



Stanford Nanofabrication Facility

Part I: Policies and Procedures Laboratory Safety Manual



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1. The Stanford Nanofabrication Facility

1.1 Introduction

Welcome to the Stanford Nanofabrication Facility! We are a state-of-the-art, shared-equipment, open-use resource. Our laboratory serves academic, industrial, and governmental researchers across the country and around the globe. The SNF is more than just a lab; it is a vibrant community of researchers. Our labmembers come from a wide variety of disciplines, with research in areas of optics, MEMS, biology, and chemistry, as well as process characterization and fabrication of more traditional electronics devices. We are especially committed to supporting use of Micro- and Nano- fabrication technologies in non-traditional research applications. The SNF is supported by the National Science Foundation through the National Nanotechnology Infrastructure Network, as part of the National Nanotechnology Initiative.

1.2 Mission

The goal of the Stanford Nanofabrication Facility is to provide researchers with effective and efficient access to advanced Nanofabrication equipment and expertise. Our objectives are:

- ✓ To provide shared experimental capabilities with advanced equipment, skilled personnel, and effective training.
- ✓ To promote and enable high quality research using Nanofabrication technology.
- ✓ To advancing fundamental knowledge in Nanofabrication technology.
- ✓ To increase the use of Nanofabrication in non-traditional areas.
- ✓ To support graduate and undergraduate research in applications of Nanofabrication.
- ✓ To disseminate knowledge to the national research community.

1.3 Brief History

The origins of the SNF can be traced to the Integrated Circuit Laboratory, which was established in the mid-60's at Stanford. By the mid-70's, this lab had become well known for device and process model simulators which led to the development of innovative devices and process test structures.

While the fabrication of integrated circuits has been the focus of this early facility, the design and fabrication of MEMS and related devices have also been important since the beginning. Early research in medical systems resulted in pioneering work in the areas of image sensors, image processing, bio probes, pressure sensors, accelerometers, implantable electronics, and high voltage drivers. A novel silicon micro-machined gas chromatograph, recognized as being the first MEMS device, was produced in this lab in 1979 (Terry, Jerman, and Angell.) In the early 80's, the facility was expanded and upgraded, which enabled it to support development of larger, more complex chips, such as the MIPS chip and the Geometry Engine.

In the early 80's, the Center for Integrated Systems (CIS) partnership was formed between Stanford University and a founding group of 20 industrial member companies, with the goal of providing infrastructure and financial support for an "integrated systems" approach to electronics engineering research and education. Through the generous support of this partnership, the Center for Integrated Systems was built. Completed in 1985, the IC lab was moved into this building and renamed CIS, both in recognition of its benefactors and for the new program focus. (The CIS partnership, although no longer directly involved in the lab, is still strongly active today in supporting academic research at Stanford.)

Throughout this time, the facility served primarily as a teaching laboratory, and was used almost exclusively by Stanford researchers. In 1994, with four other University facilities, the laboratory became a founding member of the NSF-funded initiative, the National Nanofabrication Users' Network. Renamed the "Stanford Nanofabrication Facility", the lab opened its doors to researchers from non-Stanford

organizations, including industry as well as other government and academic institutions, and thus creating the dynamic and diverse community of researchers who comprise SNF today. With the success of its program, the Network has expanded to include 13 sites total and has now become the National Nanotechnology Infrastructure Network (NNIN).

Over the years, the equipment set and staff expertise has expanded to accommodate the ever-changing research needs of its labmembers, whose research topics currently extend over a wide range of disciplines, such as optics, MEMS, biology, chemistry, as well as the more traditional areas of electronics device fabrication and process characterization.

1.4 Organization

The administration of SNF resides in the Department of Electrical Engineering, although the organization as a whole falls under the broader auspices of the Dean of Research. Approximately 30 staff members support the various functions of the lab: equipment maintenance and installation, process engineering and training, facilities, shipping & receiving, etc. The current organizational chart is available on the SNF website (<http://snf.stanford.edu>).

1.5 Programs and Partnerships

SNF is a service organization. Because the laboratory operates on the open-to-everyone, "sandbox" model, SNF itself does not initiate or sponsor research, nor does it participate directly in research programs; rather, we operate solely to provide resources for researchers to explore their ideas.

➤ *NNIN*

The SNF has an annual budget that approaches \$4M. Most operating costs are recovered through labmember fees charged for equipment use, staff support, and Stockroom supplies. Other infrastructure costs (new equipment, staff salaries) are largely supported by NSF, through our membership in the National Nanotechnology Infrastructure Network (the NNIN).

SNF, in partnership with 12 other sister facilities, form the National Nanotechnology Infrastructure Network (NNIN). This is an NSF-funded initiative with the directive of providing state-of-the-art fabrication resources to industrial and government, as well as academic researchers, across the country. The NNIN provides a platform for sharing expertise as well as resources and thus broadens the scope of tools available to our labmembers. More information about the NNIN and our sister sites can be found at <http://www.nnin.org>.

➤ *CIS Affiliates*

CIS Affiliates is a partnership between Stanford University and industrial organizations with a commitment to engineering research. During the early 80's, the CIS Affiliates generously provided the financial basis for the building of the cleanroom. Now that the laboratory is self-sustaining, the CIS Affiliates continue to provide support for engineering research. The CIS generously funds the New User Grants Program at SNF. Researchers with faculty or PI standing at any recognized university whose research groups have not made use of SNF before is eligible for a CIS New User Grant. More information and the application form for this program can be found at the SNF website.

1.6 Lab Overview

➤ *Physical Lab*

The SNF is housed in the Paul Allen Center for Integrated Systems (CIS) building. The facility extends over three floors. The class 100 cleanroom is 10,500 square feet in area and is vibration-isolated from the rest of the CIS building. Air handlers and heat exchangers are located on the floor above the cleanroom.

Support equipment, such as chilled water, vacuum pumps, air compressors, and acid waste neutralizers, are remotely located in the basement below. Corrosive and toxic gases are located in a monitored gas pad, away from the main laboratory. The DI water plant, liquid gas storage tanks, and emergency power generators are located in an outdoor area adjacent to the CIS building. Support facilities, such as the stockroom, semiclean labs and maintenance work areas, and staff offices, are located near the cleanroom.

➤ ***Lab and Building Maps***

Building and laboratory maps are available on the SNF website. A safety map is also appears in the appendix section of Part II of this manual ("Laboratory Safety.")

2. About Labmembership at SNF

2.1 Labmembership

SNF is open to anyone from any academic, government, private or industrial organization for any type of research and development activity that does not violate Stanford University Academic Research Policies and Procedures. Researchers not already affiliated with Stanford must abide by the guidelines set in the Agreement Form. Commercial activities (i.e., the production of devices for sale) are strictly prohibited; although broadly defined R&D, such as prototype development, are within the scope of acceptable activities.

2.2 Intellectual Property Policy at SNF

Stanford University policy prohibits SNF and its Staff from being party to secrecy or disclosure agreements having to do with work being performed in the lab. However, SNF also makes no claims to intellectual property developed independently by researchers using the lab. For more specific detail, please refer the SNF Agreement Form and the Stanford University Academic Research Policies and Procedures regarding intellectual property.

2.3 How You Can Help SNF

➤ ***Labmember Reports***

The National Science Foundation, through the NNIN, requires the SNF to provide an annual report detailing various statistics on labmember activities at our facility. In order to prepare this report, we ask that all active labmembers submit a brief summary of their research projects on an annual basis. The report should not contain any sensitive information, as it may be used in public forums to illustrate the broad range of research taking place at SNF.

This information is important, not only for reporting to NSF, but also for allowing us to keep track of the types of activities that are ongoing at SNF. This helps us to plan for future developments, such as equipment purchases, staffing needs, and other such infrastructure requirements, and so is a valuable tool for helping us to serve you.

➤ ***Acknowledging SNF***

Please help SNF by acknowledging any use of SNF resources in your work. Part of the value of SNF lies, in part, in the visibility our facility maintains in the research community. As such, we ask that labmembers acknowledge any contributions of SNF resources in publications or presentations. A written acknowledgement should ideally read:

"Work was performed in part at the Stanford Nanofabrication Facility which is supported by National Science Foundation through the NNIN under Grant ECS-9731293."

In presentations, please simply list the Stanford Nanofabrication Facility with your other acknowledgements. We greatly appreciate your support.

2.4 Lab Fees

Fees are charged for equipment use, lab supplies, and staff time. There is no charge just for time physically spent in the lab (and thus no charge is incurred, for example, for a labmember inspecting wafers under a microscope.) For the listing of lab use fees, please refer to the SNF website.

Equipment Use fees are used to recover operating costs associated with the lab (general supplies, cases, spare parts, etc.) This rate is generally the same for all equipment that is tracked. Some equipment (such as microscopes) is not tracked. Equipment Use fee charges begin when a labmember "enables" a specific piece of equipment on the Coral lab management system and ends when the tool is "disabled" on Coral. For more information about the Coral lab management system, see section 3.2.

The "Cap" is the maximum equipment use charge that can be accrued by a one labmember/project in a single calendar month (starting from the 1st of each month.) The purpose of the cap is to allow researchers to work without having to keep a close eye on the clock. Multiple labmembers working on the same project are each subject to his/her own cap. One labmember working on multiple projects is subject to a cap for each project. In short, the "Cap Rule" is: one cap per person, per project, per calendar month.

Process Staff Support charges are incurred for lab activities, such as equipment training and processing support. Outside the lab, process staff and technical liaisons are available to answer questions and offer advice without charge. There is also no charge for the Lab Intro and Safety Class. However, projects that require major technical assistance outside the lab may be subject to process staff support charges.

Stanford University Overhead Rates are charged for sponsored projects. Stanford-affiliated labmembers already pay overhead, as these charges are built into research contracts administered through the University (56% in FY2005-6). In addition to the base fees, industrial/government accounts are charged this overhead by SNF on behalf of the University. Labmembers from other academic institutions already pay indirect costs at their own institutions; and therefore are subject to a lower, courtesy overhead rate.

2.5 Remote Labmembership

SNF was designed to serve as a sophisticated "sandbox", where labmembers can work hands-on with fabrication tools; thus, most labmembers work on-site. However, if you have a project and are unsure whether you have the time or expertise to execute this yourself, we offer several options for fabrication services. We also invite you to discuss your projects and these options with one of our technical liaisons.

1. **SNF Remote User Process Services** (subject to availability): Whether it is one step or many, our experienced process staff may be able to fabricate part or all of your device. With a variety of web-based tools, we can work with you, even real-time, to achieve your project needs.
2. **Independent Contractors/Consultants**: Several individuals and organizations offer custom fabrication and other services. Contact and descriptive information of currently available contractors and consultants, all labmembers in good standing, are listed on the SNF website.
3. **CNRI/MEMS-Exchange**: The MEMS Exchange is a "virtual" fab, a network of university and commercial fabs offering a library of MEMS-related, fabrication processes. SNF has been a member of the MEMS-Exchange since its inception.

3. Lab Resources

3.1 Lab Hours

The lab is available for use 24-hours/day, seven days/week. However, lab staff is available generally during working hours only (Monday through Friday, approximately 7 am - 5 pm.) Use of the lab during off-hours and weekends is subject to the "buddy" requirement (see section 4.5). The lab routinely shuts down between Christmas Eve and New Year's Day for general equipment and facilities maintenance.

3.2 Coral Software System

The suite of software tools used to run the SNF lab is called "Coral", which is the acronym for "Common Object Representation for Advanced Laboratories." Some of the key featured uses of this software are:

1. To insure that only people who are trained and qualified to use a particular piece of equipment have access to it.
2. To track equipment usage by individual labmembers and thus generate bill accounts accordingly.
3. To allow labmembers to reserve equipment so that equipment use may be allocated in an efficient manner.
4. To communicate both equipment and process problems to other labmembers and staff.

Each labmember is assigned a Coral computer account. This allows you to "enable" those tools in the lab, which you have been trained and qualified to use. "Enabling" activates a piece of equipment and starts the clock for tracking your lab fees; thus, your Coral account is linked to your billing information (see other sections of this document for guidelines on Coral use). Each labmember is required to have his or her own Coral computer account, even if several labmembers are working on the same project and fees are charged to the same billing account (see "Fees".) In addition, a single individual working on several projects charged to different billing accounts might have several projects linked to his/her Coral computer account.

As in any other networked environment, you are expected to be a responsible user. You may use only your own individual account and access privileges; do not share your account name and password with anyone. Understand also that use of SNF computer resources is limited to activities, which support your work in the lab. For more information about how to use Coral and limits on use of SNF computer resources, see this manual.

3.3 CAD Resources

CAD systems are located in room CIS 151, across from the gowning room entrance. CAD resources include:

1. Two SUN workstations, known as the "Shades" cluster. These require special user accounts (contact computer@snf.stanford.edu to obtain a login). These systems are generally used for conversion of mask data for the Hitachi Ebeam system.
2. Two non-networked PC's loaded with Tanner LEdit and other CAD utility programs, available for general use for mask design.
3. A Coral, SunRay terminal.

3.4 Storage of Personal Belongings

➤ Desks

There are a limited number of desks, which are designated for use by SNF labmembers. These are located in the bullpen area just outside the lab entrance. The Labmember Services Administrator allocates desk space. Priority is given to students and researchers who have traveled to work at SNF. Any space that is

unoccupied for extended periods of time may be reclaimed and reallocated, at the discretion of the Labmember Services Administrator. No hazardous chemicals or materials may be stored in this area.

➤ ***Lockers***

Lockers are located in the hallway outside the lab entrance. These are also allocated by the Labmember Services Administrator and are for use only by SNF labmembers. Priority in allocation is the same as for desk space. No hazardous chemicals or materials may be stored in this area.

➤ ***General Storage outside the Lab***

Ample storage for personal belongings is available in CIS 151, which is located conveniently just outside the lab. Labmembers may store wafers, labware, notebooks, and other lab-related items (other than chemicals or other hazardous materials) in storage boxes on the shelves provided. For more information on use of this storage area, consult the SNF website.

➤ ***Storage in the Lab***

Assigned bins are available in the lab for storage of personal items. Individuals are generally assigned a single bin. In addition, groups of two or more labmembers may request additional storage for shared items. Bins belonging to labmembers not showing lab activity over some period of time may be reclaimed and reallocated. For more detail, consult the SNF website and the Labmember Services Administrator.

➤ ***Bunny suits***

For frequent users of the lab, personal bunny suits can be stored, hung in the gowning room in alphabetical order, by Coral login. For occasional users of the lab, visitor suits are available as well. For details about storage and use of bunny suits in the lab, please refer to Appendix A ("Gowning Room Procedures.")

3.5 Stockroom Materials

The SNF Stockroom is located next to CIS Shipping & Receiving, down the hall from the lab entrance. Basic consumables, such as wafers, boxes, etc., may be purchased here. The stockroom provides items at materiel cost; inventory costs and overhead are supported through labmember fees. Thus, the stockroom is supported by labmembers for labmembers' use and its purpose is to provide ready access to basic lab supplies. Use of the Stockroom is limited to the following:

- 1. You must be an SNF labmember and have an active Coral account.**
- 2. Purchased items must be for personal use only in the SNF lab.**

Additional Stockroom courtesy tips:

- Please limit your purchases to your immediate needs.
- Notify the Inventory Management Team if supplies of a particular item are running low.
- If you require large amounts of a particular item, plan ahead by submitting a purchase order for your request.
- Do not take items to stock another lab.

The Inventory Management Team can help labmembers with purchase order requests for bulk quantities of items stocked. Because of some long-standing arrangements with some vendors, they may also help with some materials, particularly substrates, which may not be normally stocked. Such items would be ordered by and shipped to the Stockroom and charged to the requestor's Coral account.

3.6 Lab Phones and Paging

➤ **Lab phones**

There are several phones located throughout the lab, which can be used to make local, and on-campus calls only. Phones are located in the following functional areas:

Diffusion	(650) 725-3680
E-Beam	(650) 725-7992
Gown	(650) 725-3679
Ion Implant	(650) 725-3681
Lithography	(650) 725-3675
SEM	(650) 725-3674

➤ **Cellular phones**

Many labmembers carry personal cell phones. However, because of the way the building is constructed, reception will vary depending on the phone and the service provider. Check the "labmembers@snf" discussion list for the service providers currently recommended by labmembers.

➤ **Intercom/Pager**

There is a red pager phone located just outside the gowning room entrance. There are also red phones located in the lab. These red phones connect to the PA system in the lab. To page someone in the lab, lift the receiver, speak clearly into the phone, and then hang the phone up.

3.7 SNF Committees

➤ **Safety Committee**

Safety in the workplace is the utmost priority for SNF. The Safety Committee at SNF is committed to maintaining and improving safety in the lab, and to ensure compliance with the policies of the various local regulatory agencies (namely, the Palo Alto Fire Department and Stanford EH&S.) To report a safety concern, send an email to: safety@snf.stanford.edu

➤ **Special Materials Committee**

The Special Materials Committee (SpecMat@snf.stanford.edu) was formed to help labmembers try out new chemicals and materials into the lab. The primary considerations of SpecMat are safety and potential contamination which may affect the research of others. SpecMat sets the policy for the use of new, or existing materials, on a case by case basis. The committee considers such issues as storage, handling, and potential contamination issues with respect to the lab and equipment. Over the years, SpecMat has accumulated large archive covering an enormous range of materials, chemicals, processes, and equipment. The committee members collectively have over 150 years of fabrication processing experience in semiconductor and related areas of research and industry. If you have a special request or any questions about a process or process sequence in the lab, please feel free to consult with SpecMat members.

4. In the Lab

4.1 Communications in the Lab

Effective and conscientious communication is essential in the SNF community.

1. **Individuals.** Specific process or equipment questions can be addressed to the process or maintenance staff person responsible for the equipment, or the technical liaisons, where appropriate. A directory of SNF staff is available on the website (click on the “SNF Staff” button on the header.) Any individual labmember may be contacted by directing an email to that person’s *Coral-login@snf.stanford.edu*. This will automatically forward the email to that individual’s preferred inbox.
2. **Equipment users.** Problems, questions or comments can be addressed to the subset of labmembers who use a specific tool. The alias for each equipment group list is “*Coral-name@snf.stanford.edu*.”
3. **Labmember community at large.** The entire labmember community (all registered labmembers and affiliates) can be addressed using “*labmembers@snf.stanford.edu*.”

We ask that all communications be kept at a professional level and concern only matters that are of interest to the group directed. Please do not use for non-SNF-related communications.

4.2 Gowning and Good Cleanroom Practices

All labmembers must use good cleanroom practices; everyone must, or the value of the cleanroom is compromised. For prospective labmembers who have never worked in a cleanroom environment, these practices may seem arcane and unnecessary; however, the cleanroom procedures practiced at SNF are generally very similar to those used and validated in cleanrooms everywhere. Remember: just because you can’t see a particle or a contaminant does not mean that it will not have an effect on your (or other labmembers’) devices.

Procedures for gowning and general guidelines for lab behavior are summarized in Appendix A. These procedures are designed to maximize safety and minimize contamination risks; always do your best to follow these.

4.3 Equipment Use and Training

Each piece of equipment in the lab is interlocked to the Coral computer system. In order to use it, the specific tool must be “enabled” through Coral. Only users who are qualified to use a particular tool are allowed to enable that tool. A qualified user has privileges for “enabling”, “disabling”, and making advance reservations on this tool.

1. While a piece of equipment is being used, it must be “enabled”.
2. When the labmember is no longer using a tool, it must be “disabled.”
3. The user must flag and report any equipment or process problems on Coral, or shut it down if unusable.

➤ **Training and qualification**

To begin training on equipment, you must complete this safety class and have a Coral account. Training is equipment-specific, and may be arranged by contacting the SNF staff listed on the website. Technical Liaisons are available to discuss process flow and materials issues -- this is helpful in determining which pieces of equipment may be most appropriate for your needs. Information about process capabilities and materials compatibilities for each tool is also available on the SNF website.

Understand that due to equipment and staff availability, some training sessions may take some time to arrange; thus, advance planning is very important. If you need to cancel, please try to do so at least two

days in advance of your scheduled training session ("No shows" may be subject to a charge of one hour of equipment and technician time.)

Please also be realistic in your expectations. The amount of time it takes to become trained on a piece of equipment will vary widely -- it will depend on the complexity of the tool and the process, as well as your own experience. Once the trainer is fully satisfied with your knowledge and ability, you will be added to the "qualified users" list, granting Coral privileges, which allow you to use this equipment.

➤ *Equipment Reservations*

Labmembers may reserve equipment for which they are qualified to use up to one week in advance on Coral (some high-demand tools have additional restrictions, as listed below). Here are guidelines for equipment reservation etiquette:

- Be judicious in the amount of time you reserve (avoid reserving large blocks of time which you are not likely to need.)
- Remove any reservation that you will not be able to use, as soon as you realize you do not need it (on high-demand tools, it is courteous to notify other users of a reservation cancellation using the "equipment_name@snf.stanford.edu" mailing list alias.)
- There is a grace period of 15 minutes, after which someone who does not show up may lose his/her reservation and the machine is free for any other qualified person to use.
- In research, problems happen. Someone may exceed his/her time allotment; someone else may be late in getting to his or her reservation. Make every attempt to communicate your needs and respect those of others; work out differences in a professional, courteous manner.
- Certain high-demand tools have additional reservation restrictions. Please refer to the website for the list of specific tools and their reservation limits.

➤ *Equipment Status and Problems*

We ask that labmembers report all process and equipment problems on the Coral system, so that SNF staff and other labmembers may follow the status of any piece of equipment. Each tool can have one of the following equipment states:

Up: When a piece of equipment is fully operational, its Coral icon is a green light.

Problem: When a problem is reported for a piece of equipment, its icon becomes a yellow light. In the yellow alert condition, the equipment may be operated, but there may be restrictions. If yellow light icon is present, you should check the equipment messages and station log for any special instructions (failure to do so could result in damaging your wafers or the equipment!) If you are operating a tool and observe a problem, however minor, please use the "Report Problem" function on Coral. This will turn the equipment icon yellow and inform others of potential problems. Only Staff has privileges to clear a yellow alert.

Down: When a piece of equipment is shutdown, its icon is a red light. In the red light condition, the equipment is not usable. If you are using a tool and it experiences problems, depending on the tool, you may be required to use the "Shutdown" function on Coral -- your training and the operating procedures will cover the circumstances and procedures for which an equipment shutdown may be required. When equipment is in the red light state, it cannot be used until it is cleared by Staff.

Unless your training, skill, or experience covers it, you should not attempt to repair equipment. Your help, however, in observing and noting the symptoms of any equipment problems would be much appreciated.

4.4 Materials and Contamination Control

In order to keep SNF a safe and productive place to work and to protect the environment, all process chemicals and materials used in the lab must be approved by the SpecMat committee before use (see

below). Chemicals and materials, which are already approved for use in the lab, may be processed only according to policies defined by “Equipment Groups.” This system is designed to minimize contamination risks, which can lead to device failure.

➤ ***Equipment Groups***

Equipment in SNF is classified in one (or more) of three contamination group levels:

- **Clean:** Equipment with the lowest tolerance for contamination fall into this group. Wafers processed in this equipment must not have been exposed to any metals or equipment in which metal-containing wafers were processed.
- **Semi-Clean:** Wafers containing standard metals (Aluminum, Tungsten, Titanium) are acceptable for processing in the equipment listed here.
- **Gold-Contaminated:** Wafers containing non-standard metals, including gold, may be processed in this equipment.

When defining the process flow, the choice of processing tools, which are acceptable, will depend on the previous tool used. In general, wafers can be processed in only equipment within the same contamination group or in groups representing higher contamination risk (i.e., the progression of "Clean" -> "Semi-Clean" -> "Gold-Contaminated" is acceptable, but the reverse is not, without extensive decontamination and other restrictions). Certain equipment appear in more than one group, either because of low risk of cross-contamination, or because intervening cleaning procedures reduce contamination risk, or because special precautions are defined to prevent contamination.

Equipment groupings are a very general planning tool -- as you refine your process flow, make sure to check it against the Materials requirements for each individual piece of equipment. There are a few exceptions in which non-standard equipment sequence may be acceptable -- these are explained in the "Materials" page each piece of equipment. If you have non-standard process flow requirements (or any other questions about Materials policy), please discuss your project with an SNF staff member who will be able to help you design a process flow to accommodate your needs.

➤ ***Bringing in New Materials***

All process chemicals and materials used in the lab must be approved by the SpecMat committee before use (see the website for forms and procedures.) New chemicals and materials are approved for a given process, on a case-by-case basis; use for another process will require new SpecMat committee approval. Once approved, personal-use chemicals and non-standard chemical containers must be appropriately labeled (with identification of owner, contents, and other safety info). As this is an ever-changing research environment, there is a vast number of chemicals and materials -- we need your help to keep track of them all.

Because SNF is a community of researchers, we all need to be extremely conscientious of potential problems of cross-contamination and chemical compatibility as it will affect the research of others and, thus, the value of the lab as a research resource. The SNF website should answer most questions and concerns about which chemicals and materials and where their use is acceptable in the lab. Please take time to carefully consider the process flow of your experiment and how it might affect other labmembers and other downstream processes. If you have any concerns, contact one of the members of the SpecMat Committee, who will help with your questions.

Please do note: by University and CalOSHA rules you must notify safety@snf.stanford.edu **BEFORE** bringing any material/chemical into lab or the building (CIS or CISX). If it is a new material to be used in the lab, SpecMat should be notified and consulted. SpecMat should also be consulted if you plan to use SNF standard materials and chemicals in a non-standard process. If you have a SpecMat request, please refer to the SNF website for the request form and more information.

➤ ***Other Special Processing***

In addition to new materials or chemicals, processes involving non-standard hookup of electrical equipment, bringing in electrical equipment (such as power supplies) or other equipment (such as chemical condensers) will also require special process review. Please contact one of the SNF staff members if you wish to try a new process that involves any modification of standard procedures.

4.5 Other Lab Policies

➤ ***Buddy System***

For safety reasons, no labmember is allowed to work alone in the lab at any time. Because the lab runs 24/7, there may be occasions (such as a late night, over a long holiday weekend) when there are no other people working in the lab. If you plan to work during a time when the lab might be expected to be empty, please plan ahead and coordinate your work schedule with another labmember. This way, you can be sure to have a buddy and can work safely.

➤ ***Visitor Policy***

For safety reasons, casual visitors/observers are not allowed in the lab. Labmembers should not host visitors in the lab without prior staff approval or a staff member escort. Facilities support, contractors, field service and applications technicians, and other technical support personnel, are allowed general access to the lab, but must be sponsored by a designated, responsible SNF staff member.

➤ ***Using Coral***

A few extra words about using Coral:

1. *Log into Coral before entering the lab; log out of Coral when leaving the lab.* (This can be most conveniently done at the Coral terminals just outside the gowning room entrance.) Coral is used to track labmembers' use of the lab, whether or not equipment is enabled and charges are accrued. Most importantly, it keeps track of who is in the lab, which is critical in the case of an evacuation or other emergency.
2. *Do not enable/disable equipment remotely on Coral.* Unless you are absolutely sure of the state of the equipment, enabling or disabling may damage the tool or, even worse, lead to an unsafe situation.
3. *Follow guidelines for enabling/disabling equipment and making reservations.* If everyone uses Coral in a conscientious manner, we can minimize communication problems.

➤ ***Staff Support for Processing***

Staff members are available to process materials for labmembers. Equipment and staff fees are charged to labmember's account for such special requests. For on-site labmembers, processing requests are generally limited to equipment/processes, for which the labmember is not qualified, and may be subject to equipment and staff availability. For more information about processing support, please contact the staff person responsible for the equipment/process of interest.

5. Appendices

Appendix A: Gowning Room Procedures

1. Overview

This document describes the procedures for entering and exiting the cleanroom, including the gowning protocol. These procedures are designed to minimize the potential for transferring and generating particulate matter, which could adversely affect the lab.

2. Qualification Checklist

All SNF labmembers must demonstrate or describe the following:

- The correct sequence for donning and removing a bunnysuit.
- Items required for full cleanroom attire.
- How to store a bunnysuit.
- How to bring working materials (wafer boxes, masks, etc.) into the lab.
- Recognizing what comprises acceptable versus unacceptable working materials.

3. Procedures

3.1. Gowning:

Before entering the gowning room

- Make sure you are wearing appropriate attire:
 - Shoes should fully enclose the feet (no sandals, open toe, or sling-back shoes)
 - Remove outer clothing (i.e., jackets, fuzzy sweaters).
- Visit the washroom: tie hair up, wash hands, and take a drink of water.
- Make sure you have everything you need with you to work in the lab and that it is all cleanroom-compatible (see section 3.4).
- Don blue shoe covers.
- Log into Coral.

On entering the gowning room

- Put on a paper "bouffant" cap. Make sure all your hair is covered (check in the mirror).
- Put on latex (or vinyl) gloves. Try not to touch the outside of the gloves with your bare hands.
- Obtain a bunnysuit. Personal suits are stored by assigned hanger number (refer to the SNF website). New suits are available in the gowning room.
- Don the bunnysuit, working from your head down to your feet, in the following order:
 1. Hood. Snap under the neck.
 2. Suit. Hold the sleeves and body up to keep them from touching the floor.
 3. Booties.
- Tuck the hood into the neck of the suit.
- Fasten snaps at the neck and wrists.
- Tuck suit legs into the tops of the booties.
- Fasten bootie snaps and clips.
- Put on lab glasses.
- Check yourself in the mirror. Make sure everything is tucked in, zipped up, and snapped.

- Ensure that the materials you are bringing in to the lab are cleanroom-compatible (see section 3.4).
- If you have brought in materials that have been previously bagged in the cleanroom, remove the bag in the gowning room. Dispose of the used bags in the trash.
- If you have brought in new materials (not been previously bagged in the cleanroom), take them to the wipedown station in the gowning room. Use an alcohol wipe and cleanroom wipes to wipe any dust or debris from all surfaces. Use the cleanroom vacuum to remove dust from surfaces that cannot be easily wiped.
- Where possible, label your materials with your name and Coral login. Boxes containing wafers and tweezer boxes **must** be labeled. A Dymo label maker is available in the gowning room.
- Change your cleanroom suit every two weeks or more often if needed.

In the cleanroom

Before working with wafers, put on vinyl gloves over the latex (or vinyl) gloves. Change vinyl gloves frequently: 1. whenever getting ready to handle, transfer, or inspect wafers; 2. whenever any contamination is suspected. Vinyl gloves are available in the gowning room and throughout the lab.

3.2. Rules and Guidelines for Personal Lab Behavior

- Drinking, eating and gum-chewing are **not** allowed in any part of the lab.
- Full cleanroom attire must always be worn while in the cleanroom.
- Safety glasses must always be worn in the lab, although may be removed for microscope viewing.
- Be discrete in coughing, sneezing, blowing your nose. If you can, go into the service area or gowning room. At the very least, turn away from the processing area and change your vinyl gloves before commencing processing.
- Minimize the amount of materials stored in the lab. All personal items must be labeled with your full name, login name, and contact phone number. Storage inside the lab is limited to personal storage bins. Ample storage is available outside the lab. Contact access@snf for more information about storage.

3.3. Leaving the lab

- Clean up after yourself. Leave stations neat and ready for the next person to use. Remove personal items from general-use areas after you are done processing.
- Any materials you plan on taking out of the lab with you should be bagged to prevent contamination. Zip-loc bags are available in the Litho area. A vacuum sealer and sealer bags are available at the wipedown station in the gowning room.
- In the gowning room: remove your bunnysuit from the bottom, up, in the reverse order:
 1. Booties. Snap booties to the wrist of the bunnysuit.
 2. Suit. Keep the sleeves, main body, and as much of the suit as possible, off the floor.
 3. Hood. Snap hood to the neck of the bunnysuit.
- Hang your bunnysuit in alphabetical order of your Coral login.
- Log out of Coral, as you leave the gowning room area.

3.4. Acceptable Materials in the Cleanroom

Described here is a general list of criteria of cleanroom- and non-cleanroom-compatible materials. These guidelines are subordinate to the "Acceptable Materials" policy.

The following materials are generally acceptable to bring into the cleanroom:

- Cleanroom notebooks and cleanroom paper (available in Stores.)

- Wafers and tweezers, in labeled boxes.
- Pens (preferably, ball-point).
- Materials with smooth, hard surfaces, which can be cleaned with alcohol wipes.

The following materials are not considered cleanroom-compatible:

- Wood pulp-based paper products, which includes regular paper, tissues, cardboard, books, and magazines.
- Styrofoam products.
- Any powders.
- Erasers, pencils, felt-tipped pens (other than Sharpie markers).
- Anything that can easily shred or aerosolizes; i.e., anything that may serve as a source of particles.

4. Routine Maintenance

Bunnysuits should be changed on a biweekly or as-needed basis.

Appendix B: Wafer Handling

Manual wafer transfer using tweezers:

1. Obtain tweezers.
 - Make sure they are made of the appropriate material for your process.
 - Make sure they are decontaminated to the appropriate level of cleanliness for your process (see tweezer clean procedures on the SNF website.)
2. Obtain an empty receiver cassette.
 - Receiver cassette is the one which you are going to transfer wafers into.
 - The donor cassette contains the wafers to be transferred.
3. Place the cassettes next to each other, with their H-bars facing the same direction.
 - By convention, the backside of the wafers (the dull, unpatterned side) should face the H-bar.
 - If you are right-handed, it is recommended to orient the cassettes so the H-bar is to the right (the wafers face left, making them easier to see while transferring.)
4. Using your tweezers:
 - From the donor cassette, grab a wafer at its edge. Ensure the tweezer grips do not touch any device areas, but place them far enough in to get a good handle on the wafer. This is typically about 3-4 mm from the edge. If you are using metal (or teflon-coated metal) tweezers, they will usually have convenient metal prongs, or “stops” which help guide placement of the grips.
 - Lift the wafer straight up and out of the cassette. Movement should be smooth and silent; avoid scraping your wafer along the sides of the cassette slot, as this generates particles.
 - Place the wafer into the receiver cassette. Movement should be smooth and scraping should be avoided. Ensure the wafer is not “cross-slotted.” (Improperly slotted wafers cannot be picked up by automated equipment and can lead to breakage.)
 - Where possible, start the transfer of the donor cassette from BACK to FRONT. Where possible, place the wafers into the receiver cassette from FRONT to BACK. Working the donor and receiver cassettes in this way helps avoid scratching the front side of a wafer by the wafer being moved.
 - It is good practice (and helps to minimize contamination) if you place the cassettes in such a way that you can avoid working over the wafers.

"Flip" or "Roll" Transfer" of wafers:

1. Obtain an empty receiver cassette.
 - Make sure it is the appropriate kind and level of cleanliness for your process.
 - Make sure you are wearing clean vinyl gloves.
2. Place the receiver cassette upside down over the donor cassette.
 - The protruding pins should mate with the alignment holes on both sides of the cassettes.
3. Grasp both cassettes in both hands. Make sure you have a firm grip on both cassettes and that they are properly aligned and mated; otherwise, you risk dropping (and thus damaging) all your wafers. Gently tilt both cassettes so that your wafers roll from one cassette to the other.
4. Your wafers have now been transferred.