Code of Practice
Physics Department EXSS Cleanroom B111

Contents

1. Introduction contacts and useful links

This document is a reference manual setting out basic operational policies for the cleanroom. It covers safety and cleanroom 'rules'. It also contains information on equipment and processing procedures. All Cleanroom users must read and understand the procedures, rules and protocols in this and associated documents (which are identified within this document). In addition, all users must read the Risk Assessment forms, COSHH (Control of Substances Hazardous to Health) forms and Material Data Sheets (MSDS) associated with the equipment and processes. These can be found online on the nanofabrication sharepoint.

The cleanroom (an ISO class 6) is for the sole purpose of performing semiconductor, polymer and nanotechnology processing. Please note that the cleanroom houses expensive pieces of equipment that can be damaged by users. It should also be noted that chemicals and gases, if handled incorrectly, pose significant hazard to both personnel and the facility.

The Cleanroom Committee (CRC), whose members are listed below, manage the Cleanroom. The CRC must review and approve all processes within the cleanroom. Please note that individual PIs and supervisors may not be fully aware of 'cleanroom practice' and thus it is essential that all processes are approved by the CRC.

Cleanroom Committee

Lab PI & Cleanroom Manager

Ji-Seon Kim

Cleanroom Technician

David Mack

Senior EXSS Technician

Stephen Cussell

Cleanroom Committee Members:

Matyas Daboiczi

Sam Hillman

Joel Luke

Jessica Wade

Faculty Safety Managers:

Stefan Hoyle - s.hoyle@imperial.ac.uk
Anthony Marchant - a.marchant@imperial.ac.uk
Olga Kuzmina – okuzmina@imperial.ac.uk
Emma Edwards – e.white@imperial.ac.uk

Nanofabrication Sharepoint

The nanofabrication sharepoint acts as an archive for standard risk assessments, COSHH forms and MSDS for common practices in the cleanroom. It is also used to book equipment inside the cleanroom and chemistry lab.

Each booking page for equipment has documentation, standard operating procedures and manuals for the equipment. It also contains information on makes and models of the equipment.

It can be accessed from the link below. To have your account activated on the sharepoint please contact David Mack.
https://imperiallondon.sharepoint.com/sites/fons/physics/facilities/nanofablab/SitePages/Main%20Page.aspx

EXSS Laboratory Booking Sharepoint

Due to Covid-19 Restrictions laboratory access in Blackett is being carefully monitored by Imperial. Restrictions on both total weekly access to Blackett and maximum users per laboratory have been implemented. To this end a booking system was set up to book time in the cleanroom and prevent users exceeding maximum numbers in Blackett or the cleanroom.

At the time of writing it is a requirement that any time in the cleanroom is booked on the EXSS laboratory booking sharepoint in addition the normal equipment booking done on the nanofabrication sharepoint.

For access to the lab booking system please contact David Mack

My Training

My training is used to catalogue your training and laboratory inductions. This includes Imperial College London health and safety courses such as the e-fire safety courses. More information below in the **Imperial College Safety Courses and Booking** section.

When a user is inducted into the cleanroom they must submit their hazardous local area induction as proof of their induction to the cleanroom. To do this, from the link bellow, navigate using the top bar “My Health & Safety Training Records” > “Health & Safety Inductions” > “Add new induction record” Then fill out the form making sure to select local induction in the drop down bar.

Once inducted into the cleanroom users must read and submit to My Training the Cleanroom General risk assessment, located on the nanofabrication sharepoint under Cleanroom Safety-> Risk Assessments.
To submit navigate from the link bellow to “My Health & Safety Training Records” > “Procedural and Equipment Safety Training” > “Add new procedural/equipment training record”.

After a user is trained on a piece of equipment in the cleanroom, they should submit the risk assessment for that equipment as Equipment Safety Training. These risk assessments are found on the Sharepoint site. Many pieces of equipment are covered under the cleanroom general risk assessment.

When a user starts a new technique for themselves in the cleanroom, they should first create a risk assessment and a COSHH form for the technique. This can be based upon previous risk assessments and COSHH forms but must be adjusted for the minutiae of the user’s specific process.

https://imperiallondon.sharepoint.com/sites/serv/SafetyDpt/Training/SitePages/Home.aspx

More information on Hazardous Area Inductions can be found here:
https://imperiallondon.sharepoint.com/sites/fons/faculty/safety/SitePages/Laboratory-Hazardous-Area-Induction.aspx

Imperial College Safety Courses and Booking

The college offers many courses to aid students and staff to work safely within the college and within laboratory environments. Below is listed several courses that are mandatory for the use of the cleanroom and chemistry laboratory. These courses should be enrolled upon by the user as soon as possible.

- Hazardous Substances Training (Formerly COSHH)
- Fire Safety and Awareness Training e-Learning course
- Compressed Gases and Connecting Gas Regulators e-learning
- Compressed Gases and Connecting Gas Regulators
- Risk Assessment Foundation Training (RAFT)
- Fire Safety and Awareness Training e-Learning course
- Fire Prevention and Fire Safety at Work
- Imperial College Guide to Fume Cupboards

Other very useful courses extremely useful courses for but not mandatory for cleanroom access:

- Cryogenic Liquids and Decanting Liquid Nitrogen e-learning
- Cryogenic Liquids and Decanting Liquid Nitrogen
- Introduction to Laser Safety - e-Learning
- Safe Use of Vacuum Pumps

http://www.imperial.ac.uk/staff-development/safety-training/safety-courses-/

College Health and Safety Info

The college provides detailed information upon many subjects that will need to be addressed during working at Imperial. There are two main locations for this, the Imperial Safety Site:

https://www.imperial.ac.uk/safety

And the imperial faculty of natural sciences health and safety site

https://imperiallondon.sharepoint.com/sites/fons/faculty/safety

Latest Cleanroom Code of Practice Document

The most up to date copy of this document can be found at this location on the Imperial site: http://www.imperial.ac.uk/experimental-solid-state/cleanroom/

2. Cleanroom Opening times and After-Hours Policy

Opening Hours

- **Cleanroom "core work hours" are Monday to Friday 0900-1700.**
- The opening hours for the college are 0700-2400 every day.
- Monday to Friday from 0700-0900 then 1700-2300 are cleanroom "after work hours". (Senior users only)
- No entry to the cleanroom after 2230.
- Weekend work in the cleanroom must be applied for. (Senior users only)
- Cleanroom is closed during college closure dates – e.g. Christmas Day etc. These dates are specified here:

http://www.imperial.ac.uk/human-resources/procedures/leave/annual-leave/college-closures/

After Work Hours 0700-0900 and 1700-2300 Monday-Friday.

- **After hours working is restricted to 'senior' cleanroom users,** who may use the cleanroom but are required to adhere to the following protocols without exception. Failure to comply with these protocols will result in disciplinary action.

Protocols for After Hours Work

- Only Senior Cleanroom users can carry out independent work inside the cleanroom during After Hours Work.

- Other registered Cleanroom users may work inside the Cleanroom during After Work Hours only if they are accompanied by a Senior Cleanroom User who is aware of their presence and the activities they will be performing.
- For all After Hours Work a "Buddy system" must be in place. A buddy must be someone in college who is able to perform a visual check on the cleanroom (so they must have access to the Blackett building). The buddy system should be implemented as follows:
    - Before going into the cleanroom for after-hours work, senior users are required to let their buddy know and provide and estimated exit time for the cleanroom
    - If the user does not contact the buddy at the exit time the buddy should try to make contact to check on the user and arrange a new exit time if necessary. (Cleanroom number x47707)
    - If contact cannot be made the buddy should come to the cleanroom and perform a visual check.
    - In case of accident, the cleanroom buddy will need to contact college security immediately (x4444 or from mobile 02075891000).
- In addition to the buddy system the college Safe Zone app should be downloaded and run with a timer. Please contact the cleanroom manager for details.

After Hours Allowed Operations

When working in the cleanroom after hours it is important to understand that the work that can be done is restricted to processes that are deemed "safe". There is an inherent increase in hazardousness of processes "after hours" due to the increased isolation and reduced response time in emergencies.
Before processes are done after hours the risk assessments and COSHH forms of the user for the processes should be reviewed to ensure adequate attention is paid to lone working and how this effects the process and what extra protocols are needed (i.e. buddy system)

The following are a list of processes approved for after hour use in conjunction with the above protocols.

- Lithography: Vacuum bake, Adhesion Promoter/Photoresist spinning, baking, mask alignment/exposure, development, microscope inspection, plasma Asher.
- Operate sputtering deposition system.
- Operate metrology tools, Alphastep, Dektak.
- Microscopes.
- Wire bonding.
- Small volume (<10ml) solvent work.

After Hours Restricted Operations

The following operation require another senior Cleanroom user to be present (not remotely) due to the potential for and emergency situation requiring immediate assistance. Both users are required to wear Personal Protective Equipment (PPE).

- Hot/Strong acid/base chemical work.
- Heated Solvent work.
- Large Volume (>100ml) solvent work.
- Highly toxic chemical work (<10ml).
- Equipment maintenance.

3. Cleanroom User/Senior User Application Process

Who is allowed to register to the Cleanroom

- Academics.
- Post-doctoral research assistants (PDRAs).
- Long term visitors.
- PhD students.
- Masters students authorised by supervisors.

Registration: Imperial College Users and Long-term Visitors

- Email Cleanroom technician David Mack and request to use the cleanroom.
- Complete the cleanroom registration form.
- Read and sign the cleanroom code of practice (this document).
- Attend a cleanroom induction with David Mack.
- Fill out local laboratory induction and submit it to My Training.
- Read and submit General laboratory risk assessment for Cleanroom from nanofabrication sharepoint, sign and submit it to My Training
- Be appointed a mentor by your supervisor. The mentor must be an experienced current cleanroom users. The mentor must accompany you for a minimum of the first 3 visits after the inductions. This will continue until such time as you are considered proficient by your Supervisor.

Entry for Visitors (including undergraduates)

Short term visitors and undergraduates must be accompanied by a cleanroom user who is a member of staff or a postdoctoral researcher (not a student). The cleanroom user is responsible for the safety of the visitor and at no time should the visitor be left alone. The short term visitor (including undergraduates) may carry out limited work, providing the member of staff assigned to the visitor is satisfied that they are competent to carry out the process.

Before bringing in a visitor, the cleanroom technician David Mack should be contacted, and the visit should be discussed.

Application to be Senior Cleanroom User

Users can apply to become senior users once they have a minimum of 6 months cleanroom work experience from after they are signed off by their mentor.

Applicants should email the cleanroom technician to arrange a senior user application meeting.

In the meeting, the user will be quizzed on their knowledge on cleanroom protocol covering safety, best cleanroom practice and documentation. This will then be discussed with the cleanroom committee where their input will be taken.

4. Permissible Stationary in the Cleanroom

To keep particle count in the cleanroom at an acceptable level it is very important to consider the objects that are brought into the cleanroom. Typically, anything that cannot be wiped down with IPA wipes is likely to be not suitable. Below is a list of acceptable and prohibited items. If you have, any doubts ask the cleanroom technician David Mack.

Allowed

- Cleanroom logbooks
- Cleanroom Paper
- Ball-point pens
- Sealed plastic document bags
- Phones in sealed phone bags
- Tweezers and similar tools
- Wafers
- Material with smooth hard surfaces

Prohibited

- Catalogues/magazines/manuals
- Cardboard/Cardboard boxes
- Laptops
- Pencils, erasers, felt-tip pens
- Post-it notes, paper or note books.
- Food, chewing gum
- Make-up
- Anything that would create particles

5. Entering the Cleanroom and Gowning Requirements

Pre-Gowning Requirements

- Smokers must wait 30 minutes after smoking before entering the cleanroom.
- Footwear that fully covers the foot must be worn with socks or similar. NO sandals/open toe shoes.
- Trousers or other full leg covering are to be worn.
- No makeup is allowed in the cleanroom.
- Food (including chewing gum) and drinks must not be taken into the cleanroom.
- Avoid wearing contact lenses as these can adsorb vapours and trap chemicals between the lens and your eye. In the case of wearing contact lenses the user must wear goggles in the place of safety glasses.

Storage of Outer Clothing and Excess Material

Outer clothing (caps, jackets, etc.), books, bags and any non-approved materials (see below) should be left in your office or in the cleanroom office.

Please note that some items worn under the cleanroom overalls will interfere with the effectivity of the garment. These include but are not limited to, hoodies and large collared shirts. These cause the hoods to ill fit the overall.

Gowning

- **Show you are present on the IN/OUT board**. This is a safety requirement in the case of an emergency.
- To enter the cleanroom atrium you must **put on shoe covers, a hair net and beard cover** where necessary. These items are stored in the white bins outside the gowning room. Be sure to contain all hair inside hair net.
- Avoid stepping on the sticky mat with your shoes until you have put shoe covers over them.
- **Step on to the tacky mat and enter.**
- If necessary obtain a coverall bag, hang it up and get new overalls, hood and shoe covers from the boxes to the left of the entrance.
- **Sign In.** Remember to log-in to the cleanroom by signing the logbook on the changing bench.
- **Put on a hood.** Ensure a snug fit and proper face/neck seal.
- **Step into coverall.** Be sure the sleeves and upper garment do not touch bench or floor. Tuck the hood inside coverall before zipping up and fasten all the snaps.
- **Put on boots.** This is done one at a time seated on the gowning bench. Once a foot is booted it should be placed on the cleanroom side of the bench but never before. Never pass the bench area with uncovered shoes.
- **Put on safety glasses**. These are always to be worn in the cleanroom.
- **Put on second pair of gloves**. These are worn to cover the cuff of the cleanroom suite.
- **Check yourself in the mirror.** You are looking for continuous body coverage. Look for gaps between the hood and suit, suit and shoe covers, suit and gloves.
- Use IPA wipes to clean any items that you are taking into the cleanroom.
- **Enter.**

Leaving the Cleanroom and Laundry

- Remove glasses. Place back in glasses back in your garment bag.
- Remove outer gloves. Place in bin.
- Remove boots. One at a time, swinging legs over bench to the entrance side.
- Remover cover all. Do not contact the floor and then return to garment bag.
- Remove hood. Be careful not to dislodge or remove your hair net. Place hood in garment bag.
- Remove final pair of gloves.
- Wash hands.

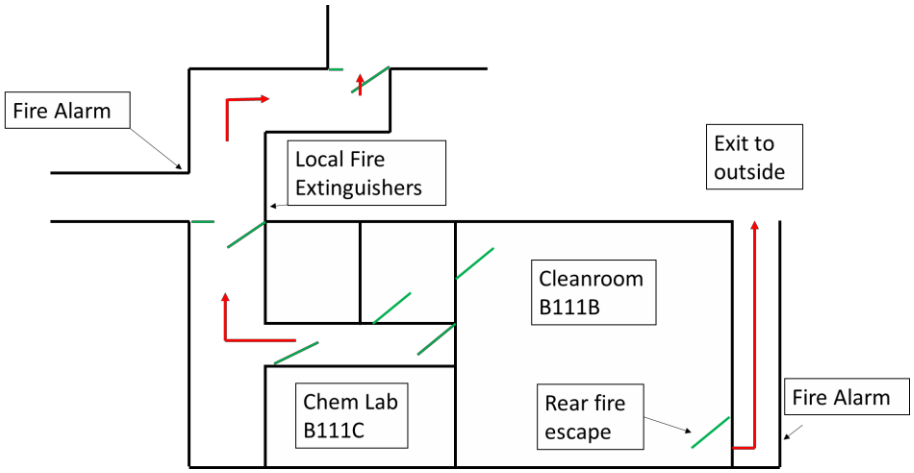
- Sign out of cleanroom.
- After exciting atrium, remove used shoe covers and hair net and place them in the labelled bin.
- If your cleanroom suit is dirty, place it inside the blue or orange bag located in the cleanroom office for laundry.

6. Emergencies in the Cleanroom, Fire, Spillage etc.

When working in the cleanroom a lot of attention is often taken to maintain a low particle count and a high cleanliness level. However, the priority is always user safety. Once things start to go wrong in emergency users must take whatever steps have been decided in their risk assessments and COSHH forms quickly and without hesitation. It is therefore very important that you make sure you have read or produced and submitted (to My Training) risk assessments and COSHH forms for all processes that you undertake in the cleanroom.

Fire Procedures (Fire, Alarms and Evacuation)

- It is a requirement that all users do the e-fire safety college safety course and the practical fire safety course. See Introduction and useful links section for details.
- The nearest fire alarm point for the chemistry laboratory B111c is immediately outside of the double doors to the B111 entrance. The nearest fire call point for the cleanroom B111b is outside the **rear** emergency exit.
- The nearest CO2 and foam fire extinguishers are immediately outside of the double doors to B111 entrance, use them ONLY if you are trained for their usage and you feel confident to do so.
- In the event of a fire in the cleanroom B111b, exit via the rear door of the cleanroom. This leads directly outside of the building.
- In the event of a fire in the chemical laboratory B111c, exit via door and follow the fire exit signs along the corridor to the main stair well. Take the stairs one floor up and exit the building.
- Personnel who have attended the college fire prevention course may attempt to put out a **small** fire as long as they do not put themselves at risk.
- If you or those with you cannot easily tackle the fire, activate the buildings fire alarm and evacuate.
- When out of the building inform fire coordinator or security of any necessary details. These can then be passed to the fire brigade.
- If the fire alarm sounds you must follow the standard evacuation procedure.



First Aid, calling for an ambulance and going to hospital

First aid. First aiders can be helpful if you have injured yourself and need help addressing the injury. Imperial's first aiders are trained in CPR and addressing minor wounds. Contact details for the closest first aiders are on the wall outside the cleanroom. David Mack the cleanroom technician is a first aider and will often be closest.

First Aiders are not trained to administer chemical related first aid. Therefor where specific first aid requirements are associated with your chemical you must ensure that you know exactly what to do rapidly.

If you require an ambulance or general first aid call security on ext 4444 on an internal phone or 02075891000 from a mobile. This is the fastest way to get an ambulance and should be used in place of 999 on the campus.

If you need to go to hospital you will need to take your risk assessment/ SOP and the relevant chemical safety data sheet with you. If you have used Diphotorine remember to tell the medics.

Chemical Incidences

You may not always be able to see or smell a hazardous substance, or feel its effects until hours, months or sometimes years afterwards. It essential that you always follow safe working practices in the Wet Benches, recirculation fume hood and never use hazardous substances in the Laminar flow cabinets. If you think there is a fault with one of the wet benches or fume hood, please report it immediately to the lab manager.

User Exposure

- **Skin Contamination.** If acid or base use diphoterine spray to neutralise it. This should be followed by rinsing it under water from the sink. Then ring the local first aider. A check at hospital may also be required depending on the nature of the chemical. Take the chemical Safety Data sheet with you. You can ring 4444 for a collage phone or 020 7589

1000 from mobile to obtain an ambulance, but remember that Security staff are not trained chemical first aiders.

- **Inhalation** remove yourself, or an affected person to fresh air immediately, and call for first aid.
- **Eye splash** wash eye immediately in the Clean Room the eye wash is to the right of the alpha step, or on the right of the Chemlab door. Irrigate the eye for at least 15 minutes; obtain first aid and an eye check at the hospital may also be required depending on the nature of the chemical. Take the chemical Safety Data sheet with you.
- **Eye splash with Acid or Base** wash eye immediately in diphoterine solution (orange bottle) to neutralise it. Use the entire container. Follow this up by irrigating the eye for at least 15 minutes. Obtain first aid and eye check at the hospital may also be required.

- **Glove Contamination** remove gloves immediately and carefully, turning them inside out as your remove them to avoid contaminating anything else and then dispose of as hazardous waste.
- **Gown Contamination** wipe off small splashes of contaminant, dispose of wipes as contaminated waste; remove as soon as possible. For a large spill, you may need to remove your gown immediately, being careful not to contaminate your clothing or anything else. Dispose of gown as hazardous waste.

Smelling or seeing fumes escaping from cabinets

Tell everyone else present and leave the room immediately. Most people can only smell chloroform when it is 100 x over the safe limit.

Spillages

If the chemical is toxic by inhalation and is volatile, you must ensure that you and others in the room evacuate immediately. As the cleanroom has 20-40 air changes an hour, the fumes will dissipate in about ~10 minutes and you can return later (after at least an hour) to clean it up. You should contact the cleanroom manager. If the chemical is also toxic and corrosive by skin contact, you must avoid touching it or contaminated wipes etc. even with gloved hands.

The spill kits are located kept on top of the benches next to the wet benches and laminar flow hoods These comprise: BDH absorption granules for mopping up spills, Binders (changes liquids to gels), and Trivorex powder (for neutralising and absorbing spills).

- **Spill in wet bench** wipe up anything left on grid, and use water to rinse it down the sink.
- **Acid spill in acid fume hood** neutralise with Trivorex and after 5 minutes dispose of neutralised powder in the bin.

- **Floor spill (small < 10 ml)** – do not dilute the spill. Immediately, use a 'White Wipe' to absorb it and then carefully wipe the floor with a wet (water) wipe. Allow wipes to dry in fume hood then dispose of into bin.
- **Floor spill (large)** if volatile, evacuate and isolate the room immediately to allow vapours to dissipate and prevent others from entering; return after one hour to continue the cleaning up process. Do tread into, wipe up or dilute the spill. Use "Binders" which binds most liquids into a non-flowing gel. They are kept on top of the benches next to the wet benches and laminar flow hoods in the clean room. BDH spillage absorption granules and a chemical binder for all sorts of chemical spills (including HF) are there. You may also use trivorex neutralising/absorption powder.

Instructions for Trivorex: first encircle the spill with Trivorex to stop it spreading, then smother the spill with it. The Trivorex powder will immediately change colour but after about 5 minutes it will change back to the original green yellow colour. Once this colour change has occurred, the neutralised powder can be scooped into the bin and disposed of as hazardous waste.

7 Working in the Cleanroom

7.1 General Rules

- Working hours (see Chapter 2).
- You must have an induction submitted to My Training documenting training on any equipment you are using. The following equipment is exempt:
    - Hot plates
    - Spin coaters
    - Plasma Asher
    - Nitrogen gas and compressed air guns
    - DI water
    - Ultrasonic bath
    - Microscope
    - Vacuum storage
    - Balance
- Several pieces of equipment in the cleanroom and chemlab require venting through the LEV system. Before use of these pieces of equipment please contact the cleanroom technician.
- The Maximum number of users at any one time in the cleanroom must not exceed 10. **(due to current covid regulations this is now set at 2)**
- All equipment usage must be logged in the appropriate log books (in addition to your own notes) along with any problems and unusual occurrences, which should also be brought to the attention of the equipment steward and the lab manager.
- Always clean your work area before you leave the cleanroom. Thoroughly rinse any glassware you used with an appropriate solvent then either isopropanol (IPA) or ethanol, then finally DI water. Store upside-down at the appropriate locations.

- If you move away temporarily to do another task, always leave a written sign by your work in the wet bench or lab bench. Use a whole piece of cleanroom paper or folded wipe.
- Never cut or tear any cleanroom paper or cleanroom wipes. This will create particulates.
- Always wipe up any spills or splashes no matter how minor and clean the area.
- Any solution and vials left on hotplates or in wet benches should be labelled with your name, the chemicals present and the date. If this information is not present then the vials will be considered as chemical waste by those on cleanroom duty.

7.2 Using Equipment

In this section we will go over some of the safety consideration of some of the equipment that is covered in the general lab induction. This should be looked at in conjunction with any standard operation procedure present for that equipment.

Hot plates

Hotplate Safety

- Careful considerations should be made for the materials and solvents heated on hot plates. Flash points and information on combustibility of materials are in MSDS.
- A hotplate may still be hot from its last use. Always assume the hotplate may be already hot.
- Keep chemical volumes to a minimum.
- Some chemicals will need to be contained within the fume hood when heated if they pose a risk to users.
- Always leave a note with unattended hotplates with your Name, Chemical and Date.
- Keep flammable solvents and materials away from hotplates.

Hotplate House Keeping

- Make sure you turn off hotplates after use.
- Wipe down hotplates after use. DI water and cleanroom wipe.
- Move hotplates out of wet benches after use.

Spin Coaters

Spin Coater Safety

- The spin coater lid is a pinch point that can trap fingers. Always be careful when closing the lid.
- Spin coaters must always be used inside wet benches as you must use uncontained solvents in them.
- Always use a closely fitting chuck on the spin coater and that the o-ring is clean allowing for a good seal between sample and chuck.

Spin Coater House Keeping

- The spin coaters are easily damaged by allowing anything to go down the vacuum line which holds the samples in place on the chuck. This damage is permanent! Spin coaters have to be sent back to the company at a cost of several thousand pounds.
- Spin coaters should be wiped down between each spin cycle and thoroughly cleaned with a suitable solvent at the end of your work.
- Spin coaters have spin coater liners in the lids that should not be disposed of as they are reusable after cleaning.
- Solvent should never be sprayed directly into the bowl as you risk getting solvent into the vacuum line.

Plasma Asher

Plasma Asher Safety

- Flammable objects should not be placed inside the plasma asher.
- Extended ashing can heat up substrates and sample carrier. This should be taken into account when handling samples.
- The asher uses oxygen from an external line that comes into the cleanroom next to the asher. This poses a hazard, flammable material should be kept away from this oxygen line.
- Remember to always turn off the oxygen line after use!

Plasma Asher House Keeping

- Do not leave samples inside the asher.
- Do not put incompatible materials into the plasma asher.

Ultrasonic bath

Ultrasonic Bath Safety

- Never put small vials directly in the ultrasonic bath cages as they will fall over. They should be placed in a suitable beaker containing DI water.
- Always cover beakers with parafilm before placing in ultrasonic bath.

Ultrasonic Bath House Keeping

- Avoid spilling material/solvents into the bath water.
- Do not leave samples in the bath unnecessarily.
- The water in the bath should be changed every week by the users on cleaning duty.

Microscope

Microscope Safety

- The microscope has no ventilation and therefor samples that have exposed solvents on them should not be used.

- Care should be taken to not crash the objective into samples as this will damage and contaminate the objectives.

Microscope House Keeping

- Do not leave samples on the microscope.
- Remember to turn off the lamp once you are finished.
- Never use dirty gloves on any of the computer keyboards and mice in the cleanroom.

Balance

Balance Safety

- Extraction fan must be turned on when open containers of powder are inside the ventilated box.

Balance House Keeping

- Cleanroom wipes should be placed down inside the ventilated box to catch any spillage.
- Powders should be added to weighing receptacle outside the weighing chamber.
- Weighing area should be wiped down with DI water after use.

Alpha Step/Dektak

Alpha Step/Dektak Safety

- The balance tip should never be lowered without a sample loaded onto the carousel. The tip can be damaged.
- There is no fume extraction on for the profilometers therefor samples should not produce hazardous vapours.

Alpha Step/Dektak House Keeping

- Clear your sample from the systems after use.
- Report any damage or error to the cleanroom technician.

Light Exposure Systems – ELC-500, UVGL-58, UV 250.

Light Exposure Systems Safety

- Light exposure systems can be harmful to eye site. Do not look directly at unprotected light sources.

Light Exposure System House Keeping

- Do not leave samples in systems after use.
- Report any damage or error to the cleanroom technician.

Fluoromax/UV vis Spectrometer

Fluoromax/UV vis Spectrometer Safety

- Both spectrometers contain Arch lamps. These can explode and should always be handled with safety glasses and nitrile gloves.
- Thin film samples should be handled with care and loaded with gloves.
- Liquid samples should be filled in the fume hood, sealed and loaded using all correct PPE for solution processing.

Fluoromax/UV vis House Keeping

- Do not leave samples in systems after use.
- Report any damage or error to the cleanroom technician.

Ovens

Ovens Safety

- Constance of oven will be hot. Care should be taken when loading and unloading things from the oven
- Flash points of any solvents and chemicals that go in the ovens should be considered and can be found on the materials MSDS.
- Do not place sealed containers inside the oven.

Ovens House Keeping

- Use Al foil to protect the inside of the ovens from spills.
- Always clean up any contamination from the oven

Wirebonder

Wirebonder Safety

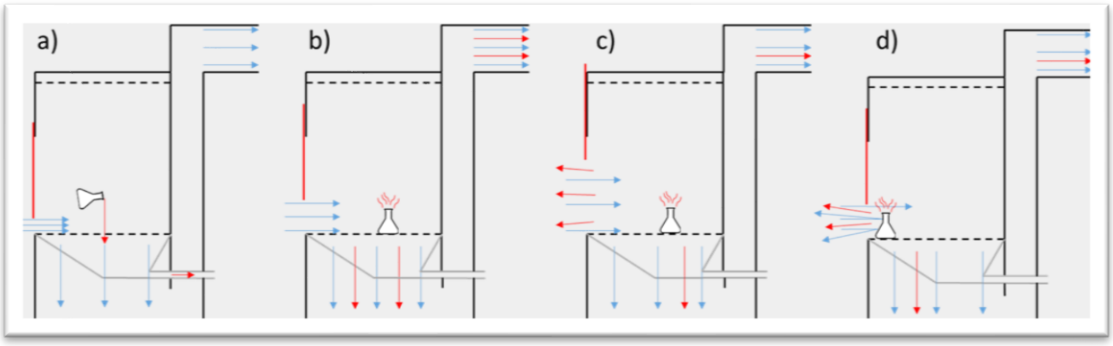
- Heating plate on for the wirebonder gets hot. Care should be taken when using it.
- Bonding needles are sharp and should be disposed of as sharps.
- Bonding needles are damaged by moving the substrate when needle is engaged.

Wirebonder House Keeping

- Do not leave samples mounted on the system.
- Use only suitable materials on the heating plate.

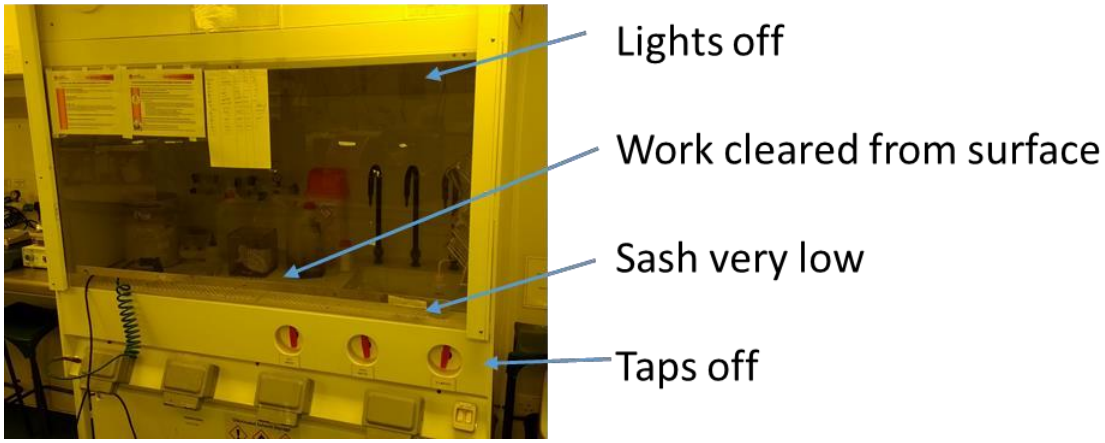
7.3 How to Use a Wet bench and Fume hoods.

In the cleanroom wet benches are an extremely important part of the safety equipment that we use to prevent exposure to dangerous chemical and fumes. Below is a series of schematic drawing of the air flow through a wet bench to illustrate how it functions. The blue lines show air flow and the red lines show the movement of hazardous liquid or fumes.

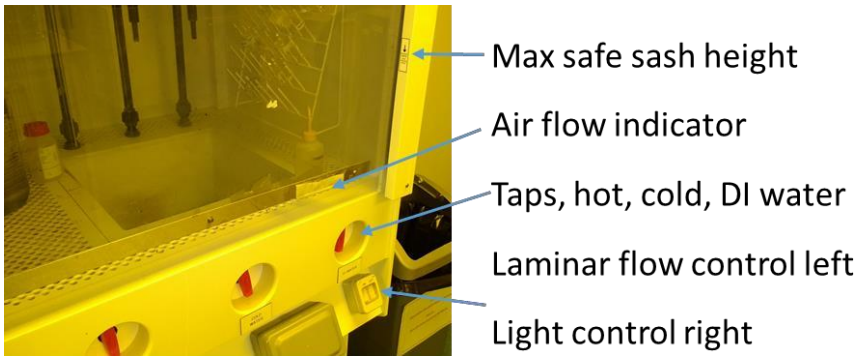


Ducted wet benches and fume hoods work by drawing air into the hood through gap below the sash. This draws air in through the gap bellow the sash. For the wetbenches in the cleanroom when the hood's sash is pulled low as see in in **a)** the flow rate though the gap becomes faster and harder to disrupted. The makes it more difficult for fumes to escape out from the hood. The difference between a wet bench and a fume hood is that a wet bench is built over a sink as show in **a)** this means that any spillage will flow away from the user down the drain. Any spillage should but washed away by large amounts of water by the user. The wet benches in the cleanroom have a maximum safe working height where the hood it most accessible but maintains good protection for the user from chemicals in the hood as shown in **b)**. It should be noted that the sash should be kept a low as possible while the user can comfortably work and should never be raised above the save working height when open chemicals are present in the hood. If the hood sash is pulled too high fumes from within the hood will escape out of the hood and pose a health risk to everyone in the lab as shown in **c)**. Lastly when objects are placed too close to the lip of the wet bench it will block the flow of air causing fumes to escape the bench as shown in **d)**.

Closed down wet bench

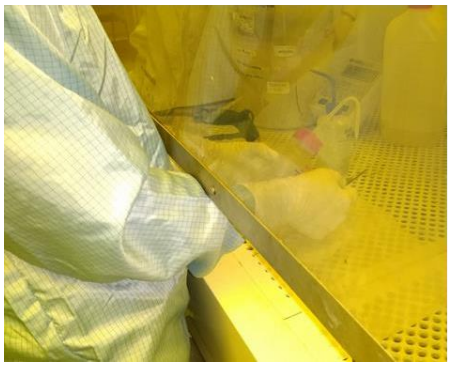


Fume Hood Controls

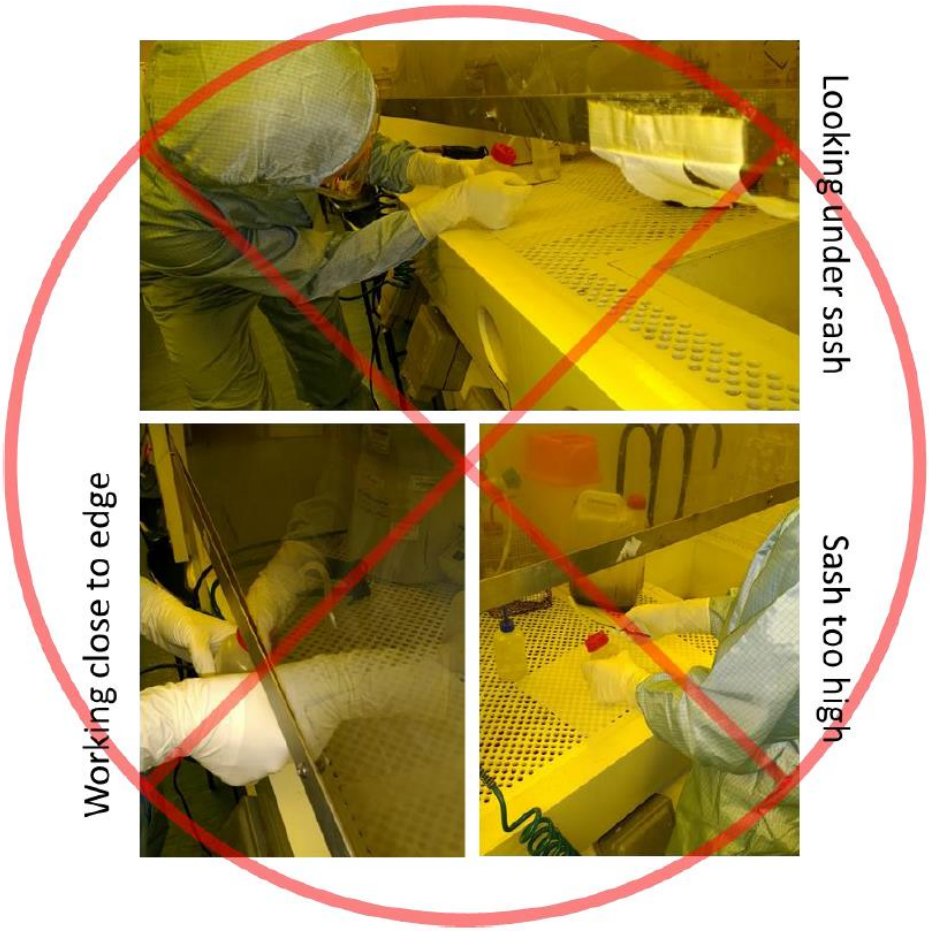


NOTE: The laminar flow should never be used with hazardous chemicals as it compromises the protection that the hood overs.

Safe working at wet bench/fume hood



- Sash low as comfortable
- Work done way from edge of the bench
- Sash between users face and work
- Hood light on for visibility
- Full PPE worn



Summary for wet bench use

- If you smell something in the cleanroom someone is making a containment mistake.
- Wet bench should be left in closed state after use with the lights off.
- Always check the flow indicator before using wet bench. If no flow contact cleanroom technician straight away.
- All material to be used in the wet bench should be contained safely before entering and being removed from the wet bench.
- Work should take place as far from the lip as possible to avoid spillage of chemicals out side the hood and escape of fumes.
- When open chemicals are in the bench the sash should be kept below the safe working height limit and beyond that should be as low as comfortably possible.
- Always keep the sash between you and your work. It cannot protect you from splashes otherwise.
- Used damp wipes should be left to dry in the drying cage inside the fume hood.
- If chemicals are spilt in the wet bench the spillage should be flushed down the drain with plenty of water.

Laminar flow hood

The purpose is to provide additional ***product*** protection to increase the Clean Room category from level 6, to Level 5. The laminar flow has only one mode of operation – a horizontal flow of air from the back of the cabinet exiting via the front of the cabinet into the room and onto the operator.

They must NEVER be used for work with hazardous substances as these will be carried straight into the operator's breathing zone.

Recirculating fume hood (in the cleanroom)

Recirculating fume hoods contain an expensive (and difficult to change) charcoal filter, which absorbs chemicals and filters particulates. They are unsuitable for: very toxic substances, very high volumes of contaminants and unknown or highly volatile reactions. Filters must be changed promptly if this ever this type of misuse occurs or when blocked by particulates. Otherwise toxic substances will not be absorbed by the charcoal but instead pass straight through the filter into the room where you will inhale them. Please tell the lab manager immediately if you think there is a problem.

Users require specific authorisation from the lab manager before they can use this hood.

The list of common suitable solvents for the recirculating fume cupboard is attached to the side of the cupboard.

7.4 Hazards of Chemicals and how to Control Them

Chemicals pose one of the main risk and dangers users face while working in the cleanroom. Some of the chemicals are extremely toxic and many can cause long-term health effects from exposure. By following the following advice the risks can be reduced to an acceptable level for safe work for yourself and users around you.

- All chemicals should be part of a COSHH form and processes part of a risk assessment to standardise the approach the user takes with the chemical. These must be submitted to the my training web page.
- MSDS should be read and understood for each chemical being used and should be submitted to the MSDS archive on the sharepoint if they do not already exist there.
- Chemicals should be stored in suitable locations inside the cleanroom.
- Chemicals should be sealed when outside the fume hoods, and wiped down before being removed from hoods. Parafilm should be used to aid sealing in most cases.
- ALL chemical work must take place inside wet benches or suitable fume hoods or equipment with in built ventilation to extract fumes away from users.
- Chemicals should be disposed of into suitable waste containers inside the wet benches where the process is taking place. They should not have to be transported to be disposed of.
- To prevent spillage vials should be enclosed in secondary containment which should only be opened again in a fume hood.
- Correct wet bench procedure should be followed to minimise fume exposure risk.

- Some chemical work e.g. acid work, requires extra PPE to be worn by users on top of the standard PPE that must be worn at all times in the cleanroom.
- Lastly, chemical work should be slow and deliberate. Always think about what you are about to do before you do it.

7.5 Brining in and Storing Chemicals in the Cleanroom

Bringing in New Chemicals

1. Check that the chemical does not already exist in the cleanroom.
2. Notify Cleanroom manager of intention to bring in new chemical (BEFOR ORDERING).
3. Make sure that the chemical is analysed in appropriate COSHH forms for your processes. These should be submitted (if new) or resubmitted (if previously existed) to My Training
4. Make sure that a copy of the relevant MSDS sheet is uploaded on the sharepoint cleanroom MSDS archive.
5. Enter the chemical into the Quatzy inventory and put the serial number of the entry onto the bottle.
6. Bringing a chemical into the cleanroom the chemical log should be signed in the atrium and chemical should be stored in a suitable location in the cleanroom.

Storage and Transport Rules

- A logbook is available to write down the solvents and chemicals taken into the clean room. The logbook is beside the user sign-in book in the gowning room.
- Unopened bottles of solvents must be stored in the two cupboards below the UV-Vis and the Fluoromax in the ChemLab (Room B111c) in the appropriately marked cabinets (non-chlorinated solvents on the left hand side and chlorinated solvents on the right hand side).
- Additional space for unopened chemical bottles is available under the fume hood in the far end of the ChemLab in the appropriately marked cabinets.
- Acids and bases must be segregated and not stored with any solvents.
- Open bottles of chemicals are to be stored under the cleanroom wet benches in the appropriately marked cabinets (non-chlorinated or chlorinated), or in the small white cabinet next to the balance (small bottles only).
- Non-chlorinated solvents are stored in the left hand drawer under the wet bench in the cleanroom. Examples of non-chlorinated solvents include; alkanes (hexane, dodecane), ketones (acetone, butanone), alcohols (ethanol, isopropanol (IPA), methanol) and other solvents that do not contain chlorine or fluorine.
- Chlorinated solvents are stored in the right hand side drawer under the wet bench in the cleanroom (next to the fire escape). Examples of chlorinated solvents include chlorobenzene, dichlorobenzene, chloromethane, and chloroform. Fluorinated solvents, such as tetrafluoroethylene, are also stored here in the chlorinated solvent drawer.

- Acids are stored in the drawer below the wet bench containing the ultrasonic bath, on the left as you enter the clean room. Examples of acids that are stored here are hydrochloric acid, nitric acid, orthophosphoric acid, and etchant solutions.
- The chemical bottles should be wiped down with 'White Wipes' before placing in the cabinet.
- The location of the chemicals storage should be selected on the Quatzy entry for the chemical.
- If transporting large (>500ml) 'Winchester' chemical bottles, a metal wire carrier (available in the cleanroom and in the gowning room) must be used (and appropriate PPE must be worn) to avoid dropping the bottles. The metal carrier can carry two bottles at the same time and this leaves one (ungloved) hand free for opening a door. Bottles must be placed in the proper storage cabinet and the carrier returned to its proper location.
- Certain solvents, in particular diethyl ether and tetrahydrofuran (THF), can form explosive peroxides on storage and therefor have a limited storage lifetime. The lifetime of any chemical must be specified in the risk assessment and the date of expiry must be written on the bottle.
- Hydrogen Peroxide must be stored in the fridge.
- All personal chemical stock can be stored in the white chemical storage cupboard and in your drawer for certain items, i.e. non-volatile solvents, formulations and solids. Liquid chemicals must be 1L or less and solids must be 500g or less. Examples include volatile solvents, thiols, and silanes. All items must be clearly labelled with the chemical name, your name, and the date of receipt / opening, or they will be removed. COSHH forms must be submitted to My training

7.6 Waste in the Cleanroom

Non Hazardous Waste	Chemical waste			Sharps		Reagent Bottles
Dried wipes, Dried gloves, paper towels clean lids etc.	Non Chlorinated Solvent waste	Chlorinated Solvent waste	Custom waste produced by users not suitable for non-cl/cl waste.	Clean Glass and broken glass	Contaminated sharps (needles, broken glass, pipettes & pipette tips	Cleaned out glass/plastic bottles.
						

Liquid– non hazardous liquids

-Chemical waste bottles ,once full should be stored in B111C chemistry waste cabinet.
-For custom waste the cleanroom technician should be notified.
-Sharps bins should be stored outside the B111 chem lab in the gray box.

- When a chemical bottle is empty (after pouring out the last of the chemical), it is your responsibility to dispose of the bottle. You must rinse the bottle with DI water at least 3 times; the rinsate can be poured down the drain. After rinsing, cross out the labelling with a pen, throw away the cap, then place the bottle in the waste bottle area inside the grey plastic tub near the entrances to the ChemLab and cleanroom office.
- If a chemical bottle is empty and there are no others in the cleanroom (under the wet benches) it is the responsibility of the user to get a new one from the Chemlab or notify someone to retrieve one for you (i.e. leave a note on the whiteboard inside the gowning room). If there are no further ones available stored in the ChemLab, it must be noted on the whiteboard in the clean room office and either 'Cleanroom Technician' or the person on the clean room rota informed.
- All chemicals on the wet benches must be properly labelled (chemical, your name and the date) and covered whenever you are not actively using them. This is not optional, this is in the event you leave the wet bench for any reason that unknown chemicals are not left on the bench since this could be a hazard to others. When you are using any particularly hazardous chemicals please inform other clean room users.
- Label your glassware (beakers, covers) and only use dedicated labelled glassware for the materials specified on the label (e.g. substrate cleaning in acetone). If labelled glassware does not already exist, that may be an indication that your chemical/etchant mixture etc. has not being approved by the CRC, ensure the chemicals have been approved before proceeding.

Liquid Waste

- In each wet bench there are separate large plastic waste bottles for non-chlorinated and chlorinated solvents (see list above for examples).
- Waste containers for ammonium sulphide, certain acids or bases, photoresists, microposit primer, and inorganic semiconductor pieces (e.g. Si and GaAs) waste etc. can also be found in the clean room.
- If these are full, it is the responsibility of the user to take it out and place it in the waste storage cabinet in the chemistry laboratory.
- If your waste mixture cannot go into one of the non-chlorinated or chlorinated waste bottles (e.g. it is a basic photoresist developer or an etchant), make sure that a waste bottle is available to store the waste. If one is not available, a clean, empty solvent bottle of a suitable size can be used. You can also bring your own compatible solvent waste bottles. Please ensure that any waste bottles are clearly labelled with the contents and the date when the waste was first collected.
- If you storing a chemical mixture containing hydrogen peroxide, you must use a vented cap on the container.
- Certain acid or base waste can be put down the drain after diluting with water (always add acid to water). Check with the risk assessment and / or the CRC regarding waste disposal.

Sharps waste

- Waste made up of sharp items, which could potentially cut or pierce, or potentially hazardous contaminated items should be deposited in the yellow ‘sharps’ container. The “sharps’ container can be found in each wet bench and in the fume hood in the ChemLab. Examples of items which should be disposed of in the ‘sharps’ container are: any broken glass items, any hard plastics, plastic and glass syringes, syringe filters, glass micro slides, plastic and glass vials, glass pipettes, plastic pipette tips, needles, blades and any hard items contaminated with potentially hazardous material. Not that many of these items would not conventionally be regarded as ‘sharp’ but should never-the-less be disposed of in a ‘sharps’ container.
- If a ‘sharps’ container is 3/4 full it should be closed securely and carried outside to the waste storage point near the entrance to the ChemLab and the clean room office. It is the responsibility of the user who disposes the material and those on the clean room rota to check the sharp bins and get new ones from the ‘Cleanroom office B111’ as and when it’s required.
- Small contaminated glass vials can be disposed of into the sharps bins.
- For larger amounts of waste, another method of waste disposal may be required and the ‘Cleanroom Technician’ and/or the chemical safety adviser should be contacted. It might be necessary to make a dedicated solids waste container for your process and dispose accordingly – this will all be detailed in the risk assessment.
- Only “soft” waste such as paper, gloves, aluminium foil and tissues should be disposed of in the normal bins.

- Special precautions should be taken when handling powders, as these pose a serious contamination risk, both as a chemical hazard and as a source of particulates. When weighing powders ensure that everything contaminated with powders is kept inside the plastic cover surrounding the balance. Any spills should be cleaned up immediately using a clean room wipe dampened with water. All other powder handling should be carried out in a wet bench.

Remember if you have any questions on waste disposal you can always ask the cleanroom manager. If you don't know exactly what to do ask!

7.7 House Keeping

The cleanroom only works if it is kept clean!

To keep it clean all users must take care to not clutter the work areas and storage and to not bring in anything to the cleanroom that produces particulates.

When leaving the cleanroom all work should be put away and any experimental work that needs to be left out should be in a suitable condition with a note explaining what it is, the date, your name and a contact number.

Glassware should not be left out in wet benches and should be cleaned and left to dry on the drying rack in the last wet bench.

All work surfaces should be wiped down with a cleanroom wipe and DI water after use. After use the balance area should be wiped down with DI water.

8 Common Chemicals in the Cleanroom

List of Tables:

Table 1: Common chemicals and their concentration and hazards

Chemical Type	Chemical	Formula	Concen-tration(%)	Hazards
Acids and Oxidizers	Acetic Acid	CH_3COOH	95	Corrosive\Flammable
	Hydrochloric Acid	HCl	36	Corrosive\Irritant
	Nitric Acid	HNO_3	68	Corrosive\Oxidizer
	Phosphoric Acid	H_3PO_4	86	Corrosive

	Sulphuric Acid	H_2SO_4	96	Corrosive
	Hydrogen Peroxide	H_2O_2	30	Corrosive\Irritant
Bases	Ammonium Hydroxide	NH_4OH	25	Irritant\Corrosive
	Ammonium Fluoride	NH_4F	40	Toxic\Corrosive
	Potassium Hydroxide	KOH	45	Corrosive\Irritant
	Sodium Hydroxide	NaOH	50	Corrosive
Solvents	Acetone	CH_3COCH_3	100	Flammable\Irritant
	Chlorobenzene	C_6H_5Cl	100	Flammable\Irritant
	Methanol	CH_3OH	100	Toxic\Flammable\Carcinogen
	Toluene	$C_6H_5CH_3$	100	Carcinogen\Flammable\Irritant
	Trichloroethylene	C_2HCl_3	100	Carcinogen\Irritant
	Xylene	$C_6H_4(CH_3)_2$	80-90	Carcinogen\Flammable\Irritant
	Isopropyl Alcohol (IPA)	C3H7OH	88-100	Flammable\Irritant
	Ethanol	C2H6O	89-96	Flammable\Irritant
	Dichlorobenzene	C6H4Cl2		Irritant\Hazardous to aquatic environment
	1,2,3,4 Terahydronaphthalen e			Carcinogen\Irritant\Hazardous to aquatic environment
	INDAN (Indane)			Carcinogen\Flammable
	Butanone (MEK-Methyl Ethyl Ketone)			Flammable\Irritant

Policy on Solvents

- All chlorinated solvents must be stored for disposal in labelled containers (use Chemical name and commonly used name in addition to chemical name not instead e.g. The photo resist remover 1165 , must be labelled as N-methyl 2-pyrrolidone)
- Trichloroethylene (TCE) and Trichloroethane (TCA) should be kept separately from containers containing Acetone, Methanol and Propanol. Acetone, Methanol and Propanol can be disposed by incineration but NOT TCE and TCA because these are carcinogenic.
- Keep all FLAMES away from the solvents because most solvents are highly flammable

Table 2: Common Photoresists and Polymers

Photoresist/Polymer	Name		
Polymer	PEDOT		Causes skin burns
	PSS		
	P3HT		
	PCBM		
Photoresist	SU-8:10,2002&2005		Flammable Irritant
	S1805/S1813/S1818		Flammable
	SF6		Harmful
Developer	MF 319		Irritant, Inhalation may cause irritation.
	MF 24		Irritant, Inhalation may cause irritation.

Table 3: Solvent Hazards

	Backround Information		International Chemical Safety Cards						
Solvent	**CAS**	**Molecular Formula**	**ISIC**	**EU (Annex I) Index**	**EU Classification**	**R-Phrases (Risk)**	**S-Phrases (Safety)**	**Flash Point °C**	**Auto Ignition Temp °C**
Acetone	67641	$(CH_3)_2CO$	0087	606-001-00-8	F, Xi	R: 11-36-66-67	(S2) S9 S16 S23 S33	−17	465
Butanal (Butyraldehyde)	123728	$CH_3(CH_2)_2CHO$	0403	605-006-00-2	F	R : 11-20-21-22-34-37/38-40-41	S2 S29 S33 S9	-7	198
Chlorobenzene	108907	C_6H_5Cl.	0642	602-033-00-1	Xn N	R: 10-20-51/53	S24/25 S61 S2	28	590
Chloroform	67663	$CHCl_3$	0027	602-006-00-4	Xn	R: 22-38-40-48/20/22	S36/37	Non-flammable	
Decon 90	1310-58-3	<3% KOH		N/A	Xi	R: 36/38	S24/25 S26	Non-flammable	
o-DiChlorobenzene (1,2 Ortho, ODCB)	95501	$C_6H_4Cl_2$	1066	602-034-00-7	Xn N	R: 22-36/37/38-50/53	S: 2-23-60-61	66	648
Dichloroethane (1,1-DCA)	75343	CH_3CHCl_2	0249	602-011-00-1	F Xn	R: 11-22-36/37	S: 16-23	-6	458
Dichloromethane	75-09-2	CH_2Cl_2		602-004-00-3	Xn	R40	S23 S24/25 S36/37	None	556
Dichloroethane (1,2-EDC)	107062	$C_2H_4Cl_3$	0250	602-012-00-7	F T	R: 45-11-22-36/37-38	S: 53-45	13	413
Ethanol	64175	C_2H_5OH	0044	603-002-00-5	F	R: 11	S: (2)-7-16	13	363
Hydrochloric Acid	7647010	HCl	0163	017-002-00-2	T, C, N	R: 35-37	S: 7/9-26-44	Non-flammable	
IPA (Isopropanol)	67630	C_3H_8O			Xi F	R: 11-36-67	S: 16-24/25-26-7	12	399
Lactic Acid	50215	$C_3H_6O_3$	0501		C	R: 34	S: 26, 36/37/39-45	110	N/A
Methanol	67561	CH_3OH	0057	603-001-00-X	F, T	R: 11-23/24/25-39	S: (1/2)-7-16-24-25	11-12	385
Nitric Acid	7697372	HNO_3	0183	007-004-00-1	T, C, O	R: 8-35	S: (1/2-)23-26-36-45	Non-flammable	
Toluene	108-88-3	C_7H_8	0078	601-021-00-3	F Xn	R: 11-20	S: (2-)16-25-29-33	4	480
Xylene (o-Xylene)	95476	$C_6H_4(CH_3)_2/C_8H_{10}$	0084	601-022-00-9	Xn	R: 10-20/21-38	S: (2-)25	32	463
Xylene (m-Xylene)	108383	$C_6H_4(CH_3)_2/C_8H_{10}$	0085	601-022-00-9	Xn	R: 10-20/21-38	S: (2-)25	27	527
Xylene (p-Xylene)	106423	$C_6H_4(CH_3)_2/C_8H_{10}$	0086	601-022-00-9	Xn	R: 10-20/21-38	S: (2-)25	27	528

Acid Definition and Reference Table

Acids:

1. Are typically soluble in water.
2. Are corrosive.
3. Taste sour.
4. Form salts when mixed with bases.
5. Turn litmus paper red.
6. Burn organic tissues and/or inorganic materials.

Special Considerations

Sulphuric Acid

When heating sulphuric acid, a mist will form. The sulphuric acid mist is a known carcinogen. As such, extreme care must be taken if you need to heat sulphuric acid and you should consider a safer alternative process where possible.

In all cases of chemical exposure, report the incident to the lab manager and seek medical attention immediately.

Table 4: Acid Hazards

Chemical	Symbol	Properties	Special Precautions
Acetic	CH_3COOH	Liquid and vapours cause severe burns to skin. Reacts vigorously with oxidizing agents and other acids (particularly nitric). Odour similar to that of strong vinegar	Incompatible with most other acids. **Store alone.**
Chromic	H_2CrO_4	Liquid and vapours cause severe burns to skin. Corrosive to nasal passages. Contains a suspected carcinogen.	Carcinogenic
Hydrochloric	HCl	Highly corrosive to skin, mucous membranes. Repeated exposure causes erosion of teeth. Strong chlorine odour detectable at 1-5 PPM.	
Nitric	HNO_3	Highly corrosive to skin, mucous membranes and teeth. Highly reactive with acetic acid. Reacts explosively with combustible organic or other oxidisable materials.	Use only glass containers
Phosphoric	H_3PO_4	Liquid is highly irritating to skin. Vapours are highly toxic. Contact with most metals causes formation of flammable and explosive hydrogen gas.	
Sulphuric	H_2SO_4	Liquid and vapours are extremely corrosive to skin and mucous membranes. Generates heat upon contact with water. Reacts with acetic acid.	Keep away from water

Base Definition and Reference Table

Bases:

1. Are typically water soluble.
2. Are slippery.
3. Taste bitter.
4. Form salts when mixed with acids.
5. Turn litmus paper blue.
6. Are corrosive.
7. Burn organic tissues.

Table 5: Base Hazards

Chemicals	Symbol	Properties	Special Precautions
Ammonium Hydroxide	NH_4OH	Irritating to skin and mucous membranes. Emits highly toxic vapours when heated.	

Special Chemicals:

1. Are not acids or bases.
2. Have similar properties to acids or bases.
3. Are as dangerous as acids or bases.

Table 6: Special Chemical Hazards

Chemicals	Symbol	Properties	Special Precautions
Ammonium Fluoride	NH_4F	Highly toxic and irritating to skin and mucous membranes. Emits toxic vapours when heated or when in contact with acids.	
Hydrogen Peroxide	H_2O_2	Strong oxidizing agent. Irritating to skin and mucous membranes. Reacts violently with acids and organic solvents.	**Cap with vented cap.** Do not boil in open vessels, may cause explosion
Phosphorous Oxychloried	$POCl_3$	$POCl_3$ and its vapours cause severe burns to the eyes, nose, throat, skin and mucous membranes. $POCl_3$ and water, when combined, will form hydrochloric acid and will produce a violent, exothermic reaction. $POCl_3$ is unstable at high temperatures	Keep away from water. Discard gloves discoloured by $POCl_3$. Discard yellow or cloudy $POCl_3$ as it may be contaminated.

Policy on Acids and Bases:

- When handling acids, bases and other chemicals, you MUST wear cleanroom coats, full-length acid smock/apron (worn over the cleanroom coat), safety glasses/goggles, safety

face shield (worn over the safety glasses/goggles), rubber gloves with cuff (worn over the vinyl gloves) and hard leather shoes (non-porous).

- All work with acids or bases must be done in a working wet bench.
- Acids must be stored in dedicated cabinet (Not with bases, solvents and other chemicals) usually under the fume cupboards, labelled 'ACIDS' and the name of the ACID.
- Bases must be stored in dedicated cabinet (Not with acids, solvents and other chemicals) usually under the fume cupboards, labelled 'BASES' and the name of the BASE.
- You must NOT have Acids and Bases side by side, as a violent reaction may occur.
- In general acids should not be disposed through the drain, however small amounts well diluted with water may be disposed down the drain.
- Waste Acids must be stored in clearly labelled waste containers for that particular acid **(in the case of acids which are mixed, use waste bottles assigned for that particular mixture). DO NOT MIX waste acids together.** Waste acid must be stored in separate containers in the appropriate location
- Do not attempt to neutralize acids by adding to a base e.g. Sodium Hydroxide, Store the waste acids separately
- Small amounts (less than 50ml) of acid may be disposed by adding the acid to a large quantity of TAP WATER (Remember: **ACID TO WATER**) and then poured down the drain (sink), though acceptable it is best to dispose it into its waste container.
- Waste bases must be stored in clearly labelled waste containers. Ammonium Hydroxide must be stored in its own container, clearly labelled. Potassium Hydroxide and Sodium Hydroxide can be stored together in a clearly labelled container. Positive Photoresist (usually with Acetone from stripping, cleaning etc.) must be stored separately and clearly labelled.
- Do not attempt to neutralize bases e.g. by adding to Hydrochloric acid. Store the waste bases separately.
- Small amounts of bases may be disposed by adding the base to a large quantity of TAP WATER to dilute and then poured down the drain (sink)
- Storage of waste acids must be in waste acid cabinets and waste bases in waste base cabinets (in the appropriate location), they must NOT be in the same cabinet

General Policies

- Do not use any chemical without first reading the MSDS, COSHH and Risk Assessment form
- You must be alert and cautious when using chemicals, to minimise the risk to yourself and your colleagues in the cleanroom. Since most chemicals in the lab look like water exercise extreme caution at all times. Assume all liquids are dangerous.
- Know which chemicals and containers are compatible. Some chemicals such as TCE (Trichloroethylene) cannot be used with plastic beakers; others such as Hydrofluoric Acid (HF) cannot be used with glass beakers.

- When working with chemicals, work under the fume hood (Wet bench) with appropriate gloves, apron, face respiratory mask etc. If you intend using face respiratory mask then you will be issued with specific respiratory protective equipment for which you will first need a face-fit test.
- Use DEDICATED beakers only with chemicals and/or process labelled on the beaker. Do not cross-contaminate beakers. Rinse beakers after use and dry upside down
- When mixing chemicals use only one bottle at a time (Do not hold bottles by the neck). Do not open new bottles unless an existing bottle is completely empty. Pour chemicals slowly, do not let it gulp. Remember the Triple A Rule **'ALWAYS ADD ACID to WATER'**, never the reverse. This prevents solvents splashing.
- Do not mix organic solvents with inorganic chemicals. This can result in a violent reaction or an explosion.
- Do not pour chemicals back into the storage bottles. If you pour out too much, dispose it appropriately.
- Put the cap back on the chemical bottle securely, Rinse or wipe (with a wet wipe) the outside of the bottle before you return it to its storage place
- Do not leave chemicals unattended. If you have to, clearly mark the name of the chemical (the formula alone is not enough), your name and what time you expect to return on a clean White wipe or a filter paper and leave this by the chemicals (beaker etc.)
- When using hot plates, ensure that the beaker is suitable and is smaller than the hot plate. Never use a Teflon or Plastic Beakers on a hot plate. Always monitor the temperature of the chemicals with a thermometer.
- Always cleanup your work area before you leave, emptying acid and bases into the appropriate containers and washing any beakers thoroughly with DI water and store upside down in their appropriate location
- Rinse your gloves in DI water before removing and discard in the 'Contaminated' Bin inside the cleanroom
- Where you see something unsafe (or if you are not sure), report it to the Lab Manager or your supervisor. Use common sense.
- Wear safety glasses when using the spinner (Safety glasses to be worn while in Cleanroom). Silicon wafers (and others) sometimes break during spinning. As a result pieces fly out in all directions, and this could be dangerous as broken glass. It is a good habit to wear safety glasses at ALL TIMES whilst in the cleanroom
- Wash your hands when you leave the cleanroom.

Policy on Solids

- Solids should be stored in appropriate containers with clear labelling

Policy on Mercury

- Mercury if spilt should be picked up with a mercury spill kit, stored in a properly labelled container for disposal

Appendix 1: Declaration

Declaration

Before you sign the declaration please make sure you have understood all aspects of laboratory and chemical safety.

I have read the EXSS Cleanroom Code of Practice, familiarised myself with the laboratory rules and the equipment within it.

I will adhere to all safety guidelines and safe working practices during my laboratory work as written in the Code of Practice explained to me during the chemical safety induction.

Name……

Imperial College ID No……

Signed……

Date……

Scan in an email this form to cleanroom technician