

**User Training for the
“Laboratorio di Ateneo”**

PoliFAB

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**Instructions for the
usage of chemical
products**

General description

In PoliFAB's laboratory we daily use chemical agents of different nature according to the needs of each fabrication process. The aim of this document is to inform users of the risks related to the utilization of chemical products, and to train users on proper usage according to dedicated spaces for chemicals use and PoliFAB's internal operational instructions. In the following table you can find a list of the most commonly used chemical products, along with their H risk phrases (following GHS hazard statements) and a description of the H phrases.

Chemical agent	Risk H	H Phrase	Description of the risk
Acetone	225 - 319 - 336 - EUH066	225	Highly flammable liquid and vapor
Isopropyl alcohol	225 - 319 - 336	226	Flammable liquid and vapor
Hydrofluoric acid (HF)	300 - 310 - 314 - 330 - EUH071	271	May cause fire or explosion; strong oxidizer
Hydrochloric acid	280 - 314 - 331	272	May intensify fire; oxidizer
Sulphuric acid	314 - 290	280	Contains gas under pressure; may explode if heated
Phosphoric acid	314 - 290	290	May be corrosive to metals
Nitric acid	272 - 311 - 314 - 330	300	Fatal if swallowed
Ammonium fluoride	331 - 311 - 301	301	Toxic if swallowed
Ammonium fluoride + HF mix	H301 - H331 - H310 - H314	302	Harmful if swallowed
Potassium hydroxide	314 - 302 - 290	310	Fatal in contact with skin
AZ 100 remover	290 - 314	311	Toxic in contact with skin
AZ 726 MIF	290 - 302 - 312 - 314 - 371 - 373	312	Harmful in contact with skin
AZ 1505	226	314	Causes severe skin burns and eye damage
AZ 5214E	226	318	Causes serious eye damage
TI Prime	226	319	Causes serious eye irritation
Ammonia solution	314 - 335 - 336 - 400	330	Fatal if inhaled
HMDS	225 - 302 - 311 - 314 - 412	331	Toxic if inhaled
TMAH 25%	301 - 311 - 314	332	Harmful if inhaled
Ammonium hydroxide solution	302 - 314 - 335 - 400	335	May cause respiratory irritation
4-Metil-2-Pentanone	225 - 319 - 332 - 335	336	May cause drowsiness or dizziness

Remover AR 300-70 (NEP)	318	371	May cause damage to organs
AR-P 7400	226 - 302 - 312 - 319	373	Causes damage to organs through prolonged or repeated exposure
AZ 400 K Developer	290 - 314	400	Very toxic to aquatic life
Hydrogen peroxide	271 - 302 - 314 - 332 - 335	412	Harmful to aquatic life with long lasting effects
Ethanol	225	EUH066	Repeated exposure may cause skin dryness or cracking

Every operator must manipulate the above chemicals and any other chemical agents present in the laboratory respecting all safety prescriptions. Therefore it is mandatory to use the appropriate personal protective equipment (PPE) and to manipulate chemicals only in fume hoods. **Every operator must be aware of the risks related with chemical agents manipulation and first intervention procedures in case of direct and indirect contact or contamination with chemical agents.** It is also mandatory to choose the most suitable PPEs according to the substance to be used. For example, when using acetone or isopropyl alcohol, users must wear protective goggles and latex gloves, along with the cleanroom coverall. In case of HF, a mask covering the whole face, neoprene gloves and chemically protective cover must be used.

On PoliFAB's website, in the "Processes" page (visible only after logging in), you can download the Safety Data Sheet (SDS) of each chemical present in the laboratory. **Before manipulating whatever chemical substance, it is mandatory that the user reads and understands its SDS, in order to operate in total safety and react properly in case of accident.** Every user who plans to manipulate chemical substances (of any nature) at PoliFAB has to ask the Staff for a chemical fume hood training, following the same procedure as for all the other cleanroom equipment training. Users who manipulate chemicals in improper ways or show insufficient knowledge of procedures or SDSs will be suspended. Users are not allowed to introduce in the laboratory new chemicals unless they ask for specific permission to the Cleanroom Manager, who will evaluate risks and compatibility with existing processes, grant permission via written communication and integrate the new chemical in this document.

In PoliFAB's cleanroom there are 12 fume hoods dedicated to the manipulation of chemical substances. In the following table you can find their denomination, laboratory location and type of chemicals they are designed to be used with.

Denomination	Location	Type of chemicals allowed
Development	Yellow room	Solvents, developers (bases)
Spinner and hotplates	Yellow room	Resist, solvents
Single wafer	Wet area	Acids, bases
Multipurpose	Wet area	Acids, bases (right), solvents (left)
Lift-off	Wet area	Solvents
PDMS	Back-end	Solvents, PDMS
Spinner PDMS	Back-end	Solvents, PDMS, Polyimide
Magnetic	Magnetic thin films	Solvents, Plating solutions
Electroplating	Deposition area	Plating solutions
Cleaning	Deposition area	Acids, bases
Development	Advanced Lithography	Developers (bases)
Lift-off	Advanced Lithography	Solvents

Chemical substances are stocked in 8 safety cabinets present in the laboratory, which are under aspiration. Hereafter you find their location and type of chemicals allowed.

Denomination	Location	Type of chemicals allowed
Acids cabinet	Grey corridor	Acids
Solvents cabinet	Grey corridor	Solvents
Bases cabinet	Grey corridor	Bases and other reagents
Lithography cabinet	Yellow room	Developers, strippers, solvents
Miscellaneous cabinet	Wet area	Acids, solvents (small quantities)
Waste cabinet	Grey corridor	Miscellaneous waste
Stock cabinet	Deposition area	Acids, bases
Lithography cabinet	Advanced Lithography	Developers, strippers, solvents

In the yellow room there are two fridges dedicated to low-temperature resist storage; a third fridge is present in the back-end to store protective coating and non-photosensitive substances. Other lithography resists that do not need low-temperature storage can be stocked in the Lithography cabinet in Yellow Room. When taking a resist from the fridge, allow sufficient time for warming up before opening the bottle (10 minutes or more) in order to limit water vapor condensation and ageing of the resist content.

For every fume hood, regardless of the type of chemical agent to be used, it is mandatory to use proper PPE during operation. Typical PPEs are: goggles and masks for protection of eyes and face, gloves for hand protection (in the wet area you can find a chemical resistance chart for different glove materials with most commonly used substances) and chemical coverall for body protection. In the cleanroom there are 4 emergency showers with eyewashes to be used in case of accident: one in the wet area, one midway in the grey corridor, one in the deposition area and one in the advanced lithography area.

Operating instructions

Utilization of whatever chemical agent is allowed only inside fume hood. Before using a fume hood it is mandatory to check that power is present (illumination is on) and that the fume hood itself is not in alarm state (green light on). In case of malfunctioning of the centralized aspiration the fume hoods automatically switch off and set to alarm state (red light and buzzer on). If the fume hood is off or in alarm state, users are not allowed to operate. It is also mandatory to check that a pressure difference of at least 10mm of water is present between inside and outside the hood, by visually inspecting the differential pressure indicator Magnehelic (in the fume hoods where it is installed). If this is not the case the fume hood cannot be operated and users must inform the Staff about the malfunctioning. **Every operator must ensure that the working area inside the hood is clean and free from chemicals or instruments which may be incompatible with the process to be executed.**

For each fume hood, on the front window there is a clear indication of the maximum aperture allowed in order to keep the safety frontal speed of air aspiration, labelled "Maximum Operating Level"; during operation it is forbidden to open the window more than this indication. Finally, before starting working, it is mandatory to wear all necessary PPEs (gloves, goggles, face mask and coverall). Checklist before fume hood operation includes: regular status of the hood (light on), aspiration on (no red light/differential pressure indicator), working area clean and safe, window open below the maximum operating level and proper PPEs worn.

Fume hoods have two ways of operation according to the model and the specific needs of each user. The first one involves the use of reaction tanks for single wafers or wafer cassette (25 wafers), while the second one involves the use of removable containers (beakers/Petri dishes) which are suitable in the case of small pieces or small wafers requiring little amount of chemicals. In the first case the operator must inform PoliFAB's Staff that he/she is going to fill and drain reaction tanks. Users are not allowed to fill/drain reaction tanks without supervision. In the second case, users can work independently and are responsible to operate according to the fume hood training received. **An exception is represented by HF, for which an observing operator is also required to be present with the working operator, due to the great risk of this reagent.**

After chemical processing, each user must leave the used fume hood perfectly clean and tidy. It is forbidden to leave inside fume hoods containers of chemical agents of whatever nature, except small spray bottles loaded with commonly used solvents (acetone and isopropyl alcohol). Such spray bottles are allowed to be stored over the working areas, provided they are inside a working fume hood, due to the flammability of their vapors. All other reagents must be stored in the chemical cabinets after use. In case you need to leave the fume hood, including short periods of few minutes, it is mandatory to cap the containers with chemicals and leave in immediate proximity of each container a clearly visible message with the following information: user name and surname, name of the reagent and date/time of writing. Finally, before leaving, the window must be completely closed and rinse baths drained.

After finishing your processes, chemical waste must be disposed in proper containers provided by the Staff and stored in the waste cabinet located in the grey corridor close to the emergency exit or in the cabinets of wet area and yellow room. Waste disposal must differentiate reagents of different kind, avoiding to mix non compatible substances (like solvents and oxidizers). To this end, **PoliFAB adopts a simple color code for waste bottle labelling: BLACK for organics (not halogenated) GREEN for alkalines (bases); ORANGE for acids.** For acids only, there is also a semi automatic system for waste management which is maintained by the Staff. **Before disposing of Piranha solution or other solutions that can develop gas, users must wait at least 4 hours and dilute the exhaust solution with the same volume of water or more.** Waste disposal charts are available in the cleanroom, with all the instructions for disposing the most commonly used substances. If the reagent to be disposed is not included in the three categories listed above, consult the Staff.

Fume hoods are equipped with rinse tanks that can be loaded with de-ionized water. Such tanks must be used for sample rinsing only, and can be loaded and drained freely by users. The discharge goes into the sewer, therefore it is forbidden to dispose of chemicals in the rinse tanks.

In case of emergency

In case of accidents during cleanroom work, the operator must act in total safety for him/her-self and for colleagues present in the laboratory. Even in case of accidents without damage to people or things, the operator must report as soon as possible and with as much detail as possible to the laboratory Staff personnel. The operator must also inform the Staff in case of situations or behaviors that could be dangerous for people and for the cleanroom itself, or that could be in contrast to the prescriptions reported in this document and the other cleanroom safety training documents.

In case of spillovers of chemicals, if the substance is not dangerous for the operator and the amount dropped is not too large, the operator can dry up the liquid with the safety spillover kit and dispose of the contaminated cloth in the trash bins present besides the fume hoods; after

that, in any case inform the Staff of the event as soon as possible. In case of dangerous substances or large amounts of chemicals, ensure you can secure the working area and call the Staff personnel (also on the phone, if not present in the lab). Besides the chemical fume hoods you can find the safety spillover kits containing absorbing cloths suitable for chemical products; for HF a dedicated neutralizing product with acid indicator is available.

In the event of a health emergency, defined as any situation where one or more operators show health problems, even of light intensity, it is necessary to evaluate how dangerous the event is. Only after checking that the accident scene is not dangerous for other people, you can help the involved operators. At the same time it is mandatory to inform the Staff about the events. In case Staff members are not available and the event can be dangerous for other users, you must activate the fire alarm. In case of health emergency, defined as risk to human life, any user can call the emergency number 112. After this, inform the Staff personnel.

In the event of fire, push and activate the fire alarm button and inform the Staff. If you hear the fire alarm, prepare for evacuation through the emergency exits and gather at the emergency assembly point in the backside yard at the gate towards via Pascoli. May it be more convenient, it is also possible to use the emergency exit located on the stairs between the basement and the offices floor.

Examples of accidents

In this paragraph we report two images of the effects of chemical burns originated from contact with hydrofluoric acid (left) and sulphuric acid (right).



A cream containing calcium gluconate is stored in the transparent cabinet in the wet area: this must be used only in case of skin contact with HF.

Attachments

Attachments to this document: a chemical resistance chart for different glove materials and a list of the most commonly used chemical products organized by family of waste and their respective color code in use at PoliFAB.