Laboratory Manual Part I: Policies & Procedures

SNF is proud to be part of nano@Stanford, supported by National Science Foundation through the NNCI initiative.

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1.1 INTRODUCTION

Welcome to the Stanford Nanofabrication Facility! As a shared-equipment, open-use resource, our laboratory serves academic, industrial, and governmental researchers across the country and around the globe. 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, medicine and chemistry, as well as electronics fabrication, processing, and characterization. We are especially committed to supporting use of micro- and nano- fabrication technologies in non-traditional research applications. The SNF is part of the National Science Foundation funded National Nanotechnology Coordination Infrastructure initiative at Stanford.

1.2 Mission

Our goal is to provide researchers with efficient access to Nanofabrication technology, with these objectives:

- To provide shared lab capabilities with advanced equipment, skilled personnel, and effective training.
- To enable high quality research at the undergraduate as well as graduate level.
- To advocate safety and responsibility in research conduct.
- To advance fundamental knowledge using Nanofabrication technology.
- To encourage application of Nanofabrication technology in non-traditional areas.
- To disseminate knowledge to the national research community.

1.3 Brief History

SNF is descended from the Integrated Circuit Laboratory, established in the mid-60's at Stanford. By the mid-70's, the ICL became well-known for device and process model simulators which had led to the development of innovative devices and process test structures.

Although the ICL was conceived for the fabrication of integrated circuits, applications in MEMS and related devices quickly followed. 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.) By 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 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 fostering an "integrated systems" approach to electronics research. In 1985, new building was completed, housing what was arguably at the time the most advanced semiconductor processing facility in a University setting. The CIS Cleanroom served primarily as a teaching laboratory, used almost exclusively by Stanford researchers. In 1994, 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.

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. Today, National Science Foundation's support continues, through nano@Stanford, a member of the National Nanofabrication Coordination Infrastructure initiative (nnci.net).

1.4 Organization

The SNF is overseen by the School of Engineering at Stanford. 19 full-time equivalent staff members support the various functions of the lab:

- Maintenance: equipment installations, maintenance, and repair;
- Process: process engineering, training, monitoring;
- Administration: stockroom, finance, management.

A contact list can be found on the SNF website.

1.5 Programs and Partnerships

SNF is a service organization. Because the lab 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.

nano@Stanford

SNF, in partnership with sister facilities, the Stanford Nano Shared Facilities (SNSF), the Mineral Analysis Facility (MAF) and the Environmental Measurements Facility (EMF), make up the nano@stanford 13 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.

1.6 Lab Overview

Physical Lab

SNF is comprised of several research lab spaces. The main Cleanroom facility is housed in the Paul G. Allen building and encompasses 10,500 square feet of space. The Cleanroom extends over three floors and is vibration-isolated from the rest of the 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 building. Support facilities, such as the stockroom and maintenance work areas, and staff offices, are located near the cleanroom.

In addition to the main Cleanroom, the SNF also include the nSiL, which encompasses about 1500 ft2 of lab space outside of the Cleanroom envelope, within the Paul G. Allen building, and the MOCVD lab, which is 1000 ft2 of lab space located on the third floor of the adjacent Allen Annex building.

Lab and Building Maps

Building and laboratory maps are available on the SNF website.

2. ABOUT LABMEMBERSHIP

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 policies outlined in the Stanford University Administrative Guide. All members of the lab community (lab and staff members) must abide by the SNF Code of Conduct. 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 Administrative Guide regarding intellectual property.

2.3 How You Can Help

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 in the nano@Stanford labs, which

are supported by the National Science Foundation as part of the National Nanotechnology Coordinated Infrastructure under award ECCS-1542152."

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, stockroom or lab supplies, and staff time. There is no charge being in the lab.

Equipment Use Fees and the Cap System

Fees are used to recover operating costs. Outside the cleanroom (the nSiL and MOCVD labs), equipment use is strictly on an hourly basis. In general, inside the cleanroom (and room 159), the cap system prevails.

In the cap system, most tools are charged at the Base Rate, although some may be charged at Reduced or Premium Tool Rates, or are not charged at all. For the listing of tool fees, refer to the SNF website. Equipment Use fee charges begin when a labmember "enables" a specific tool on the lab management system and ends when the tool is "disabled". (For more information about the lab management system, see section 3.2.) Equipment use charges plateau at the monthly "Cap", after which no additional equipment charges are incurred until the "Notched Cap", where a reduced rate is charged. For a more detailed description, see the SNF website.

The Cap system allows researchers to work without having to watch the clock -- and has the added benefit of allowing project managers to accurately budget for lab fees since they become more predictable, which particularly important for funding proposals. Multiple labmembers on the same account are each subject to his/her own caps. One labmember working on more multiple accounts is subject to a cap for each account. In summary: one cap or notched cap per person, per project, per calendar month.

Process Support

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. However, projects that require major technical assistance may be subject to process staff support charges.

Overhead

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 (see the website for the current overhead rate). 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 be a "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.

- 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.

- Independent Contractors/Consultants: Several individuals and organizations offer custom fabrication and other services. Contact and descriptive information of currently available contractors and consultants, all of whom are labmembers in good standing, are listed on the SNF website. Be aware that these are not employees of Stanford or SNF. Neither Stanford nor SNF can warrant their services. SNF lab fees incurred by consultants on behalf of a labmember researcher are billed directly to that researchers' account. Compensation for the consultants' services are negotiated solely between the researcher and the contractor.

3. LAB RESOURCES

3.1 Lab Hours

The lab is available for use 24-hours/day, seven days/week. Lab staff is available generally during working hours only (Monday through Friday, approximately 6 am - 6 pm.) Use of the lab during off-hours and weekends is subject to the "buddy" rule (see section 4.5). The lab routinely shuts down between Christmas Eve and New Year's for general equipment and facilities maintenance. Shutdowns may be extended to accommodate University-wide shutdowns or special projects.

3.2 Lab Management System: Badger

The suite of software tools used as the lab management system at SNF was conceived and largely developed here. Initially introduced as Open Coral, this system is now deployed in over two dozen university labs across the country and is now hosted by MIT, a co-developer of many of the Coral tools. SNF has now converted over to a commercial version of the Coral suite, called “Badger.” Some of the features of the Coral suite are that it:

- insures only people who are trained and qualified on a particular tool have access to it;
- tracks equipment usage by individuals and generates billing accordingly;
- allows labmembers to reserve tools;
- facilitates communications of tool status.

Each labmember is assigned a lab 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. Each labmember is required to have his or her own lab 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 lab 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 Badger and limits on use of SNF computer resources, see this manual.

3.3 Computing Resources

Desktop and computer resources available for labmembers include:

- The ASML Emulator, a workstation used for ASML job writing.
- A SunRay terminals located throughout the lab.
- Two non-networked PC's loaded with Tanner LEdit and other CAD utility programs, available for general use for mask design.
- Additional Tanner LEdit keys, available for checkout on a limited basis.
- The non-networked PC's also include some off-line programming and modeling software for equipment in the lab.

3.4 Storage of Personal Belongings

Workspace Outside the Lab

The SNF shared space is located just inside the southwest entry to the Paul G. Allen Building. Labmembers are free to bring laptops and make themselves comfortable in any of the unassigned areas.

Lockers

Lockers are located in the hallway outside the lab entrance and are for use only by SNF labmembers. No hazardous chemicals or materials may be stored in this area. These are rented on a monthly basis; contact snf-access@stanford.edu for more information.

Storage in the Lab

Assigned, unsecured bins are available in the lab for storage of personal items. These are rented on a monthly basis; contact snf-access@stanford.edu for more information.

Bunny suits

For frequent users of the lab, bunny suits can be temporarily assigned and stored in the gowning room racks. For details about storage and use of bunny suits in the lab, please refer to Appendix A ("Gowning Room Procedures.")

3.5 Stockroom Items

The SNF Stockroom makes available items for purchase for lab use, such as wafers, boxes, cleanroom notebooks, tweezers, etc., may be purchased here. You must be an active SNF labmember to purchase items from the stockroom.

Additional Stockroom courtesy tips:

- Limit your purchases to your immediate needs.
- Notify the Stockroom personnel if supplies of an item are running low.
- Do not take items to stock another lab.

3.6 Lab Phones and Paging

Lab phones

Several phones are located throughout the lab. To dial within Stanford, only the last five digits is required. For local calls off-campus, dial "9" before the seven-digit phone number.

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

Cell phones

Cell reception will vary depending on location in the building and the service provider. Cell phone use in the lab is subject safety restrictions (i.e., do not use while operating equipment; do not use ear buds.)

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 that transmits throughout the lab and the SNF staff office areas. To page someone, lift the receiver, speak clearly into the phone, and then hang the phone up.

3.7 SNF Committees

Safety Team

Safety in the workplace is the utmost priority for SNF. The Safety Team at SNF is committed to maintaining and improving safety in the lab, and to ensure compliance with the policies of local regulatory agencies. To report a safety concern, notify a Staff member or send an email to: snf-safety@lists.stanford.edu

Process and Materials Committee (Prom Comm)

The Process and Materials Committee (snf-promcomm@lists.stanford.edu) was formed to help labmembers successfully try out new chemicals, materials and processes within the bounds of our shared facility. The primary consideration of the PromComm is safety. Next, is potential contamination which may affect the research of others. Lastly, the PromComm is a clearinghouse and archive of non-standard processing in the lab.

The PromComm approves requests and sets policy for the use of new or existing materials. The committee considers such issues as storage, handling, and potential contamination issues with respect to the lab and equipment. Over the years, the committee has accumulated a 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 any questions about a process or process sequence in the lab, please feel free to consult with

PromComm members. If you would like to submit a PromComm request, visit the SNF wiki, under the Processes tab to see the PromComm form.

Faculty Advisory Committee

The Faculty AdCom meets on a semiannual basis with the SNF and Faculty Directors to decide on the broader technology needs and strategic direction of the lab.

4. IN THE LAB

4.1 Communications in the Lab

Effective and conscientious communication is essential in the SNF community.

- **Individuals.** Specific process or equipment questions can be addressed to the process or maintenance staff person responsible for the equipment. The staff directory is available on the website. Any labmember can be contacted using his/her individual lab login/email address.
- **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 *tool*@snf.stanford.edu where *tool* is the name of the equipment of interest.
- **Labmember community**. 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. Email lists are managed on the SNF mailman at http://snf.stanford.edu/mailman/listinfo where you can subscribe or unsubscribe at will.

4.2 Gowning and Good Cleanroom Practices

In the Cleanroom, 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

Enabling and disabling Tools

Each piece of equipment in the lab is interlocked to the lab management system. In order to use it, the specific tool must be "enabled". 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.

- While a piece of equipment is being used, it must be "enabled".
- When the labmember is no longer using a tool, it must be "disabled."
- The user must flag and report any problems, or shut a tool down if it is not usable.

Training and qualification

To begin training on equipment, you must complete this safety class and have a lab account. Training is equipment-specific, and may be arranged by contacting the SNF staff listed on the website. Regularly scheduled training sessions are posted on the Training Calendar (link on the SNF home page.) 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 Wiki.

Understand that due to equipment and staff availability, some training sessions may take some time to arrange, so plan in advance. If you need to cancel, 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, allowing you to use this equipment.

Equipment Reservations

Labmembers can reserve equipment, subject to some restrictions:

- You must be qualified on a tool to reserve.
- The default is up to one week in advance.
- Certain high-demand tools have additional limits. To check reservation rules, click on the Policy tab on Badger.

Here are guidelines for equipment reservation etiquette:

- Reserve just the amount of time you realistically need (don't over-reserve).
- Remove any reservation that you will not be able to use. On high-demand tools, notify others of a reservation cancellation using the *tool*@snf.stanford.edu" mailing list alias.
- Do not reserve time for others.
- There is a grace period of 15 minutes, after which someone who does not show up loses his/her reservation.
- In research, problems happen. Someone may need more tool time; someone else may be late in getting to theirreservation. Make every attempt to communicate your needs and respect those of others; work out differences in a professional, courteous manner.

Equipment Status and Problems

All lab and staff members must report process and equipment problems so that everyone can check the status of any equipment. Each tool can have one of the following equipment states:

Up: When a piece of equipment is fully operational, its icon is a green up arrow.

Problem: When a problem is reported, the tool icon is a yellow question mark. This means the equipment is operational, but must be used with caution. 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, report it. The yellow icon informs others there is a problem. Only Staff has privileges to clear a yellow alert.

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

Unless your training covers it, you should not attempt to repair equipment. Your help, however, in observing and noting the symptoms of any equipment problems is 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 non-standard process chemicals and materials used in the lab must be approved by the PromComm (section 3.7) before use. 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. This is equivalent to "Front end" or pre-metal layers in semiconductor processing.
- **Semi-Clean:** Wafers containing standard metals (Aluminum, Tungsten, Titanium) are acceptable for processing in the equipment listed here. This is equivalent to "Back end" or post-metal layers in semiconductor processing.
- **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" -> "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 SNF Wiki for each tool. 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

CalOSHA requires that all chemicals in the building must be documented. In addition, SNF requires that all process chemicals and materials used in the lab must be approved by the PromComm before use (see

the Wiki 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 PromComm committee approval. Once approved, personal-use chemicals and non-standard chemical containers must be appropriately labeled and registered on the lab chemicals list. As this is an ever-changing research environment, there are 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 PromComm who will help with your questions.

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 condensors) 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

Respectful Workplace

The Stanford Nanofabrication Facility is committed to providing an environment that is conducive to high-quality research, learning and productivity. Effective interpersonal communication is essential in this environment. As such, all members of the community (students, industrial visitors, staff and faculty) are expected to act in a manner based on courtesy, civility, mutual trust and respectful communication. All members of the community should treat one-another with an awareness of the potential impact of their interactions, and strive to conduct themselves at the most respectful and professional level.

Code of Conduct

All members of the lab community are expected to read and abide by the Code of Conduct which appears as Appendix C in this document. The Code of Conduct goes beyond Respectful Workplace by listing the specific responsibilities of individuals in the lab in the context of our shared facility.

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 wishing to host visitors should fill out a Visitor Form. These forms, along with emergency medical forms, are available near the gowning room entrance. Visitor forms serve as an acknowledgment of responsibilities and are signed by the visitor, the labmember host, and approved by a staff member. 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 Badger

- Logon before entering the lab; log out when leaving the lab. In case of an emergency, this reports who is in the lab. Before leaving, you should check you have disabled all the equipment you are no longer using or you may be charged for this teim.
- Do not enable/disable equipment remotely on Badger, unless you are absolutely sure of the state of the equipment. Enabling or disabling when the tool is not in a safe state may damage the system.
- Follow guidelines for enabling/disabling equipment and making reservations. If everyone uses Badger 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.

Video Monitoring

Video cameras are installed throughout the lab and in the receiving/stockroom areas of the building. These cameras serve multiple purposes: they enhance safety, they provide security for protected areas of the building, and they are used for remote training purposes. Video may be recorded, but will not be viewed or accessible by the public. Details on video monitoring policy at SNF can be found at http://snf.stanford.edu/labmembers/cameras.html

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, sweaters).
- No cosmetics.
- 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).
- Step on the sticky mat to clean shoe bottoms.
- Don blue shoe covers.
- Logon.
- Put on a paper "bouffant" cap. Make sure all your hair is covered (check in the mirror).
- For facial hair, put on beard cover.

On entering the gowning room

- Put on cleanroom gloves. Avoid touching the outside of the gloves with your bare hands.
- Obtain a bunnysuit. Personal suits can be labeled and hung on racks.
- 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.
- 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.
- Where possible, label your materials with your name and Badger 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 cleanroom gloves. Vinyl gloves minimize cross-contamination while using wafer handling tools (i.e., tweezers and cassettes), but should not be used to touch wafers. Fresh vinyl gloves are available throughout the lab. Change vinyl gloves frequently:

1. whenever getting ready to handle, transfer, or inspect wafers;
2. whenever any contamination is suspected.

3.2. Rules and Guidelines for Personal Lab Behavior

- Drinking, eating, gum-chewing are not allowed in the lab; the exception is the drinking station in the service area.
- 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.

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 should be bagged to prevent contamination. A vacuum sealer and sealer bags are available inside of the lab. Zip-loc bags are available throughout the lab and 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 its proper place.
- Log out, as you leave the gowning room area.
- Remove the paper bouffant cap, gloves, and blue shoe covers; place them in the trash bin.

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 weekly 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 tweezers 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.

Wafers should not be touched with gloved hands, even clean vinyl gloves (which have plasticizer residue). Good, careful handling practices will help ensure wafers are undamaged and minimize the possibility of contamination which could adversely affect device processing and performance.

APPENDIX C: CODE OF CONDUCT

SNF Rules of Conduct are based the principles of Safety, Community, Respect, and Integrity. EVERYONE in the lab community, lab and staff members, and visitors alike, is expected to abide by these principles.

Safety: Safety is of the utmost priority. Community members must behave in a safe, conscientious, and professional manner in all lab activities. Each individual is responsible for his/her own safety—AND the safety of his/her fellow labmembers.

We recognize the need to test and develop new ideas and capabilities; your responsibility is to work with staff and other knowledgeable people to ensure that any new procedure/chemical/equipment is introduced in a safe manner. It is also your responsibility to address any safety concerns you may have with fellow lab and even staff members. The best response is to address the issue directly with the person concerned. If this is not practical, you should report the concern to the staff person responsible for the station in question or senior management, as appropriate. To report any potentially unsafe conditions or practices, or to offer suggestions for improving safety, you can contact any staff member or direct an email to snf-safety@lists.stanford.edu

Community: In a shared lab, everything each individual does can and will affect others, thus, it is everyone's responsibility to minimize the impact of activities that can adversely affect others and contribute positively toward the good of the community. Remember, this is YOUR lab.

- **Contamination.** Labmembers are responsible for ensuring their work does not result in the contamination of equipment or labware which can harm the work of others. All new materials and processes must be approved through the PromComm (snf-promcommittee@lists.stanford.edu).
- **Communication.** Effective communication is essential to success in the lab. Report equipment and process issues on Badger Use email lists to inform or negotiate with others. When differences arise, make every attempt to communicate your needs and respect those of others.
- **Sharing.** Because equipment and workspaces are shared, everyone is responsible for being a good lab citizen. Clean up after yourself. Respect Badger reservations. Log run data in station logbooks. Consideration for equipment and all others who share it is everyone's responsibility.

Respect: All members of the SNF Lab community are expected to abide by the Statement of Respectful Workplace:

"The Stanford Nanofabrication Facility is committed to providing an environment that is conducive to high-quality research, learning and productivity. Effective interpersonal communication is essential in this environment. As such, all members of the community (students, industrial visitors, staff and faculty) are expected to act in a manner based on courtesy, civility, mutual trust and respectful communication. All members of the community should treat one-another with an awareness of the potential impact of their interactions, and strive to conduct themselves at the most respectful and professional level."

Integrity:

- Take responsibility. Everyone makes mistakes. But it is expected that each person take responsibility for his or her actions so that measures can be taken to minimize the problem or prevent it from recurring. For example, a labmember who accidentally contaminates an acid bath should inform other labmembers who may be affected as well as the staff member responsible for the station, and if trained, should also decontaminate it.
- This is YOUR lab; take care of it. Clean up after yourself; leave no trace except for Badger. If the station is messy before you start, depending on the situation you can: ask the person before you to clean it up, clean it up yourself, or report it to Staff. Do not do nothing!
- This is YOUR lab; contribute! Enhance the process knowledge base of the lab by contributing your measurements, observations, and comments to the tool's Wiki page. By taking the time to document your results, you will be helping your own run, as well as those of other labmembers.
- Enable equipment when you are using it; disable when you are done. Make sure to report any problems or observations and to shutdown when potential damage to the machine or other labmembers' experiments is suspected. Observe good lab manners when making and using reservations. Remember, your accounts are subject to the Stanford University Computer Usage and Network Usage Policy. Make sure to read and abide by this policy (http://adminguide.stanford.edu/62.pdf).

- Act according to the intent of a policy. Just because there is no rule against a practice does not make it acceptable. Making reservations you do not intend to use, for example, is not acceptable. Rules are imperfect; but acting with consideration for others is always respected.

Corrective or Disciplinary Measures:

Any member of the community, lab or staff, who violates of any of the above principles is subject to corrective or disciplinary measures. Staff violations are addressed through the University's internal Corrective Action and Discipline policies. Labmember violations will be reviewed by senior staff on a case-by-case and may involve PI's; corrective or disciplinary actions will be administered as appropriate for the specific offense. Circumstances such as the experience level or demonstrated repeated behaviors may be taken into account. Disciplinary actions can take the following forms:

- Community service. A commitment of time or completion of a task that benefits the lab community.
- Disqualification on one or more tools.
- Notification of the PI.
- Restriction or limits placed on lab use (for example, daytime use only).
- Revoking of lab access and privileges.

As a teaching organization, SNF understands that the vast majority of violations are simply mistakes, best addressed through retraining or mentoring as appropriate; the rare, intentional violations are addressed on the strictest terms. We believe the greatest resource in our lab is the lab community and strive to foster a culture that places high value on mutual respect and personal and scientific integrity.