Laboratory for Advanced Materials Processing

General operating procedures

April 2002, prepared by
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For more information, consult LAMP web site @
http://www.enma.umd.edu/LAMP

Outlook

This document is supposed to provide basic operating procedures and general guidelines to work safely in the Laboratory for Advanced Materials Processing.

For more details, consult the LAMP web site or contact the lab manager.

Introduction and Research in LAMP

see LAMP website at www.enma.umd.edu/LAMP

LAMP Management and contacts

see LAMP website at

http://www.enma.umd.edu/LAMP/lamp_management.htm

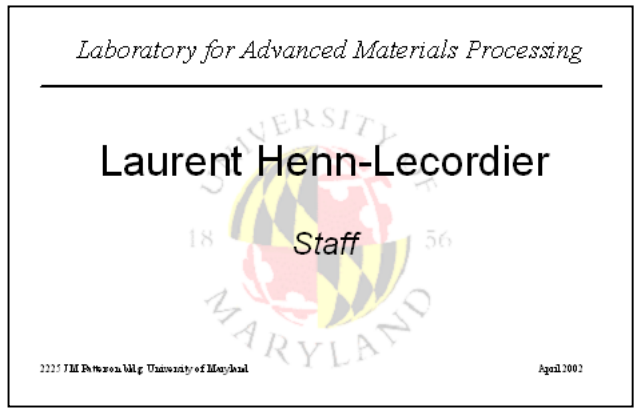
Work in LAMP

Authorized personnel

- For safety reasons, only authorized personnel are allowed to work in LAMP
- LAMP users can only be authorized by the lab manager who will give them access to the LAMP key card system and will provide them a name tag that must worn at all times when working in the lab.
- If you see a non-authorized user working in the lab, please inform this person that he/she is not allowed to work in this lab. Inform the lab manager if necessary.

LAMP user's name tag

- Name tags can only be issued by the lab manager and attest that a user is authorized to work in the lab
- The name tag should be attached to the front of your lab coat at all times



  - Name tags help to know people's names
  - Name tags helps to make sure that LAMP users are authorized to work in the lab

Access to LAMP

- To gain access to LAMP and be authorized to work in LAMP, refer to instruction on LAMP web site (http://www.enma.umd.edu/LAMP/lamp_access.htm)
  - Download written request
  - Receive safety training from DES
  - Lab orientation with the lab manager
  - Equipment training and qualification

LAMP “10 commandments”: part 1

- Safety is non negotiable. Safety must be your primary concern at all times.
- Be proactive about safety. If you see a safety hazard, you are responsible to report it to the lab manager even if it implies other users of the lab. Each person has the right to question a procedure that he/she considers inherently unsafe.
- Never leave the lab without cleaning or in unsafe conditions
- Report incidents in the lab. Occasional accidents are understandable and forgivable. Secrets or continuing mal practice are not acceptable
- Never assume that other users are knowledgeable about your activities. Make sure to clearly label or mark any recipient, chemical solution, source of potential hazard... you leave unattended (even for a few minutes).

“LAMP 10 Commandments”, part II

- Each user must take responsibilities in the training and organization of the lab. It is everyone's responsibility to maintain LAMP in order. If you see something wrong, do not assume somebody else will fix it for you.
- Learn from your colleagues and teach them in return.
- Document your activities or problems in the log books put at your disposition in LAMP.
- Report ideas to improve work in LAMP
- Most of all, respect other people's work. Your work is valuable so is other people's work! Be clean, be safe, be considerate and professional.

Dress code

- Inside the cleanroom clothing, shoe covers, Tyvek coat (or bunny suit if you are wearing a short or skirt), hair net must be worn at all time.
- Gloves and safety glasses must be worn all the time when you are working in the cleanroom, no matter what you are doing.
- No sandals and open-toed shoes.
- Smoking, food, drinks are **prohibited** anywhere in the LAMP facility (cleanroom and pre-cleanroom). They all are huge sources of dust and can present serious safety risks.
- Torn or dirty coats should be discarded after use. Hair nets are not to be reused.
- Do not reuse shoe covers: they are cheap and a huge source of dirt as well
- It is not allowed to leave the facility wearing the garments

How to get new garments

- Get new garments (shoe covers, hair nets, frocks, gloves…) from the unlocked cabinet in the LAMP annex. Extra garments are available (ask lab manager or Jung Jin Park, pjj@glue.umd.edu)

Get your personal Tyvek coat

- Use the coat hangers in the LAMP annex for your personal Tyvek coat.
- Leave your name tag on it and write down your name in the back.
- Be careful with your Tyvek coat. They are expensive.

General storage in clean room

- Clean room space is a premium.
- Only store clean items in the clean rooms: cardboard boxes, dusty materials are not allowed in the clean room.
- Any items that is not put away in proper storage area will be taken out of the cleanroom

In the cleanroom, use storage boxes that were allocated to your group

Cleanroom tools must be kept in labeled tool boxes

General storage in the annex

- Use shelves and cabinets put at your group's disposition in the annex to store any non-critical or packed items.

Make sure to leave your name and your supervisor's name on the shelf you are using

Work with Chemicals

Chemicals storage and supply

- For safety concerns, chemicals inventory is now managed by a student supervisor. He will make sure that all the Materials Safety Data Sheets and chemical inventory are up to date.
- You must get the approval of the lab manager or the student in charge of the chemical inventory before importing any new chemicals in the LAMP facility.

- Contact: Manas Dash, 55229, mrdash@glue.umd.edu or manager

Supply of chemicals by LAMP

- LAMP will provide the followings:
  - Nitrogen dewars, acetone, methanol, TCE, AZ 400K developer, hydrofluoric acid.
  - The student in charge will make sure to keep the supply of these items up-to-date

The cabinets in the pre-cleanroom are only to be used to store unopened and sealed flammable containers (acetone, methanol, developer and TCE)

Storage of chemicals in the clean rooms

- All chemicals solutions must be kept in the allocated vented storage space under the flow hoods (flammables, acids or bases).
- All chemicals solution must be clearly labeled with the user's and supervisor's names, the date of import in LAMP, the full name and composition of the solution

Store chemicals in the right location

Solutions must be clearly labeled

Import of new chemicals in LAMP

- You must inform the lab manager or the student in charge of the chemicals inventory before importing any new chemicals in LAMP
- An electronic copy of the Materials Safety Sheet must be provided to the lab manager prior to taking any new chemicals into LAMP
- Any chemicals without MSDS or that do not figure on the chemicals inventory will be removed and disposed of without notice.
- If you are not sure in which cabinets to store your container, contact the student in charge of the chemicals.

Refrigerated chemicals storage

- Storage space for chemicals that require to be refrigerated is very limited.
- Keep your chemicals in the smallest quantities, do not use oversized containers, make sure to label all your solutions
- Keep small containers in labeled boxes.

Work with chemicals

- Always wear appropriate gloves and safety glasses.
- Never carry directly hazardous chemicals thru the lab
  - Use the acid bucket or a cart
- All chemicals must be handled under an operating flow hood
- Never leave an unattended or non labeled solution in the lab
- When working with dangerous materials (corrosive, toxic…), make sure to inform people around you and leave a warning sign near your solutions.
- Never use glassware or tools that belong to another group
- Always clean up your work area before you leave. Thoroughly rinse the beakers you used with DI water and then store upside-down in their appropriate locations.
- Wash thoroughly any chemical bottle you used. Use cleanroom wipes to dry and then store in the appropriate cabinet.

Chemicals waste disposal

- Do not dispose of chemicals in the sink
- Collect waste in the 1 gallon waste containers located on cart in cleanroom
  - Provided containers for acetone/methanol, TCE, developer, KOH, HF and BOE
  - If other, bring your own waste container, label it very clearly(your name, supervisor's name, full name – not just formulae - and composition of solution), close tightly and leave it on tray
- Lack of labeling of chemicals used in the cleanroom significantly increases the cost of disposal and may lead to the forfeit of cleanroom privileges

Chemicals waste disposal

- Thoroughly rinse empty chemical bottles with regular tap water. Fill and dump at least 3 times. Put a scratch through the original label and mark it with "WASHED BOTTLE" and place in the corner next to the entrance door
- No unauthorized solutions
- No unlabeled solutions
- No chemicals in waste baskets
- No unwashed bottles in waste baskets

Chemical waste management

- 1 gal waste containers in clean room will be emptied on regular basis by trained personnel only and disposed of.
- Contact Famodu Olubenga, ext. 54208, or manager if problems
- See waste guidelines and DES web site to handle chemicals *http://www.inform.umd.edu/CampusInfo/Departments/EnvirSafety/hw/index.html*

Waste disposal guidelines, acid bucket and chemical spill kit are located in the pre-cleanroom

Use of equipment in LAMP

Future plans for LAMP

- Photoresist and sol-gel spinner will be installed on same vented rack.
- Furnaces and hot plates will be removed from the chemical flow hood and installed on a vented rack next to the mask aligner
- A second sink will be added in the center flow hood for additional wet process capability
- Laminar flow hood taken out of the clean room to bring new clean room equipment ???

Use of equipment in LAMP

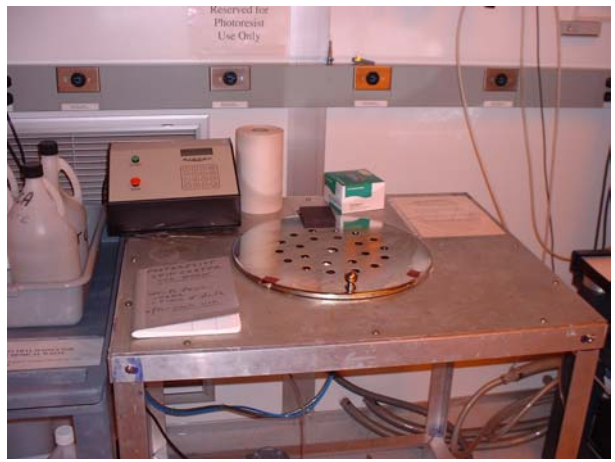
- Only qualified users are allowed to use equipment in LAMP
- To be qualified and have your name added to a tool user's list, contact the tool supervisor (see http://www.enma.umd.edu/LAMP/equipment.htm)
- Access to the lab will be suspended for users that operate tools without being qualified.

The tool user's list can only be updated by the tool supervisor

Sol-gel and photoresist spinners

- Never use the sol-gel spinner for depositing photoresist materials or vice-versa
- Report your activities in the log books prior to use this equipment (your name, supervisor's name and date).
- Always clean the spinner after usage: replace the aluminum foil, clean the bowl with acetone under the flow hood if necessary, clean any spills of photoresist.

Leave the spinners clean for the next users and use the log books to report your work.



Use of the furnace and hot plates

- Hot plates and furnaces under the Kewaunee flow hood are often used for PZT (contains lead!) sol-gel annealing
- Always keep these flow hood closed to limit exposure to cancer-agent fumes
- Contact tool supervisor for any questions

Keep the clean room clean

Keep the clean room clean

- It is everybody's responsibility to keep the clean room clean. Respect other people's work and their need to work in a clean environment
- Do not bring into the cleanroom anything that can generate particles or dirt.
- Do dirty work in the annex or in the hallway
- Clean up after yourself
  - If you spill any chemicals, clean it up
  - Don't leave pieces of paper, tools or any items in the clean room without putting it away
- First come in the morning, take the emptied trash containers in and replace the blue sticky mats.
- "Last one" in the evening takes the trash out

Cleaning schedule

- From April 23, cleaning must be performed by team of 3 LAMP users every 2 weeks for 6 weeks
- Cleaning schedule will be set by lab manager for a one year period
- Lab manager will remind the 3 users one week in advance.
- Cleaning should take approximately 2 hours per visit for each person
- Cleaning includes (a checklist will be provided):
  - Vacuuming lamp clean room, sweeping the floor in pre-cleanroom and annex
  - Cleaning work spaces (flow hoods, tables, storage spaces)
  - Discarding any unattended, non-labeled items

Safety

Refer to the LAMP safety web pages @
http://www.enma.umd.edu/LAMP/safety.htm

Safety: on-line information

- LAMP safety reference guide
  - http://www.enma.umd.edu/LAMP/safety.htm
- LAMP safety overview document
  - http://www.enma.umd.edu/LAMP/GalSafety.htm
- LAMP Materials Safety Data Sheets and Standard Operating Procedures
  - http://www.enma.umd.edu/LAMP/lamp_SOPs.htm
- The UMD Department of Environmental Safety web site
  - http://www.inform.umd.edu/CampusInfo/Departments/EnvirSafety/index.html
  - Provides on-line safety training, safety reference guides, workshops…….

Safety bottom line

- Safety is paramount in LAMP. Due to the nature of semiconductor and microsystems processing, activities within LAMP must be undertaken with extreme care and a full understanding of all proper safety procedures. Violations of safety protocols will result in temporary expulsion from the lab. Permanent expulsion will result from gross negligence of the safety rules. This can mean serious delays or even the end of your thesis. You have been warned!

LAMP hours of operation

- LAMP hours of operation are from 9 am to 6 pm Monday to Friday.
- Performing hazardous processes outside of these operating hours is not allowed
  - Handling high voltage equipment, use of acids and other corrosive materials, use of process gases are considered hazardous
- When working on a dangerous process, you must systematically be with another person that is knowledgeable of the risks and rescue procedures
  - Dangerous processes would include: work with hydrofluoric acid based solutions (even diluted), use of process gases on the Ulvac, repair of high voltage equipment

Incident report

- All LAMP users are encouraged to report all incidents, near misses, and unsafe acts they encounter while working at the lab to the lab manager. It **is not intended** to criticize or 'pick on' any person. By reporting these incidents, corrective actions may be recommended to prevent similar or more catastrophic incidents from happening.

  - Contact Laurent Henn-Lecordier
    (301) 405 5858
    hennlec@isr.umd.edu

Minor chemicals spills

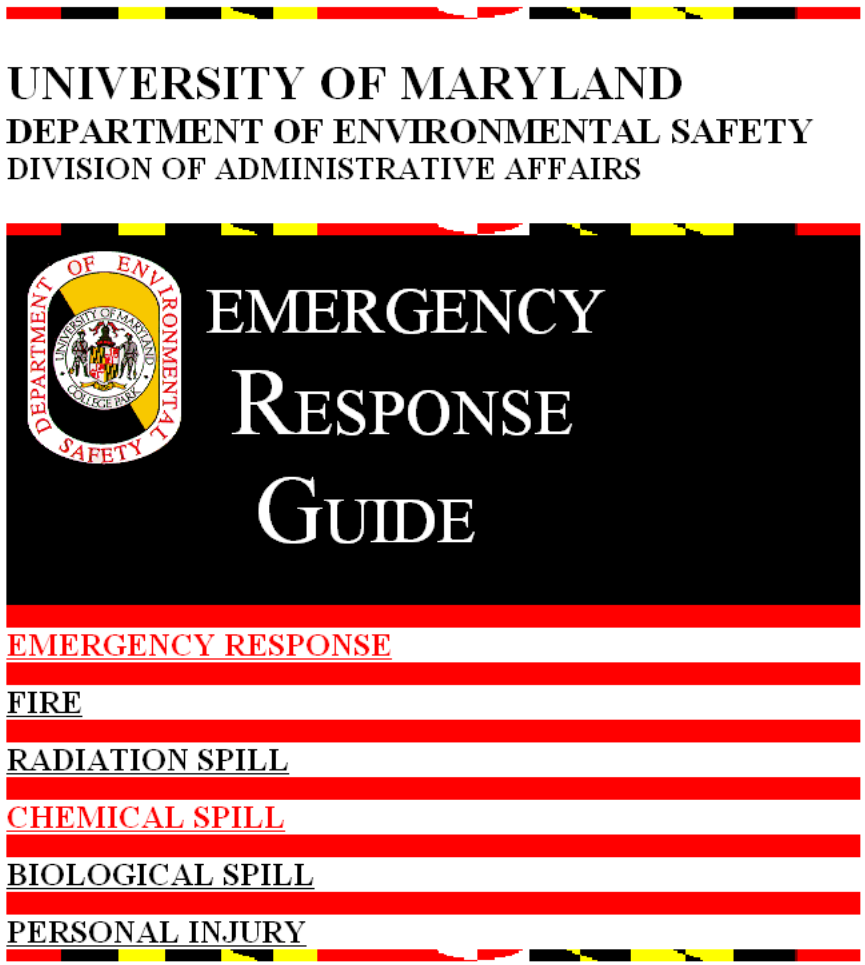
- Alert people in immediate area of spill.
- Wear protective equipment including chemical splash goggles, appropriate gloves and lab coat.
- Avoid breathing vapors from spill. (Individuals using respiratory protection must comply with requirements of the Respiratory Protection Program.)
- Confine spill to small area. Use appropriate spill kit to absorb the spilled material.
- Bag cleanup material and label it with the DES Hazardous Waste label and send in a Hazardous Waste Removal Form to DES.
- Clean spill area with water.
- Call DES for advice as needed - **x53960**.

Major chemicals spills

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the laboratory to evacuate.
- If spill is flammable, turn off ignition and heat sources, evacuate area, activate fire alarm.
- Close doors to affected area.
- If spill or its vapor migrates outside of laboratory to other occupied spaces, activate building evacuation alarm.
- Call **Chemical Spill Emergency Response number** 9-1-1 if spill is confined to laboratory.
- Have person knowledgeable of incident and laboratory remain available to provide information to DES and emergency personnel

Emergency Response Guide

- Any LAMP user must be knowledgeable of the procedures described in the Emergency response guide
- Online from LAMP web site http://www.enma.umd.edu/LAMP/lamp_SOPs.htm
- Hardcopy in the lab near entrance door



Emergency equipment location

Spill kit is located in pre-cleanroom on waste container cart

Fire extinguisher and LAMP emergency push button to the left of lab entrance door

Telephone and emergency response guide to the right of lab entrance door

Emergency equipment location

Eye wash station and
emergency shower (40 gal/min)
in left back end corner of cleanroom

Additional fire extinguisher and fire alarm pull station in front of LAMP exit door

LAMP gas detection system

- MDA System 16: to monitor and enunciate potential leak of pyrophoric silane
- Also includes smoke detectors, overpressure and overflow sensors, hydrogen and HF gas sensors
- In case of silane positive detection (above 2ppm), MDA system will automatically:
  - Trigger internal LAMP alarm system
  - Trigger JM Patterson building alarm
  - Enunciate incident to UMD police department thru supervisory unit

General emergency procedure

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people to evacuate the area.
- Call for Emergency Response: **FIRE9-1-1CHEMICAL, BIOLOGICAL OR RADIATION SPILL9-1-1**
- Close doors to affected area.
- Have person knowledgeable of incident and laboratory remain available to provide information to emergency personnel.
- Call lab manager or lab director from a safe location

LAMP emergency push button

- Pressing the red push button at the entrance of the LAMP lab will:
  - Trigger the internal LAMP alarms (2 audible and visual actuators in cleanroom and pre cleanroom)
  - Trigger the JM Patterson building alarm
  - Call 911 thru the LAMP automated supervisory unit
  - Shut down all process gases to the Ulvac CVD cluster tool

Main hazard sources in LAMP

- Electrical: Ulvac CVD cluster tool, e-beam evaporator, any electrical equipment that uses high voltage.
- Chemical:
  - Silane: 100 g container, pyrophoric, in gas cabinet
  - Tungsten hexafluoride, toxic (produces HF), in gas cabinet
  - Hydrogen, flammable
  - Hydrofluoric acids and other corrosive materials
  - Chemicals containing cancer agents (PZT, toluene, xylene…)
  - Most of the solvents over long exposures can be carcinogen
- Radiation: use of the UV mask aligner
- Thermal: hot plates, furnaces, thermal CVD equipment

Electrical hazards

- Only qualified UMD employees are allowed to work on live high-voltage equipment
- If you need to repair a piece of high voltage equipment:
  - Ask for guidance if you need to
  - Never work alone
  - Always shut down the tool and pull off the power breaker
  - Tag out the area and leave clear written instructions whenever you leave the lab without putting the system back into a safe mode
  - Live high voltage sources should never be accessible to anyone

Materials Safety Data Sheets

- Materials Safety Data Sheets for all chemicals used in LAMP can be downloaded from LAMP website
- Make sure to review carefully the MSDS before handling any chemicals
- MSDS contain very important information about chemicals and gases:
  - Chemical toxicity, flammable, corrosive, carcinogen properties
  - Permissible Exposure Limits
  - Compatibility with other materials
  - Required Personal Protective Equipment
  - Emergency procedures in case of contamination

Standard Operating Procedures

- The LAMP Standard Operating Procedure and Hygiene Plan are available in a binder located in the LAMP annex
- Online SOPs can be downloaded from the LAMP website
  - Waste management and disposal guidelines
  - LAMP emergency enunciation system
  - Use of hazardous process gases on the Ulvac CVD system
  - PZT processes
  - Mask aligner

Lab signage system

- No food or drink anywhere in LAMP
- Cancer suspect agents:
- Toxic gas
- Flammable materials
- Toxic chemicals
- Corrosive materials (acids, bases)