

Laboratory Safety in Metallography

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Hydrofluoric Acid Exposure

Concentrated HF Acid

Concentrated HF acid, also referred to as reagent HF acid, is supplied in spill-proof containers. Concentrated HF must not be placed in a container that is not spill-proof, except for a brief period necessary to measure it for dilution. All dilution of concentrated HF must be carried out in a laboratory hood where emergency treatment is available.

Hydrofluoric acid is available in concentrations up to 100%, unlike other mineral acids. The following does not address concentrations of 60% or higher, except to state that it may require substantially different and more extreme precautions:

- When HF is diluted to concentrations of less than 10%, they are no longer considered concentrated, but they still require special treatment on exposure.
- Exposure should be treated with *instantaneous* and continuous flushing with *cold* water.
- Skin exposure to 50% HF will probably not be immediately painful but will be excruciating, possibly resulting in death if untreated.
- There is a danger of miscommunications with medical treatment personnel resulting from the similarities between HF (hydrofluoric acid) and HCl (hydrochloric acid). For this reason, one must be aware that exposure to *concentrated* HF will *always* require hospitalization immediately following first aid, and it is the responsibility of the exposed person to insist if confusion arises.
- Fluoboric acid (HBF₄) is also used in the metallography lab, but in the complexed form, the fluoride ion is relatively safe and noninvasive. This procedure does not apply to fluoboric acid.

Before opening a bottle of concentrated HF, do the following:

1. Calculate the fluoride ion concentration of the mixture being prepared and include it on the label.
2. Put on disposable polyethylene gloves and cover them with disposable latex gloves for grip.
3. Place the HF and all equipment and containers in the laboratory hood.
4. Turn on the hood exhaust and light.
5. Put on a rubber apron and safety glasses or goggles.
6. Lower the hood glass below the line of sight to the equipment and acid.
7. Tell a coworker what is taking place, and have him remain in earshot for the duration.
8. Test the eyewash station.
9. Run the cold tap water in the hood to be certain that it will come out cold if needed.

Safety precautions for concentrated HF include:

- Hydrofluoric acid and most fluorides should *never* be used in contact with glass, which they will dissolve.

- Polyethylene containers must be used with HF.
- Disposable gloves must *never* be reused.
- Disposable gloves must be removed as if the outside surfaces were contaminated.
- Pure acid leaves no residue when dry, but mixtures may leave a toxic residue.
- Always rinse the apparatus, reagent bottle, and containers in water when finished.

Safety procedures for concentrated HF exposure to the eyes are:

1. *Call for help.*
2. Use eyewash or dilute calcium gluconate to irrigate until medical professionals provide other treatment. The dispensary may provide ophthalmic pain reliever. *Do not* use other chemicals in the eyes.
3. Have the assisting person call the dispensary and report HF exposure. An ambulance will provide transportation to a hospital.
4. Note: Inform assisting medical professionals that the person being treated has been exposed to a *contact poison*, not a strong acid.
5. Note: Exposure of a surface area greater than the forehead may require injections of calcium gluconate and the ingestion of Tums (Smith Kline Beecham) or soluble calcium to prevent death by hypocalcemia and so on. Plasma chemistry should be monitored.

Safety procedures for concentrated HF exposure to the skin are:

1. *Call for help.*
2. Rinse with *cold* tap water if possible; otherwise, use the shower while chemical solutions are prepared by the assisting person.
3. Have the assisting person call the dispensary to report HF exposure and to request ambulance transportation of the exposed person to a hospital.
4. Note: Inform assisting medical professionals that the person being treated has been exposed to a *contact poison*, not a strong acid.
5. Note: Exposure of any surface area greater than the forehead may require injections of calcium gluconate and the ingestion of Tums or soluble calcium to prevent death by hypocalcemia, and so on. Plasma chemistry should be monitored.
6. Note: It is generally recommended that no pain killers be given for skin exposure, because the pain is used as a map to the sites that require further local calcium gluconate injections.
7. When the hands are exposed, the area under the fingernails requires early special attention, including calcium gluconate injections.

Dilute HF Acid

Hydrofluoric acid in various mixtures and dilutions is invaluable in metallography. These invariably contain less than 10% fluoride ion concentration. All HF and fluoride exposure must be reported to the dispensary. However, hospitalization is not necessary with very dilute exposure. (Bear in mind that fluoride concentration in fluoride mouthwashes and rinses varies from 0.05 to 1.0% in prescription strengths.)

Fluoride ion concentrations are now a required part of the label for metallographic etches and must be part of the initial report to the dispensary. This is necessary so they may judge their first aid reaction to the incident.

Some mixtures also contain very strong mixed acids, which may require precautions and first aid independent of the actual fluoride ion concentration.

Before opening a bottle of dilute HF or dilute HF mixture, do the following:

1. Place the HF mixture and all equipment and containers in the laboratory hood.
2. Turn on the hood exhaust and light.
3. Put on safety glasses or goggles.
4. Lower the hood glass below the line of sight to the equipment and acid.
5. Test the eyewash station.
6. Run the cold tap water in the hood to be certain that it will come out cold if needed.
7. Put on heavy elbow-length elastomer gloves (or disposable polyethylene gloves covered with disposable latex gloves).
8. Take precautions normal for the other ingredients of the mixtures; for example, notify the guardhouse if you are the only lab technician on duty.

Safety precautions for dilute HF and dilute HF mixtures include:

- Hydrofluoric acid and most fluorides should *never* be used in contact with glass, which they will dissolve.
- Polyethylene or synthetic fluorine-containing resin containers must be used with HF.
- Disposable gloves must *never* be reused.
- Disposable gloves must be removed as if the outside surfaces were contaminated.
- Pure acid leaves no residue when dry, but mixtures may leave a toxic residue.
- Always rinse the apparatus, reagent bottle, containers, and hands in water when finished.

Safety procedures for dilute exposure to the eyes are:

1. Use eyewash or dilute calcium gluconate to irrigate. The dispensary may provide ophthalmic pain reliever. Do *not* use other chemicals in the eyes.
2. Call the dispensary. Describe the HF exposure to the eyes as dilute and provide the solution ingredients and concentrations.
3. The nurses will determine further treatment based partially on pain levels if no pain reliever was given.
4. The dispensary should transport the exposed person to the emergency room if a pain reliever was given.

Safety procedures for dilute exposure to the skin are:

1. Rinse well in cold water.
2. Call the dispensary and describe the solution, as previously mentioned. Also describe the total surface area exposed.
3. Soak the exposed area in the provided chemical solution or apply the provided ointment or powder.
4. The dispensary will determine further treatment, partially dependent on the information provided. Whenever pain develops, further treatment is required.

Spills and Cleanup

The following precautions should be followed in the event of spills and in cleanup:

- Disposable gloves must never be reused! With HF, they should be rinsed before discarding.
- Exposed clothing should be neutralized with a calcium salt. Do not simply discard it.

- Dilute spills should be neutralized with a calcium salt. Do not call hazardous materials (HAZMAT) authorities for small dilute spills unless other considerations warrant it.
- Concentrated spills may require calling HAZMAT authorities if a large part of a liter bottle is spilled. For very small concentrated spills, dilute and treat as a dilute spill.
- If HAZMAT authorities are called, they should respond with full protective equipment and self-contained breathing apparatus (SCBA).
- The SCBA air tanks are wrapped with fiberglass, which is dissolved by HF. There are incidents where SCBA tanks used in HF response have later exploded in storage.