DEPARTMENT OF CHEMICAL ENGINEERING

Name of SOP	Manual Hydrofluoric Acid (HF) Etching of Glass Microneedles – JHE A110
Effective Date	December 1st, 2007
Author	Geetha Mahadevan
Reason for SOP	Risk of HF Exposure via Inhalation and/or Direct Contact
Approved by (supervisor)	Dr. Heather Sheardown (Chemical Engineering) Dr. Ravi Selvaganapathy (Mechanical Engineering)
Date reviewed by (JHSC)	Wednesday, November 14, 2007

Definitions

Terms	**None**
acronyms	RMM – Risk Management Manual JHSC - Joint Health and Safety Committee EOHSS - Environmental & Occupational Health & Support Services OHSA – Occupational Health and Safety Act

Requirements

Applicable OHSA regulations and / or codes of practice.

1. OHSA code.
2. McMaster University Risk Management Programs

Training and competency.

1. HF Training (offered by the EOHSS) for anyone undertaking the task.
2. Competency is shown by the individual after training.

Description of the Task

Location and time of work	JHE-A110; Normal working hours for all experiments. Work performed using this SOP may not be performed alone under any circumstance.
Individuals and skills required	Graduate students / proper training
Equipment and supplies required	Various concentrations of Hydrofluoric Acid, fused silica capillary tubing, polydimethyl siloxane (PDMS), HF-compatible plastic labware
Personal protective equipment required	Fume Hood, safety eye goggles, lab coat, two layers of nitrile gloves and HF Safety Kit

Sequential steps to complete the work safely.

General safety instructions

1. All users must obey the safety instructions and warnings posted in the lab.
2. All persons following this SOP must have attended HF Safety Training offered through the EOHSS.
3. All users must have thoroughly read and understood the attached Hydrogen Fluoride Emergency Protocol.
4. HF must be brought into the lab using only approved carrier containers.
5. HF is a glass etchant; only use plastic labware to contain HF.
6. Personal protective gear is imperative as noted above.
7. Do not attempt an experiment if an HF Safety Kit cannot be found in JHE A110. Check the chemicals in the HF Safety Kit before commencing any experiment to ensure that they have not passed their expiry dates.
8. If a personal spill occurs, dial 88. Seek first aid and/or appropriate remedies from the HF Safety Kit. A mechanical engineering staff should be notified to fill out an incident report.
9. An eyewash station is available in JHE A110 while a safety shower is not available in JHE-A110; the nearest location of the shower is in JHE A105. The key for this lab will be obtained and kept on my keychain. Other group members will be informed to the whereabouts of the key to gain

entry to JHE-A105 to access the safety shower in case of an accidental personal spill.

10. A fire extinguisher is not available inside JHE A110. The nearest extinguisher is in the hallway next to JHE A111.

Dispensing and Setup of the HF Etch Solution

1. Either Buffered Oxide Etch (BOE) (mixture of ammonium fluoride (40% by weight in water solution) and HF in a 10:1 ratio - 10 parts ammonium fluoride:1 part Hydrofluoric Acid) or concentrated 49% weight/weight HF will be used for experiments outlined in this SOP. Both acids can be purchased as is and no preparation of the acid is required. The acids are stored in the appropriately labeled acid cabinets at all times.
2. In the designated fume hood in JHE A110, the bottle of HF will be opened. Approximately 5 mL of either BOE or 49% HF will be carefully dispensed into a plastic beaker that is suitable to contact HF. The HF acid bottle will be immediately closed after dispensing and returned to the acid cabinet.
3. Approx. 1 mL of mineral oil will be poured into the solution of HF to contain HF vapors.

Procedure for Manual Etching

Sample Placement into HF

1. Set up a standard ring stand with a clamp holder. Place a clamp high up on the ring stand. Load the sample into the clamp by clamping down on the silicone substrate of the sample. Ensure that the glass tubings to be etched are positioned downwards
2. Gently place the beaker of HF/oil underneath the sample.
3. Carefully lower the clamp so that the glass tubing is immersed in the HF solution.
4. Place a note stating 'CAUTION: HF EXPERIMENT IN PROGRESS" on the window to the fume hood.
5. Leave tubings to etch for 2 hours.

Sample Retrieval

1. After the experiment terminates, raise the clamp high up on the ring stand.
2. Retrieve the HF beaker.
3. Transfer the HF to the waste container specifically designated for HF waste (in the acids cabinet below the fume hood). A single waste container will be used to dispose of the HF/mineral oil solution and will be dedicated to waste solutions produced solely through experiments performed using this SOP. Next, rinse the beaker that contained the HF/mineral waste once with deionized (DI) water and pour into the waste container. Immediately cap the waste container and return it to the acid cabinet. Then immerse the beaker into a large bath of water. Turn on water to flush the container for 10 mins. Retrieve the beaker and wash and dry as usual.
4. Thoroughly flush/clean all labware that was exposed to HF with DI and thoroughly dry.
5. Rinse sample in DI for 10 minutes. Dry and proceed.

Waste Disposal Details

1. Each experiment will result in no more than 15 mL of liquid waste. At the end of the experiment, the solution will be transferred to a dedicated plastic 'Hazardous Waste' bottle labeled with the appropriate yellow waste sticker. No other chemical shall be disposed of in the container. NOTE: Glass bottles should NEVER be used to store HF as it is a glass etchant which can result in accidental spills.
2. Store the waste container in the Acids cabinet below the fume hood in JHE A110.
3. As the experiment will be conducted 2-3 times/week, a monthly waste pick up is deemed reasonable. In order to schedule a pick-up, please fill out and email a chemical waste disposal record form (http://www.workingatmcmaster.ca/link.php?link=eohss%3Aeohss-hazardous+waste) by the Friday before the Tuesday that you want a pick up. The form should be emailed to waste@mcmaster.ca (Hazardous waste pick-up for JHE occurs every Tuesday between 8:30 and 10 AM.)
4. A new plastic waste bottle will be labeled with the appropriate waste sticker. The waste bottle will be stored in the acids cabinet below the fume hood in JHE A110.

Contingency Plan and Reporting

Accident / injury response

1. Apply first aid as required; if personal exposure to HF has occurred, immediately consult the attached HF Emergency Protocol and follow instructions to treat the specific mode of contamination that has occurred. Dial 88 in any case.
2. Notify Mechanical Engineering technical staff immediately.
3. For all injuries complete an "Injury/Incident Report" and provide a copy to the Department Chair and EOHSS.
4. In case of injury resulting from any HF exposure (inhalation or contact), call security (DIAL 88).
5. In case of injury resulting from any HF exposure (inhalation or contact) notify EOHSS immediately, ext 24352.

Spill response

1. In case of a non-personal HF spill, contain the area and immediately contact a mechanical engineering technical staff immediately.
2. Post warning signs on doors and around spill location to read 'HF SPILL – CAUTION'.
3. Dial 88 to call security.

Environmental Responsibility

Waste disposal procedures

All HF used for experiments will be disposed of in accordance with McMaster University HF disposal protocols.

1. Each experiment will result in no more than 15 mL of liquid waste. At the end of the experiment, the solution will be transferred to a dedicated plastic 'Hazardous Waste' bottle labeled with the appropriate yellow waste sticker. No other chemical shall be disposed of in the container. NOTE: Glass bottles should NEVER be used to store HF as it is a glass etchant which can result in accidental spills.
2. Store the waste container in the Acids cabinet below the fume hood in JHE A110.
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4. A new plastic waste bottle will be labeled with the appropriate waste sticker. The waste bottle will be stored in the acids cabinet below the fume hood in JHE A110.

Building air quality

All experiments and chemical handling will be carried out in a fume hood so that lab and building air quality is not compromised.

References (OHSA/ regulations, EPA and Municipal environmental regulations, McMaster University Program/ Policy, Material Data Sheets (MSDS).

1. RMM Policy #300 Safety Orientation and Training Program
2. RMM Policy #301 Standard Operating Procedure
3. RMM Policy #309 Laboratory Safety Manual
4. RMM Policy #310 Eye Protection.
5. RMM Policy #506 Hazardous Waste Management
6. RMM Policy #1000 Reporting and Investigating Injury, Incidents and Occupational Disease
7. McMaster University Laboratory Safety Handbook (2nd Edition 1996) – McMaster University Hydrogen Fluoride Emergency Protocol

Distribution

1. Supervisors in Mechanical Engineering (Dr. Selvaganapathy) and Chemical Engineering (Dr. Sheardown).
2. Technical Staff of Mechanical Engineering
3. Faculty of Engineering JHSC

Risk Management Manual (RMM)
http://www.workingatmcmaster.ca/link.php?link=Job+Matters%3APolicy-Manual

Environmental and Occupational Health Support Services
http://www.workingatmcmaster.ca/link.php?link=Job%20Matters:EOHSS

 Appendix 1

McMaster University Hydrogen Fluoride Emergency Protocol

Contents:

Hydrogen Fluoride Emergency Protocol

1.0 Hydrogen Fluoride (HF)

Most fluorides produce HF when coming into contact with moisture and produce similar burns and health effects. This protocol applies to fluoride compounds as well as both anhydrous and aqueous HF.

Both liquid and vapour can cause severe burns, which may not be immediately painful or visible. HF will penetrate the skin and attack underlying tisues.

Systemic toxin that may result in severe hypocalcemia, hypomagnesemia, hyperkalemia, metabolic acidosis, cardiac dysrhythmias and death. HF may produce severe ocular and dermal injury as well as acute life threatening systemic toxicity with minimal external tissue damage.

2.0 Routes of Exposure

Ingestion, inhalation, dermal and eye exposure

3.0 First Aid Measures

At all times, persons touching the injured person must wear protective rubber gloves.

3.1 Skin Burns:

3.1.1 Immediate measures:

1. **Immediately** flush area with copious amounts of **cold** water by either at tap or safety shower. **Quickly and thoroughly** wash the acid off the affected areas.
2. Remove all clothing coming into contact with the acid.
3. Continue under water until calcium gluconate gel is available for application.
4. Calcium gluconate can be massaged into skin while flushing with water.
5. Contact emergency medical personnel and continue with first aid measures.
6. Apply calcium gluconate 2.5% gel every 15 minutes and massage continuously until the pain disappears. If pain recurs, apply calcium gluconate gel and massage while transporting the injured worker to the nearest emergency room.
7. Using 23% aqueous calcium gluconate, massage into the affected area(s). Apply cold compresses of the same solution, changing frequently and when the compresses are losing their wetness.
8. Continue while transporting to a medical facility.

McMaster University Laboratory Safety Handbook (2nd Edition 1996) 3

3.1.2 For deep burns:

Administration of the following procedure should be performed by a physician only.

1. Infiltration of aqueous calcium gluconate 5% solution with a small-gauge needle around the affected area and intralesionally may be necessary. Initially use no more than 0.5cc per square centimeter of burned skin. Do not distort skin appearance.
2. Caution must be observed to avoid calcium overdosing. Do not use local anaesthetics. Resolution of pain is the means to determine effective medical treatment.
3. In some cases, it may be necessary to surgically remove damaged tissue and then apply calcium gluconate (5% aqueous solution) to the affected area.
4. Persons with HF burns covering >8 square inches should be admitted immediately to an intensive care unit and monitored carefully for 24 to 48 hours. Serum calcium, potassium and magnesium levels should be monitored. The Q-T interval should be followed for signs of hypocalcemia. Hypocalcemia results in prolonged QT intervals. Systemic hypocalcemia can be immediately life threatening. Large surface area burns may require massive intravenous calcium infusions. Awaiting a serum calcium level may be too late. Following the Q-T interval is the better clinical adjunct.

3.2 Eye Burns:

1. Flush immediately with water for at least 15 minutes while holding eyelids open.
2. Do not use oils, salves, ointments or other HF skin burn treatments.

3. Sterile saline solution is available, flushing may be limited to 5 minutes. Place a Morgan's lens or the Eye irrigator on patient and irrigate the eye intermittently for 20 minutes with an aqueous calcium gluconate 1% solution.
4. Transport patient to emergency for further treatment.
5. Instill aqueous calcium gluconate 1% solution every 2 to 4 hours for the next 2 to 3 days.

McMaster University Laboratory Safety Handbook (2nd Edition 1996) 4

3.3 Inhalation:

1. Remove victim from source of HF fumes.
2. If not breathing, begin artificial respiration immediately.
    a. Mouth to mouth resuscitation is not recommended.
3. Give 100% oxygen by mask.

Further emergency care should be performed by a physician only or licensed emergency medical personnel.

4. As soon a possible, emergency first aid provider will give 2.5 to 3% calcium gluconate solution by inhalation by Intermittent Positive Pressure Breathing using a nebulizer or by nebulizer alone.
5. Patient should be referred to a pulmonologist for further care.
6. Carefully watch the patient for edema of the upper airway with respiratory obstruction. The airway may be maintained by either endotracheal intubation or tracheotomy if necessary.
7. Pulmonary edema should be treated by placing the patient on IPPB with Positive End-Expiratory Pressure (PEEP). Close supervision and continued use of 2.5% to 3% calcium gluconate solution by inhalation is necessary.
8. Patients with neck, chest or head burns should be watched for delayed pulmonary edema.
9. Hemodialysis must be considered for fluoride removal and to avoid or correct hyperkalemia and recurrent hypocalcemia not responsive to replacement therapy.
10. A patient with a history of recent exposure who is experiencing respiratory irritation should be admitted immediately to an intensive care unit and observed closely for 24 to 48 hours. Administration of nebulized 2.5% calcium gluconate should be considered.
11. Do not give stimulants. Patient must remain inactive for at least 24 hours.

3.4 Oral Ingestion

1. Do not induce vomiting
2. Do not give patient any baking soda or emetics.
3. Give 250 – 750 ml of water, 500 ml bottle sterile water in kit
4. Effected person swallow 3 tablets of calcium carbonate (Tums) and transport to hospital.

Further emergency care should be performed by a physician only or licensed emergency medical personnel.

5. Gastric lavage with calcium chloride or calcium gluconate may be performed by a physician. Extreme caution must be observed when passing the Levine tube.

6. Extreme throat swelling may occur which may require a tracheotomy.

7. Patient should be admitted to a hospital intensive care unit.
8. Hemodialysis may be necessary for fluoride removal and to avoid or correct hyperkalemia and recurrent hypocalcemia not responsive to replacement therapy.

3.5 Nail Burns

1. Irrigate with water until calcium gluconate solution is available, submerge affected fingers in calcium gluconate 23% solution. Add ice to solution if available. Use ice cubes, to prevent frostbite.

Further emergency care should be performed by a physician only or licensed emergency medical personnel.

2. If pain does not completely cease, 2 to 3 holes should be drilled in the nail using an 18 gauge needle. Continue soaking.
3. If pain still does not subside, the nail must be removed by a physician. The nail bed should be massaged with 1.5% calcium gluconate gel. Infiltration of aqueous calcium gluconate 5% solution with a small gauge needle (#25-#30), around the burn and intralesionally must be used only in severe cases due to the risk of obstruction of the microcirculation.
4. Do not use calcium gluconate 5% injection without first removing the nail.
5. The use of 0.5% calcium gluconate given intraaterially has also been reported.

*Poison Control Canada does not recommend that lay persons trephine the nail nor that a physician remove the nail and infiltrate the bed. This is a painful and disfiguring procedure. It is our recommendation that inta-arterial injection of calcium gluconate be done under radiologic control if possible.

4.0 Supplies

Medical supplies must be readily accessible at all times.
See List in Appendix A.
HF Antidote Gel for external use; 2.5% calcium gluconate gel
Rubber or PVC gloves for persons treating HF burns/injuries

5. 0 Training

5.1 Persons working with HF/Fluorine Compounds:

Employees must be trained in the following wearing of personal protective equipment (PPE), in the hazards of HF, its effects and in this emergency response procedure.

5.2 Managers:

Managers will be trained in the use of PPE, in the hazards of HF, its effects and in this emergency response procedure.

5.3 Emergency Response Personnel

McMaster University Security and EFRT (Emergency First Response Team) will be trained in the use of PPE, in the hazards of HF, its effects and in this emergency response procedure.

5.4 Hamilton Health Sciences (HHS) Emergency Medicine:

EOHSS will provide information and orientation to HHS with regards to the McMaster

University Hydrogen Fluoride Emergency Response Program and its requirements.

6.0 Reporting and follow up

1. Complete a McMaster University Injury and Incident Report.
2. Complete a summary of the first aid administered to the injured person.

7.0 Information for presentation at Emergency medicine services

The injured person will take with them to Emergency:

1. Notice of HF Emergency
2. MSDS
3. Summary of treatment
4. McMaster University Hydrogen Fluoride Emergency Protocol

This information will be present in all labs and work areas where fluorides are present and/or handled and contained in a plastic pouch for transport with the injured person.

8.0 References

Air Products and Chemicals Inc. Hydrofluoric Acid Burns: Health Effects and Treatment Plan for Medical Professionals and Emergency Responders; Approved 1/97, Rev. 6/02 and 6/03

McMaster University Laboratory Safety Handbook (2nd Edition 1996) 7

Appendix A

First Aid Supplies

It is extremely important that medical supplies be acquired and kept on hand in sufficient quantities at all times. Some of supplies are difficult to acquire and must be ordered. Others must be prepared by a pharmacist, and a few require a doctor's prescription. The immediate application of first aid using HF specific medical supplies is the key to a positive outcome; rapid and successful recovery from HF absorption.

1. Calcium gluconate 2.5% gel
2. Calcium gluconate 23% solution
3. Basins – assorted sizes for immersion
4. Ice cubes
5. Triangular bandages for wet compresses
6. Gauze, compression dressings
7. Plyers - open 23% Calcium gluconate solution
8. Sterile 0.9% saline 500 cc IV bag
9. Sterile water for injection 500cc
10. Tums – calcium carbonate tablets
11. Eye irrigator - syringe to irrigate the eye
12. First Aid shears/scissors – to open saline bag
13. Eye wash
14. Safety shower
15. Pocket mask to give rescue breathing
16. Rubber/PVC gloves
17. Tyvek coats
18. Safety glasses

Appendix B
Material Safety Data Safety Sheets
McMaster University Laboratory Safety Handbook (2nd Edition 1996) 9
Appendix C
HF First Aid Summary Report

Name: _____
Injury Date: _____ Injury Time: _____
Injury Description: _____
Dermal: _____
Inhalation: _____
Ingestion: _____
Nail Bed: _____
Eye: _____
Supervisor's Name: _____
Room/Location/Building: _____
Contact phone Number: _____
Person Administering First Aid: _____
Contact Phone Number: _____
Time of Treatment: _____
Name of Drugs/Solutions administered: _____
_____
_____
First Aid Measures taken: _____
_____
_____
_____
_____
_____
McMaster University Laboratory Safety Handbook (2nd Edition 1996) 10
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McMaster University Laboratory Safety Handbook (2nd Edition 1996) 11

Appendix D
McMaster University Injury and Incident Report
McMaster University Laboratory Safety Handbook (2nd Edition 1996) 12
Appendix E
Medical Facilities

McMaster University Medical Centre
Hamilton Health Sciences
Emergency Department
1200 Main Street West
Hamilton, ON
905-521-2100
Hamilton General Hospital
Hamilton Health Sciences
Emergency Department
237 Barton Street East

Hamilton, ON
905-527-0271
St. Joseph's Hospital
Emergency Department
50 Charleton East
Hamilton, ON
905-522-4921

Appendix F

Emergency Treatment Sign for Transport with Injured Person