HF (approximately 50% or greater) immediately results in serious and painful destruction of tissue. Not only can skin contact cause burns, but systemic fluoride poisoning is deadly. One of HF's most insidious properties is that skin contact at lower concentrations may not produce pain or burning sensations until hours after the exposure. Because of the ability of HF to produce severe delayed tissue damage without necessarily producing pain, all skin, eye, or tissue contact with HF should receive immediate first aid and medical evaluation, even if the injury appears minor or no pain is felt.

3.2.2 Inhalation of HF vapor

Inhaling HF vapors can seriously damage the lungs. Delayed reactions up to and including fatal pulmonary edema (flooding of the lungs with body fluids) may not be apparent for hours after the initial exposure. Airborne concentrations of 10 to 15 ppm will irritate the eyes, skin, and respiratory tract. Exposures of 30 ppm is considered immediately dangerous to life and health and may have irreversible health effects. At airborne concentrations above 50 ppm, even brief exposure may be fatal.

3.3 Chemical fume hood

- HF must be used with adequate ventilation to minimize inhalation of vapor. Concentrations greater than 5% should always be handled inside a properly functioning chemical fume hood. The chemical fume hood needs to have a current calibration sticker.
- Prevent contamination of the work surfaces by placing plastic trays on the work surface before starting HF procedures.
- Label the fume hood sash with the below specific signage.



3.4 Personal Protective Equipment

3.4.1 Eye Protection

- Chemical splash goggles in addition to face shield when handling concentrated HF. Due to HF's highly toxic nature, safety glasses with side shields do not provide adequate eye protection.

3.4.2 Gloves

- Medium or heavyweight viton, nitrile, or natural rubber gloves should be worn when working with HF. Silver Shield® gloves are the best option. Always consult the manufacturer's glove selection guide when selecting a glove for HF. If you have any questions about which glove to choose, contact HSE at hse@kaust.edu.sa.
- A second pair of nitrile exam gloves should be worn under the gloves for protection against leaks.
- Gloves that have not been contaminated with HF may be disposed of in the common trash. If gloves become contaminated with HF, remove them immediately, thoroughly wash your hands, and check your hands for any sign of contamination. Contaminated gloves must be disposed of as HF hazardous waste.

3.4.3 Body Protection

- Wear a laboratory coat with a chemical splash apron made out of natural rubber, neoprene, or viton. Never wear shorts or open-toed shoes when handling HF or other corrosive chemicals.

3.5 First Aid

All exposures to HF require immediate first aid and prompt medical treatment.

3.5.1 Skin Exposure

1) Move the victim immediately under an emergency shower or other water source and flush the affected area with large amounts of cool running water. *Immediately washing off the acid is of primary importance.*
2) Remove all contaminated clothing while flushing with water.
3) While the victim is being rinsed with water, someone shall call 911 (012-808-0911 from mobile) for emergency medical assistance. Inform 911 that the accident involves exposure to hydrofluoric acid.

4) Immediately after flushing with water begin massaging Calcium gluconate gel into the burn site. Apply the gel every 15 minutes and massage until pain/redness resolve or until medical care is available. *Wear gloves when applying the gel to prevent transfer of HF and secondary burns.*

3.5.2 Eye Exposure

1) Immediately flush eyes for at least 15 minutes with copious cool flowing water.
2) If only one eye is affected, be careful not to flush contaminated water into the other eye.
3) Call 911 (012-808-0911 from mobile).
4) Apply ice water compresses during transport.

3.5.3 Inhalation

1) Ensure the victim's clothing or skin has not been contaminated by HF before removing him to fresh air.
2) If breathing has stopped, begin artificial respiration.
3) Call 911 (02-808-0911 from mobile) for immediate medical assistance.

3.5.4 Swallowing

1) Rinse the mouth with cold water. Do not induce vomiting.
2) If the victim is conscious, have them drink lots of water to dilute the acid. Follow with milk or milk of magnesia if available.
3) Call 911 (02-808-0911 from mobile) for immediate medical assistance.

3.5.5 Calcium Gluconate gel

Calcium gluconate gel is a topical antidote for HF skin exposure. Calcium gluconate works by combining with HF to form insoluble calcium fluoride, thus preventing the extraction of calcium from tissues and bones. Keep calcium gluconate gel nearby whenever you're working with HF. Calcium gluconate has a limited shelf life and should be stored in a refrigerator if possible and replaced with a fresh supply after its expiration date has passed. Use disposable nitrile gloves to apply calcium gluconate gel. Even after applying calcium gluconate, it is essential that a medical evaluation be made.

3.5.6 HF First Aid kit

Every lab that handles HF must have an HF spill kit available.

HF Kit Contents:

- Calcium gluconate gel.
- Disposable coveralls (to wear if clothing becomes contaminated).
- 2 pairs nitrile gloves.
- SDS and medical treatment instructions.
- Heavy plastic waste bag for waste items.

3.6 Spills

If HF is spilled outside a chemical hood, evacuate the area, close the doors, post the area with a sign to prevent others from entering, and call 911 (012-808-0911 mobile). Small spills of HF inside a chemical fume hood can be cleaned up by laboratory staff if they have received spill clean-up training from HSE, have the correct equipment, understand the hazards, and are confident in their ability to clean up the spill safely and dispose of the waste properly. Calcium carbonate, or a spill absorbent specified for HF should

be used for clean-up. Organic spill kits that contain Floor-Dri, kitty litter, or sand should not be used because HF reacts with silica to produce silicon tetrafluoride, a toxic gas.

3.7 Additional information

Additional information on the safe use and handling of hydrofluoric acid (HF) can be found on the Honeywell website – the world's largest producer of Hydrofluoric Acid. This website contains useful information on HF such as:

- Safety Data Sheets
- Technical Data Sheets
- Recommended Medical Treatment for HF exposure
- HF Properties charts
- Online Training

4 References

- OSHA 3404-11R (2011) – Laboratory Safety Guidance
- KAUST Laboratory Safety Manual
- HSE-RST-Chem001M – Chemical Safety Program

5 Help

Questions about this guideline? Contact: hse@kaust.edu.sa