

Safety Guidelines and Laboratory Practices for the School of Materials Engineering

I. Introduction

During your career as a student in the School of Materials Engineering, you will come into contact with many things that are considered “hazardous.” Hazards arise from improper safety practices as well as the hazards associated with the materials or procedures themselves. Materials Engineering is an interdisciplinary field, and you will need to familiarize yourself with safety for procedures ranging from the use of chemicals to use of equipment. This guide is meant to give an introduction to these practices, but is by no means complete. You are encouraged to read the “*Purdue Chemical Hygiene Plan and Hazardous Materials Safety Manual*” and “*Hazard Communication at Purdue University*” available on the Purdue Radiological and Environmental Management (REM) website at <http://www.purdue.edu/rem/>. Also, a list of helpful safety references is provided at the end of this guide.

II. General Safety Practices

This section outlines some of the most basic safety practices. Many of these points will be elaborated on below. The most important safety practice you can follow is not to start a procedure until you are certain that what you are doing is safe. **When in doubt, ask the faculty, technical staff, or graduate students whether you are following recommended safety procedures.** Never assume that what you are doing is safe.

1. Undergraduates are prohibited from working alone and unsupervised in the laboratories after regular hours and on weekends. Graduate students should also avoid working alone in the laboratories.
2. Familiarize yourself with the location of exits, telephones, fire extinguishers, safety showers, and eye washes for use (either your own use or to assist someone else) in case of an emergency.
3. Safety glasses with side shields or goggles will be worn in laboratories, as posted on the doors.
4. All major chemical spills must be reported immediately to the laboratory technicians and cleaned up following established procedures.
5. Open and/or unlabeled chemicals or solutions may not be stored in the laboratories at any time.
6. Volatile chemicals must be opened and used under a fume hood.
7. Perchloric acid and hydrofluoric acid pose special hazards. They may not be used without approval of a technician.
8. No undergraduate student is allowed to mix chemicals (including preparing etching solutions) without approval of a technician or faculty member.

9. All chemical polishing and etching (including electropolishing and electroetching) must be conducted under a fume hood. Electropolishing leads must be properly insulated.
10. After using acids, bases and solvents, all sinks and surfaces must be thoroughly rinsed. Disposal of these materials must be as outlined in Section V of this document.
11. All broken glass and sharps must be disposed of in approved containers. Waste chemicals must be disposed of as outlined in Section V of this document.
12. Protective clothing (lab apron, heavy rubber or nitrile gloves, and face shield) must be worn when handling strong chemicals (i.e. when preparing or using etching solutions).
13. Long hair and dangling clothing or jewelry must be tied back, removed, or secured when working with mechanical equipment.
14. Open-toed shoes (i.e. sandals, flip-flops, Tevas) and bare legs (i.e. shorts, short skirts) may not be worn in posted laboratories.
15. Large volumes of concentrated acids, bases, and volatile solvents can be transported only in approved safety carrying containers.

III. Emergency Procedures

A. In Case of a Fire

If you discover a fire, immediately leave the building and pull the closest fire alarm on your way out. Do not use the elevator. Call 911 from a safe place outside the building. Provide building personnel with the details for the fire/police, and then move to the Emergency Assembly Area. Never re-enter the building for any reason!

B. In Case of an Accident

Call 911 or have someone else call and give the following information:

- Your name, location, and nature of the emergency
- The name and amount of the chemical involved (if applicable)
- The areas of the body affected
- Symptoms

Follow appropriate actions such as using a chemical wash-down shower or eye-wash. If in doubt what to do, ask the 911 emergency personnel for assistance while on the telephone. Have someone inform a department faculty or staff member that an accident has occurred. Do not move a seriously injured person unless he/she is in further danger. Have someone locate a copy of the MSDS, emergency contact sheet, or other information that may be needed when the emergency personnel arrive.

Non-emergency and non-essential personnel will be forced to leave the site of the accident. Do not comment or answer questions about the accident to anyone but faculty, staff or emergency personnel. Direct all media inquiries to the Department Head (44110).

IV. Handling Chemicals

Some of these points were covered in the General Safety Practices section, but are repeated here for emphasis.

1. Undergraduates are prohibited from working alone in the laboratories after regular hours and on weekends. Graduate students should also avoid working alone in the laboratories.
2. Safety glasses with side shields or goggles will be worn in laboratories, as posted on the laboratory door.
3. Ensure that those working around you are following safe laboratory practices. Their poor practices may affect you.
4. Familiarize yourself with the chemicals that you will be working with, especially if you are mixing chemicals or performing chemical reactions. You should obtain and read the Materials Safety Data Sheets (MSDS) for any chemical you have not worked with before. If there is something in the MSDS you do not understand, ask a technical staff member, faculty member, or fellow student for an explanation. Be aware of commonly used etching chemicals that require special treatment in case of contact with skin (i.e. hydrofluoric acid).
5. Check for chemical incompatibilities before making substitutions when mixing etchants or doing chemical reactions.
6. Use the fume hoods for all operations involving noxious fumes or operations where containment of spills is essential. Open the hood only enough to do your work and never stick your head into a fume hood.
7. Use the smallest amount of chemical necessary to perform your experiment. Minimizing the amount of hazardous material reduces the chances for a serious accident and reduces the amount of hazardous waste.
8. Never heat a closed system, as you will overpressure the vessel.
9. Protective clothing (lab apron, heavy rubber or nitrile gloves, and face shield) must be worn when handling strong chemicals (i.e. when preparing or using etching solutions).
10. When pouring concentrated acids, wear heavy rubber or nitrile gloves. When working with organic solvents, wear chemical nitrile gloves. Disposable latex or polyethylene gloves are only suitable for working with powders or protecting electron microscopy samples from contamination.
11. When making dilute solutions, always add the acid (or base) to the water; never add the water to the acid (or base). Do this slowly because these substances produce heat when added to water.
12. Never pour anything back into a reagent bottle, as this could lead to contamination of the entire container. Take only what you need from the bottle at the start.
13. Use a funnel when pouring into a narrow mouth vessel.

14. When you have completed work for the day, clean up your area and return the equipment to its original location. You should always leave the laboratory as you found it, if not better.

V. Storage, Transportation, Cleanup, and Disposal of Chemicals

A. Chemical Storage

Acceptable containers for chemical storage include glass vials and polyethylene bottles with screw caps. Examples of unacceptable storage are flasks, and beakers (these may be acceptable for 1-2 day storage if covered). Be sure all chemical containers are clearly labeled, even if they are only left for a few hours. Labels are available in the labs or on the MSE website. If you are using a sample numbering system for synthesis reactions, list the hazardous precursor chemicals and ensure that the sample numbers are clearly cross referenced to the complete chemical content in your lab notebook.

B. Transportation of Chemicals

Hazardous chemicals such as organic solvents and concentrated acids and bases should be transported between labs using a plastic 4 liter bottle carrier. This will protect the bottle from breakage and, if the bottle were to break, any spillage would be confined to the bottle carrier.

C. Clean up of Chemicals

All major chemical spills must be reported immediately to the technical staff. Even in the event of a minor spill, obtain assistance if you are unfamiliar with the chemicals. Wear chemical resistant gloves and wipe small spills with a paper towel or wipe. Towels used to clean up organic solvent spill should be placed in a fume hood to evaporate the solvent before they are placed in the trash. Concentrated acids spills should be diluted with water and/or neutralized with sodium bicarbonate solution before being wiped. The towels used to clean up acids should be rinsed with water before they are placed in the trash.

D. Disposal of Chemicals

Refer to "*Guidelines: Handling and Disposal of Chemicals*," a booklet available on the REM website for disposal of chemicals. Many water soluble chemical wastes can be disposed of in the sink with no problem. Concentrated acids or bases must be diluted by a factor of more than 10 (remember add acid to water, not water to acid) before putting them down the sink with running water. Slurries of powders and water (such as Plaster of Paris or ball milled ceramics) should be dried, placed in a zip-lock bag, and marked as non-hazardous waste before being placed in the trash. Some of the things that may not be put down the sink or into the trash are:

- Compounds containing lead, silver, barium, cadmium, mercury, selenium, or arsenic.
- Organic solvents
- Organometallic compounds.
- Compounds containing cyanides.

If you need to dispose of these items, please use a bottle with a screw cap and place an orange *Purdue University Hazardous Waste Disposal Tag* on the bottle. These tags are

available in the labs or from the technical staff. List the contents on the tag. Do not mix chlorinated and un-chlorinated organic solvents. Before starting a new bottle, check with other students or lab staff to see if a bottle for your chemical waste already exists.

E. Mercury Spill

In the event of a mercury spill, contact technical staff for assistance. All waste mercury must be turned into REM (46371) for disposal. Any mercury thermometers in the department should be replaced with the non-mercury type, and the mercury thermometers should be turned over to lab staff for disposal by REM.

VI. Handling Gas Cylinders

1. Always use the proper regulator when dispensing gas from a compressed gas cylinder.
2. When storing and moving a cylinder, have the cap securely in place to protect the stem. If in a fall, the regulator valve is cracked or broken off, the heavy cylinder will be propelled violently and anyone in the path may be injured and/or lose their hearing.
3. Use suitable racks, chains, or stands to support cylinders while in use.
4. Remember that any gas may be an asphyxiation hazard. Check for leaks and have proper ventilation in the room where the gas is being used.
5. All oxygen, hydrogen and natural gas cylinders must be used with a flash arrestor.
6. Ensure that you are using the proper regulator for the gas. A list of the proper regulator fitting for each gas type can be found on the Matheson Gas web site.

VII. Working with High Temperature Equipment and Furnaces

1. Remember that below about 800°C, hot materials do not “glow.” Therefore, be very cautious when picking up anything in the vicinity of a furnace.
2. When you remove a piece from a furnace and place it on the bench to cool, place one of the metal “HOT” signs nearby.
3. Red hot graphite will ignite if removed from a hot furnace into the open air.
4. Do not try to remove an alumina crucible from a furnace that is above 500°C. These crucibles do not have large thermal coefficients of expansion and may crack or shatter.
5. Never pour water onto molten metal. You may get burned by spattering water and/or metal.
6. Never charge a metal melt with cold scrap. Always pre-heat the charge before adding it to the molten metal.

7. Never look into a crucible of molten metal without a face shield. And always wear full protective gear (glasses, gloves, apron, face shield) when handling or pouring molten metal.

VIII. Working with Cryogenic Liquids

Hazards associated with working with cryogenic liquids, such as liquid nitrogen, include cold burns, explosions, and asphyxiation.

1. When working with liquid nitrogen, always wear low temperature protective gloves and wear safety glasses or goggles. It is important not to dispense liquid nitrogen when wearing open-toed shoes.

2. Dispense liquid nitrogen only into containers designed for cryogenic liquids. Glass Dewars should have the exterior surface shielded with plastic mesh or electrical tape to prevent shattering in case of breakage.

3. Do not use or store liquid nitrogen in confined spaces where an oxygen deficient or hazardous atmosphere could develop.

4. Avoid transporting liquid nitrogen (>10 liters) in the passenger elevator. Use the freight elevator.

IX. Working with Metallographic Preparation Equipment

When grinding or polishing small samples, mount the sample to prevent grinding your fingers or having the sample pulled from your fingers and propelled across the lab.

X. X-Rays

Visit the MSE website, X-Ray Facility link to get information about obtaining the required safety training for using equipment in the X-Ray Facility.

XI. Bibliography

Here are a few commonly used references. More references are available in the library and on the MSE and REM websites.

1. ***The Merck Index***, M. Winholz, Ed., 615.1M53 2001, available in the Chemistry and Engineering Libraries.

2. ***Handbook of Reactive Chemical Hazards***, L. Bretherick, 660.028 B755h 2007, available in the Chemistry Library and as an Electronic Resource.

3. ***CRC Handbook of Laboratory Safety***, A. K. Furr, 542.1 St32c 2000, available in the Veterinary Medical Library and as an Electronic Resource.

4. ***Safety and Health Topics: Laboratories***, US Dept of Labor Website <http://www.osha.gov/SLTC/laboratories/index.html>.