

Cleanroom Protocols

W. M. Keck Microfabrication Facility

On-Line Training Module

Cleanroom Standards

- **Why is low-particle count important?** Particles are on the same order of size as critical features of devices that are fabricated and characterized in the cleanroom.
- Table of Cleanroom Class versus Particle Concentrations

Class	Particles/ft ³					ISO Classification
	0.1 μm	0.2 μm	0.3 μm	0.5 μm	1 μm	
1	35	7	3	1		3
10	350	75	30	10	2	4
100	3500	750	300	100	22	5
1,000				1,000	218	6
10,000				10,000	2,180	7
100,000				100,000		8

- **W. M. Keck Facility cleanroom:** Class 10 (Thin film and etch) and Class 100 (Photolithography)

Protocols to Maintain Cleanroom Status

To maintain low particulate level, we follow these protocols:

- Step on tacky mats repeatedly when entering the gowning room and the air shower.
- Gowning – required for every entry
 - Jumpsuit – Can be reused 3 times unless contaminated; Mark name and number of uses with a permanent marker.
 - Use one time only – gloves, hair cover, shoe cover, beard cover (required for facial hair).
 - Shoe covers have conductive strips to reduce electric shock. Static electricity build-up is high in the cleanroom due to dry, blowing air.



Protocols to Maintain Cleanroom Status

- Limiting dust/particle generation
 - Limit movement.
 - Wipe down surfaces of all items with cleanroom wipes and isopropanol before entering.
 - Do NOT unzip your jumpsuit in the cleanroom.
 - Use the pass-through window to introduce wiped down items into the cleanroom. This window has interlocking doors (see image).



Prohibited Items

- Cloth/fabric (exposed)
- Cell phones (exposed, unless wiped down with IPA)
- Cardboard
- Paper
- Sandpaper
- Food
- Powders
- *Any other dust- or particle-generating materials and objects*



Site-Specific Safety

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Cleanroom and Tool-Related Hazards

- **Cleanroom:**
 - Environment leads to dry air and static discharge.
- **Specific tools:** Receive training and become aware of hazards before using any of the following tools
 - Mask aligner and thermal evaporator - **Moving parts** (pneumatic systems)
 - Cleanroom and vacuum ovens, hotplates, plasma cleaner - **High temperature**
 - Plasma cleaner – **Plasma**; may be supplied with O_2 or CF_4 ; possible explosion hazard if not used correctly



Chemical Hazards

- **Reactive and toxic gases:** To be used after training that covers the standard operating procedure for the specific gas and tool
 - Reactive and toxic gases are currently not present in the Facility (as of 8/12/16)
 - Facility has capability to handle many reactive or toxic gases
 - Users will be notified if new gases are supplied to the cleanroom tools
- **Facility-provided solvents:** Use in a fume hood
 - Organic: Acetone

Know and Read Chemical Hazard Symbols



E

Explosive



O

Oxidizing



F
F+

Highly Flammable
or Extremely
Flammable



T
T+

Toxic or
Very Toxic



Xn
Xi

Harmful or
Irritant



C

Corrosive



B

Biohazard



N

Dangerous for the
Environment



R

Radioactive

Chemical Hazards

- **User-provided chemicals:** Use according to MSDS, do NOT use chemicals brought in by another user without permission
 - **These examples should be used in a fume hood only**
 - Strong acids and bases: H_2SO_4 , HNO_3 , HCl , NH_4OH , Chrome etchant, AZ photoresist developer, Metal free aqueous developers for SPR resist
 - Organic: SU-8, AZ, SPR photoresists; SU-8 developer; propylene glycol monomethyl ether acetate (PGMEA)
 - **These examples require special permission**
 - **Piranha**
 - Boiling base bath
 - HF (hydrofluoric acid)

The traditional **piranha** solution is a 3:1 mixture of sulfuric acid and 30% hydrogen peroxide. The solution may be mixed before application or directly applied to the material, applying the sulfuric acid first, followed by the peroxide. **Piranha solutions are extremely energetic and may result in explosion or skin burns if not handled with extreme caution.**

Management of Hazardous Waste

- Sort waste into the following waste categories:
 - Organic
 - Aqueous
 - Acidic
 - Basic
 - Piranha – DANGER! Piranha reacts explosively with organic materials; Allow waste to cool prior to storage; Store waste in a poly-coated glass bottle with vented cap.
 - Solid – This includes photoresist contaminated gloves and Aluminum foil
 - Metal sharps
 - Glass waste
 - Plastic sharps

Location and Use of Safety Equipment

- **Emergency phone**
 - Provide to colleagues
 - Cleanroom: 515-294-6573
 - Keck (outer) Office: 515-294-4764
 - **Campus Police: 911 (dial directly with no prefix)**
- During on-site training, identify location of each of the following:
 - Spill kit
 - First aid kit
 - Safety shower
 - Eye wash station
 - Fire extinguisher



Illustration of clean-up with spill kit

Location and Use of Safety Equipment

- Fume hoods
 - Located in photolithography and thin film rooms
 - In photolithography room – keep fume-generating chemicals near work surface (low position)
 - In thin film room – keep fume-generating chemicals away to right of **blue tape**
- Personal protective equipment including gloves and goggles to be worn at all times



Working Alone

- The cleanroom entrance locks after each user enters.
- Do not attempt *new* potentially hazardous protocols after hours.
- If working alone, let someone know when you plan to enter and leave the facility. Ask that person to check on you if you don't return when planned.
- **Working in the cleanroom after 10 p.m. or before 6 a.m. is not permitted.**

Working Alone

- In the event of an injury, hazard exposure, or a fire, call for help on the **emergency phone**, located in the photolithography room, or the office phone, whichever location is safest. If neither phone is clear of the hazard, take an **emergency exit** and find help or a phone outside of the Facility.
- An **emergency access code (1234#)** is posted next to the gowning entry door. This code can be entered on the keypad for immediate entry. **If the code is used, an incident report must be filed.**

Keck Facility Policies

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Gaining Access

- **Account Sign-Up**

- Users must register online at <http://www.microfab.chem.iastate.edu/gaining-access/account>
- Users new to Chemical Services must obtain approval from their Major Professor/PI. The account sign-up form will be routed electronically to the PI for approval.

- **Training**

- Prior to accessing the Facility all users must complete this Online Training Module and an On-Site General Training Session (e-mail kecklab@iastate.edu to schedule).
- **Prior to booking and using a Tool, a user must be trained to use that Tool by Keck staff.**

- **Card Activation**

- Upon completion of Online and On-Site General Training, a user's ID card can be activated to allow access to the cleanroom.
- The user must show the ID card to Facility Staff for it to be registered.

Using the Facility

- **Tool Reservation**

- Prior to use, Tools must be reserved through the Booked portal, which can be accessed through the Keck Facility website.
- Booked requires a user account, which will be created by Facility Staff after Online and On-Site General Training is complete. **Do not create your own Booked account.**

- **Log-in Procedure**

- Prior to entering the gowning room, each user must log in on the computer at the entry. Logging in opens a Ticket and starts to count usage time for billing purposes.
- Users must log out upon exiting the Facility to close the Ticket and stop billing.

- **Billing**

- Users will be billed through Chemical Services on a monthly basis.
- Current rates are available on the Keck Facility website:
<http://www.microfab.chem.iastate.edu/billing>

Behaviors that warrant a **ban** from Facility use

- Using a Tool prior to training
- Allowing unpaid access to other users ('carding' them in)
- Any behavior that is unsafe or jeopardizes cleanroom integrity
- Working in the cleanroom after 10 p.m. or before 6 a.m. without special permission from Keck Staff

Please proceed to the online quiz at:

<http://www.microfab.chem.iastate.edu/gaining-access/training>