

CLEAN ROOM HANDBOOK  
TABLE OF CONTENTS

A. ARL, Orientation and Equipment Training

B. ARL Cleanroom Website

C. Policies and Procedures Summary

D. Policies and Procedures

I. Introduction

II. Enforcement

III. Access

IV. Items Allowed Into the Cleanroom

V. Pair System

VI. Visitors

VII. Procedures

VIII. Wafer Handling

IX. Tools and Repairs

X. Common Sense

XI. Habits

XII. General

XIII. Hygiene

XIV. Cleanroom Equipment Support

E. Spill Response

I. Introduction

II. Spill Response

III. In Case of a Spill

IV. Left over Spill

V. First Aid

F. Cleanroom Gowning

I. Introduction

II. Notes

## G. Cleanroom Courtesies

### I. Non-Functional Equipment

### II. Broken & Dirty Glassware/Wafers/Other Sharp Objects

### III. Labeling

### IV. Solvent & Photoresist-Soaked Materials Disposal

### V. What if I Don't Know How to Use Something, or if it Malfunctions While I'm Using it

### VI. Clean Up

### VII. Storage

### VIII. Warning others

## H. Cleanroom Rules

### I. ARL Cleanroom Facilities & Emergency Exits

## A. ARL ORIENTATION AND EQUIPMENT TRAINING

### WARNING!!!

DO NOT ENTER THE CLEANROOM OR USE ANY EQUIPMENT UNTIL YOU HAVE FOLLOWED THE PROCEDURES OUTLINED BELOW. IF YOU NEED HELP IN UNDERSTANDING THESE INSTRUCTIONS, PLEASE ASK A CLEANROOM STAFF MEMBER. THE PENALTY FOR NON-COMPLIANCE IS SUSPENSION OF CLEANROOM PRIVILEGES.

A user must be trained before he/she is allowed to operate any equipment in the ARL cleanroom. The following is the basic procedure for a newcomer to be eligible for equipment operation.

1. Participate in a cleanroom orientation. You may apply to become a cleanroom user after this mandatory prerequisite. Contact the administrative staff at [gure@fen.bilkent.edu.tr](mailto:gure@fen.bilkent.edu.tr) for the information on the [orientation schedule| Orientation takvimi aşağıda buraya girecek] and how to become a cleanroom user. After you become a cleanroom user, you will be granted cleanroom access and added to the Cleanroom user mailing list. All cleanroom-related information is circulated through this mailing list.
2. Consult with your advisor and get his/her approval on the equipment for which you should be trained. Plan one month ahead on what equipment you are going to use since the training class is offered once a month. Do not sign up for the class if you are not going to use that equipment in the near future.
3. Go to the web page <http://arl.bilkent.edu.tr> and find the name of the superuser responsible for that equipment. Then send him/ her an e-mail to sign up for a class.

The sign up is on a first-come first-serve basis. If you are unable to sign up for a class due to its limited size or no class is offered on the equipment you need, please follow the instruction to request a new class.

4. After you sign up for class, read the equipment instructions from the web page <http://arl.bilkent.edu.tr>
5. Arrive at the training site (equipment site) on time. Please bring a set of printed instructions and your cleanroom notebook with you and try to get hands on experience during the training.
6. You may ask anybody in your group who has been qualified to go over the equipment after your training session. The superuser will give you the detailed info on how to operate the equipment as well as the safety concerns.
7. You then use the equipment always with an authorized user, for at least two weeks.
8. Make an appointment with your superuser for your qualification. He will determine whether you know how well to operate that particular equipment and whether you are eligible to be qualified.

Remember: You are allowed to operate the equipment only after your superuser qualifies you. Unauthorized operation may cause equipment down and delay many research projects. If you have any equipment training-related questions, please contact the cleanroom staff.

## B. ARL CLEANROOM WEBSITE

## C. POLICIES AND PROCEDURES SUMMARY

REQUIRED ATTIRE : Hood, gown, booties w/shoe covers, masks, gloves, and safety eyewear. Bouffant caps are required for long hair.

Keep all hair and ears covered with hood or cap.

Never open your gown in the cleanroom.

Never touch your skin with your gloves. If you do, put on clean gloves immediately.

Only authorized users may enter the cleanroom unescorted.

You must not use the cleanroom alone. There should be at least one more person with you (PAIR SYSTEM)

Visitors must be escorted by a cleanroom qualified faculty/staff member.

Visitors must sign in/out in the visitor log.

No food or drink is permitted in the cleanroom.

No corrugated cardboard, styrofoam, foam rubber or non-cleanroom paper is permitted in the cleanroom.

No pencil, erasers or retractable pens are permitted in the cleanroom.

Be considerate by cleaning up your own mess, not messing up someone else's work, letting the staff know when new supplies are needed, etc.

Ask for permission before bringing anything in or taking anything out of the cleanroom.

DO NOT modify equipment without the approval of the ARL Staff.

IF YOU AREN'T SURE HOW IT WORKS, ASK BEFORE YOU USE IT!

Follow the ARL and Bilkent University Safety Guidelines.

ARL staff contact information: [gure@fen.bilkent.edu.tr](mailto:gure@fen.bilkent.edu.tr)

## D. POLICIES AND PROCEDURES

### I. Introduction

A Class 100 cleanroom is defined as having less than 100 particles of more than 0.5 micron in size within a cubic foot of air. Similarly, a Class 10000 cleanroom has less than 10000 particles of more than 0.5 micron in size within a cubic foot of air. This level of cleanliness is necessary to maintain the reproducibility of electronic device processes. To reach and maintain this level of cleanliness, the transfer of particle and chemical contaminations must be eliminated wherever they are found.

Your attitude towards cleanliness will ultimately determine the success or failure of any cleanroom policy. All the elaborate equipment installed to provide a microscopically clean or controlled atmosphere would be to no avail if our users do not believe in and help enforce these policies. It is also recognized that technology is continually changing and that cleanroom users are a tremendous resource for new ideas. With this in mind, you are strongly encouraged to recommend changes that may make the facility safer, cleaner, easier to use, or less expensive to maintain.

When in the cleanroom, be aware of your knowledge limitations. It is extremely important that you ask someone for help if you are unsure about the operation of these facilities.

### II. Enforcement

The policies and procedures described here are intended to ensure the safety of our users, protect the equipment in the cleanroom and to create an environment in which many different research groups can co-exist peacefully. It is expected that the cleanroom users will police themselves by encouraging and assisting one another in adhering to these policies. Flagrant or repeat offenders will be penalized, typically through suspension or expulsion from the cleanroom.

### III. Access

The cleanroom is equipped with a card system, which limits access to authorized users. Users must have a card in order to enter the cleanroom. Except in the case of emergency evacuations, users are required to use their cards in order to exit the cleanroom. The card system will record the times of entry and exit for each user. Prior to being given access to the cleanroom, applicants must attend an orientation session on cleanroom safety and procedures.

Applicants must sign a form acknowledging that they have read and understood the contents of the handouts.

The cleanroom is open 24/7 except during Ramazan Bayramı, Kurban Bayramı and the New Year nights.

Authorized users are able to come in at any time, when open. However, you should always follow the Pair System as described in Section V.

### IV. Items Allowed Into the Cleanroom

Many users need to bring items in and out of the cleanroom such as wafers, notebooks, etc., but due to the nature of the cleanroom, you need to be very careful of what you bring in and how clean it is. Certain items are not allowed into the cleanroom: non-cleanroom paper, cardboard, wood, etc. If you are not sure whether an item is allowed inside, please ask a staff member first. Remember, it is better to be safe than sorry. After you know you can bring an item into the cleanroom, you must make sure it is clean. Bring the item into the dressing room then dress up. When you are dressed up and gloved, take a tex wipe, wet it with ISO, and wipe down your item thoroughly. Make sure to get all the nooks and crannies where dust and dirt may hide. Only after the item has been wiped down may it be brought into the cleanroom.

### V. Pair System

The pair system must always be used in the cleanroom. As implemented here, the pair system requires that a minimum of two people be inside the cleanroom at all times, both of whom should be authorized users. This is to ensure the safety of the users. A list of emergency phone numbers is located in the cleanroom and in the corridor outside the cleanroom.

### VI. Visitors

PERMISSION IS NECESSARY. Whenever possible, visitors should remain outside the cleanroom where they may view the entire facility through the windows in the corridor. If a visitor must enter the cleanroom he/she must first ask for permission from Murat Güre. Once permission is given, they must follow the same policies and procedures as authorized users. They must always be escorted by an authorized user while inside the cleanroom. The escort will be responsible for ensuring that the visitor follows the facility policies and procedures.

### VII. Procedures

- A. Use special care to keep fume-hoods in ultra-clean conditions.
- B. Emergency exit doors are ONLY for EMERGENCIAS, such as fire or explosion in the lab, or for the movement of very large pieces of equipment in and out of the cleanroom. In case of an alarm, exit immediately, DO NOT take time to remove your garment until you are clear of the building.
- C. IMPORTANT - Hot plates (one of the main causes of cleanroom fires):
  - 1. Never leave on when unattended
  - 2. Make sure that the temperature is: 20C below the flash point of its contents and 20C below the melting point of beaker materials.
  - 3. Ask for help if you are unsure of any part of the process.
- D. Do not walk around unnecessarily and be cautious when approaching another work area. Personnel movement is to be restricted to minimize the stirring up of settled particulate matter.
- E. Excess storage in the cleanroom is not permitted.
- F. If you turn it ON, remember to turn it OFF.

Examples:

Vacuum Chucks, DI Rinse Tanks, Nitrogen Gas, Hot Plates, etc.

Exceptions:

Pieces of equipment that must be left on all day for practical reasons.

- G. If you make a mess, clean it up. Return everything to its original condition, or leave conditions better than you found them. This includes your entire set-up for experiments or projects.
- H. Only cleanroom paper or plastic-laminated paper will be allowed in the cleanroom. Cleanroom paper taken out of the cleanroom may be brought back into the cleanroom.
- I. At no time will paper in any form be torn or mutilated within the cleanroom. Corrugated cardboard, styrofoam, or foam rubber of any type will not be allowed in the cleanroom without plastic containment and prior approval.
- J. Remove cartons and packaging material before taking materials into the cleanroom area.
- K. Pencils, erasers, and retractable pens shall not be used within environmentally controlled areas. Non-retractable ballpoint pens are approved for writing purposes.
- L. Users will make proper entry each time a piece of equipment is used that has a logbook.
- M. Be aware of supplies. If quantities of stock appear to be low, report it to the ARL staff.
- N. Do not remove dedicated items from the cleanroom without the ARL Staff's permission.
- O. If you require a special equipment set-up, consult the ARL Staff.
- P. If you think you may have accidentally messed up someone's work or equipment, please try to find whose it is and what to do about it.
- Q. Do not contaminate the Nitrogen blow off guns.

R . When spinning photo resist, do not allow photo resist to bypass the wafer chuck. The resist will clog the vacuum port in the spindle, potentially causing your sample to fly off of the chuck.

### VIII. Wafer Handling

- A. NEVER sneeze, cough, or spit toward your wafers even with a mask. Resulting spots are non-removable.
- B. Never speak towards your wafer.
- C. Avoid passing anything over your wafer which may release particles (i.e., don't look down on your wafer, don't cover the wafer with your hand).
- D. Whenever possible, store wafers in covered containers.

### IX. Tools and Repairs

- A . Vacuum or blow clean all equipment followed by an Isopropyl alcohol wipe before taking it into the cleanroom. No equipment will be modified without prior approval of the ARL Staff. No new equipment will be moved into the cleanroom without prior approval of the cleanroom manager.
- B. Keep parts and tools at the workstation as clean and orderly as possible. Use toolboxes where possible.
- C. Any work or tools dropped on the floor shall be considered contaminated, and must be cleaned.
- D. Never leave exposed critical parts on the workbench.
- E. Work on a clean surface.
- F. Operations such as lapping, filing, deburring, and heavy soldering are prohibited in the cleanroom, except where contamination is isolated and exhausted from the clean areas.

### X. Common Sense

- A . Obey signs on equipment or in specific areas.
- B. Refill squirt bottles that you find empty.
- C. Let empty solvent jugs evaporate dry. Rinse acid and solvent jugs three times with tap water before placing in cart next to cleanroom office.
- D . When working with acids or solvents, wear chemical resistant gloves available in the storage room. Before using the gloves, be sure they are in good shape. Replace them if they are not.
- E . When disposing of acid mixtures, dilute with lots of tap water.
- F . Label all mixtures with Chemical Safety Warning Sheets.

### XI. Habits

- A . If your glove touches bare skin, replace your gloves immediately.
- B . Avoid scratching or rubbing your head or exposed skin areas.

C. Never comb or brush hair within the cleanroom or gowning area.

D. Limit the use of cosmetics, colognes, and perfumes in the cleanroom and gowning areas as much as possible.

E. No eating, chewing, or smoking shall be allowed in any environmentally controlled areas.

## XII. General

A. Personal items such as combs, cigarettes, matches, tissues, and similar particle-shedding products shall not be carried into the cleanroom. Such items may be carried into controlled areas in street clothes pockets, provided they are not removed from the pockets within the clean area.

B. Do not wear jewelry, except plain wedding bands, watches, and pierced ear studs.

C. Report adverse changes in environmental conditions (particle generation or accumulation, marked changes in humidity or temperature) and/or changes in your physical condition (profuse a nasal discharge, skin conditions, etc.) to the ARL Staff (tel: 1968).

## XIII. Hygiene

Personnel with colds, temporary sneezing and coughing, and severe sunburns should not enter the cleanroom until they have recovered. The high degree of cleanliness required necessitates the development of the following habits:

A . Bathe frequently

B. Shampoo regularly and take action to control dandruff.

C. Wear clean under and outer garments.

D . Do not wear open-toed shoes, sandals or worn out shoes.

## XIV. Cleanroom Equipment Support

Every user is responsible for the support system of the equipment that he/she is using at that time. The support system for the equipments includes the gas lines, the chillers, cooling water lines, pressurized air and the nitrogen lines and the vacuum pumps. Every user should switch off the equipment and the support system properly after the usage. In the case of consecutive users or usages the users can keep the systems on. The last user of the equipment for that day is responsible for switching off the equipment and the support system.

Switching off an equipment support system (chillers, pressurized air lines, nitrogen lines, water lines) improperly or partially will be penalized.

## E. SPILL RESPONSE

### I. Introduction

We use many potentially dangerous chemicals in the cleanroom and the possibility of a major spill always exists. It is necessary to know how to react quickly and properly to any chemical spill to avoid injury, death or major equipment damage. A large acid spill, HF for instance, might cause serious injury or even death if

handled improperly. These procedures are intended only to provide guidelines. Common sense should always be used when dealing with any chemical spill. Safe practices should be foremost on your mind whenever you are in the cleanroom.

Be advised: You should never work alone in the cleanroom. ARL policy dictates that you must have at least one other person in the cleanroom with you at all times (PAIR SYSTEM).

## II. Spill Response

The ARL spill response kits available in the Class 100 room. And at the outside corridor.

5 kg chemical spill absorbent bucket  
acid neutralizer  
HF ointment (calcium gluconate 2.5%)  
pH paper  
acid gloves  
two respirators with acid gas cartridges  
two pair of vapor-resistant goggles  
trash bags

If you have any other suggestions or questions please contact the ARL staff (tel: 1968)

## III. In Case of a Spill

If you are the person responsible for the spilled chemical, clean up should be straightforward.

### 1. Did the chemical spill on you?

If the chemical is a strong acid or base, remove contaminated clothing and apply the acid or base neutralizer kit first. Then wash the affected area under water for 10 to 20 minutes. This should relieve some of the pain and reduce the danger of severe burns.

If the chemical is HF, remove contaminated clothing and run the affected area under water for 15 to 20 minutes. Apply a liberal amount of calcium gluconate gel to the area, following the directions on the package. Seek medical attention as soon as possible.

### 2. Is the chemical hazardous?

If the chemical is hazardous and you feel you cannot handle it, alert others to its presence and evacuate the cleanroom. During the workday, notify ARL staff. After hours, call the Bilkent University security (1234) and health center (6666-1666), then notify ARL staff at 1968

If the chemical is a solvent or possesses a strong odor, evacuate the bay and put on a respirator and goggles before returning to clean up the spill.

If the chemical is acidic or basic, don acid gloves, respirator and goggles before attempting to clean up the spill. Isolate the area around the spill.

### 3 Attack the spill:

If you are using an absorbent powder, sprinkle it onto the the spill. Do not use water on the spill until after the chemical is soaked up.

### 4. Clean up:

Do not remove your safety equipment until you have finished cleaning up. There may still be some active chemical on the floor.

When the liquid has been completely absorbed, place the absorbent powder in a double trash bag.

If any glass is involved, place the glass in a separate trash bag and label it as "SHARPS".

Wipe down the spill area with the wipers and DI water.

Then remove all the mess outside the cleanroom and notify ARL staff.

#### IV. Left over Spill

Finding a chemical spill can be more dangerous than spilling the chemical yourself if the proper precautions are not taken. In most cases, the spill will be of a small amount of unknown chemical. In this situation, we assume that you do not know the identity of the chemical.

##### 1. Assess any immediate hazards:

Is there a strong odor? If so, evacuate the bay and don a respirator before continuing.

Is a violent reaction taking place? If so, it may be wise to wait until the reaction has finished.

##### 2. Attempt to identify the chemical:

Look for clues to the chemical's identity: labels, tipped containers, etc.

Wearing an acid glove, use the pH paper to identify whether the chemical is an acid, base or solvent and its strength.

If the chemical can be classified as an acid or base with the paper but not identified, assume it is a very strong acid (HF) or a very strong base (Sodium Hydroxide).

##### 3. Is the chemical hazardous?

If the chemical is suspected of being hazardous and you feel you cannot handle it, alert others to its presence and evacuate the cleanroom. During the workday, notify ARL staff. After hours, call Bilkent University security (1234) and Health Center (6666/1666), then notify ARL staff at 1968.

##### 4. Attack the spill:

If you are using an absorbent powder, sprinkle it onto the the spill. Do not use water on the spill until after the chemical is soaked up.

##### 5. Clean Up:

Do not remove your safety equipment until you have finished cleaning up. There may still be some active chemical on the floor.

When the liquid has been completely absorbed, place the absorbent powder in a double trash bag.

If any glass is involved, place the glass in a separate trash bag and label it as "SHARP".

Wipe down the spill area with the wipers and DI water.

Then remove all the mess outside the cleanroom and notify ARL staff

#### V. First Aid

First aid is an important element of cleanroom knowledge. The cleanroom environment contains many potential hazards, especially the chemicals we use.

This section presents only a simplified first aid procedure for a hazardous chemical spill. For more specific information, consult the MSDS data sheets and ARL staff.

##### 1. Did the chemical spill on you?

If the chemical is a strong acid or base, apply acid safety aerosol and then run the affected area under water for 10 to 20 minutes. This should relieve some pain and reduce the danger of severe burns.

If the chemical is HF, run the affected area under water for 15 to 20 minutes and then apply a liberal amount of calcium gluconate gel following the directions on the package. Seek medical attention as soon as possible.

If the chemical is a solvent, rinse the affected area for 10-15 minutes to reduce any irritation.

##### 2. The chemical spilled on someone else:

If the person is coherent, find out what chemical they were using.

If they are unable to tell you, have someone place them under a safety shower and remove contaminated clothing while you attempt to identify the chemical:

Look for clues to the chemical's identity: labels, tipped containers, etc.

Wearing an acid glove, use the litmus paper to identify whether the chemical is an acid, base or solvent and its strength.

If the chemical can be classified as an acid or base with the paper but not identified, assume it is HF or Sodium Hydroxide.

Take necessary first aid action, including the use of HF ointment. Notify emergency services at 1234 and 6666 as soon as possible and then notify ARL staff at 1968.

## F. CLEANROOM GOWNING

### I. Introduction

By far the dirtiest thing in our cleanroom will be the people who use it. Even the most carefully manicured person generates a shroud of particles from their skin, hair, clothing, and breath. Consequently, all cleanroom users must wear cleanroom garments which trap and hold the particles emitted by their bodies and clothing.

The Advanced Research Laboratory has adopted the following gowning procedure for use in the Cleanroom. It is important that each person who enters the cleanroom carefully follow this procedure.

Frequent cleanroom users will be assigned a garment hanger. Infrequent users and visitors will not be assigned any hanger.

A. Leave your hat, coat, and any other street garments not required for warmth and/or modesty at the office.

B. Put on shoe covers located inside at the entrance of the gowning room. Only flat or very low-heeled shoes may be worn. No sandals or open-toed shoes.

C. Remove your cleanroom garment from the storage cabinet and inspect. Inspect your garment each time you wear it for tears or soiling.

D. Put on your cleanroom gown.

E. Put on booties.

F. Carefully put on a hood or cap.

G. Put on Cleanroom Gloves.

H. Put on Goggles.

### II. Notes

1. Cleanroom garments shall be worn only within the cleanroom complex, except under emergency conditions.

2. While in the cleanroom, keep your hands away from your face. The oils on your face can be transferred to the gloves and subsequently to the cleanroom equipment or your samples.

3. Do not wear soiled, dirty or lint-producing street clothes under cleanroom garments.

4. Do not hang street clothes or lab coats in the gown cabinets. Use separate "Coat Closet".

5. Half finger glove liners are available to be worn under your gloves.

6. Facemasks are to be worn over the top of the nose.

7. Never open your gown in the cleanroom.

## G. CLEANROOM COURTESIES

### I. Non-Functional Equipment

Frequently, lab equipment stops working or gets damaged during normal use. Whenever something quits working, please give it to a member of the cleanroom staff, who will then either repair it or decide if it needs to be disposed of. Lab equipment is inherently expensive, and eventually much of the cost is passed on to the users. Therefore it helps everybody when we can avoid buying new equipment needlessly.

### II. Broken and Dirty Glassware/ Wafers/Other Sharp Objects

With all the glassware used in the cleanroom, obviously breakage will occur, or things will get contaminated beyond the point of being cleanable. If you find glassware meeting this description, please be sure to throw it into the container and marked "Sharp Objects" This also applies to the following materials: wafers, razor blades, needles, microscope slides and cover slips, and anything else that is questionable. Please be careful about this one: many poor, innocent co-ops have been stabbed by sharp things carelessly thrown into the regular garbage.

### III. Labeling

Frequently, cleanroom users will need to leave things under the fume hoods overnight or for part of the day unattended. Our policy here is simple: Anything left unattended must be labeled with your NAME, PHONE NUMBER WHERE YOU CAN BE REACHED (not the number of any front office), WHAT IT IS THAT IS SITTING THERE, and the DATES AND TIME of when you left it AND when you will return to get it. If you do not do this, your chemical(s) will be disposed of immediately.

### IV. Solvent-and Photoresist-Soaked Materials

While many folks think of the solvents we commonly use as "safe, the fact of the matter is that they all can be dangerous if you get exposed to them enough. While it may seem like a couple of TexWipes with photoresist on them is not that bad, just remember that the air in the cleanroom is constantly recirculated, so all those vapors will find their way back in eventually for everyone to breathe. The following materials should be put in the solvent cans:

Any alcohols (ethanol, methanol, isopropanol, etc.)

Acetone

TCE (Trichloroethylene)

Chlorobenzene (this stuff is particularly dangerous)

Photoresist and related products

### V. Don't Know How to Use or In Case of Failure

If you need to use a particular piece of equipment and you are not absolutely sure how to use it, first of all, DO NOT TRY TO LEARN BY DOING IT!!! The staff is here to help you, and they can point you to the right person to show you how to do it. If something breaks during a process, tell the staff and they will take care of it. Above all, please DO NOT try to fix something on your own.

### VI. Clean Up

All cleanroom users are responsible for cleaning up their own mess. You should put away all tools, throw away all wipers and disposable items, and thoroughly clean all glassware. Make it look as though you were never

there, or better yet, make it look better than it was before you were there. If you find a beaker that someone else left dirty, why not wash it while you are washing your own?

## VII. Warning others

From time to time, people will have other things on their mind and unintentionally do something they really shouldn't do. Most people don't mind a friendly reminder now and then. It's up to the users to keep the cleanroom operating smoothly, and as long as everyone cooperated then the chances of ruined projects, injuries, and problems in general are greatly reduced. If anyone has a problem with being politely told about something that may endanger somebody, tell the staff about it and we will take care of the problem.