Safety and behaviour in the cleanroom
Safety and behaviour in the cleanroom

- What is a cleanroom?
- CMi cleanroom concept
- CMi User Manual
- Working in CMi cleanroom
- Safety at CMi
- Visit of the cleanroom
What Is a cleanroom?
What Is a Cleanroom?

- Continuous air supply through filters. Laminar flow top to bottom.
- Tight control of working conditions (temp, humidity, UV-light)

**FRESH AIR**
- 60,000 m³/h
- Filter efficiency: 99.97% for particles size: 0.1-0.3 µm

**EXHAUST**
- 36,000 m³/h

**FFU**
- 0.7 m² active area
- Filter efficiency: 99.999% for particles size 0.1-0.3 µm
What is a cleanroom?

- Continuous air supply through filters. Laminar flow top to bottom.
- Tight control of working conditions (temp, humidity, UV-light)
What is a cleanroom?

- Continuous air supply through filters. Laminar flow top to bottom.
- Tight control of working conditions (temp, humidity, UV-light)
What Is a cleanroom?

- Tight control of media:
  - **Water** (minerals, particles, dissolved ions)
  - **Chemicals** (purity, mobile ions)
  - **Gas** (purity, water vapor content, particulates)
What Is a cleanroom?

Concentration max allowed of particles (particles/m³ of air)
Particles sizes equal or superior to that given below

<table>
<thead>
<tr>
<th>Class ISO</th>
<th>0.1 µm</th>
<th>0.2 µm</th>
<th>0.3 µm</th>
<th>0.5 µm</th>
<th>1 µm</th>
<th>5 µm</th>
<th>Class US FS209</th>
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<td>4</td>
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<td>0</td>
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<tr>
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<td>1</td>
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<tr>
<td>ISO 5</td>
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<td>29</td>
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<td>35200000</td>
<td>8320000</td>
<td>293000</td>
<td></td>
</tr>
</tbody>
</table>

Standard ISO 14644-1

(0.5µm particles/ft³ of air)

CMi BM -1
CMi BM +1
What is a cleanroom?

Cleanroom environment requires special cloth, compatible tools, lint free paper.

- Body may contaminate by:
  - Flakes of dead skin
  - Hair
  - Touch by hand
  - Breathing

- Wrong cloth may release:
  - Fibers
  - Dust

- Wrong tools may create:
  - Particles
  - Dust
CMI cleanroom concept
CMI cleanroom concept

CMi BM -1

- 100 mm wafers
- ISO 5
- MEMS cleanroom processes

CMi BM +1

- non conventional processes
- easier access
- ISO 6 and 7
- wafers, chips and piece parts

Ebeam
- Lithography
- Photolithography
- Etching
- Thins films
- Metrology

Grinding
- Thermal imprint
- Inkjet printer
- PDMS line
- Photolithography on chips
- Customized chemistry
- Metrology

Easier access
- Non conventional processes
- Wafers, chips and piece parts

ISO 5
- MEMS cleanroom processes

ISO 6 and 7
- CMi cleanroom concept
CMI cleanroom concept

BM +1

Zone 15
Metrology

Zone 14
Wet processing

Zone 13
Photolithography

Zone 12
PDMS

Zone 11
Dry processing

Zone 16
Metrology

BM 0

Zone 9
Dicing

BM -1

Zone 8
FIB

Zone 10
Parylene

Zone 7
EBL

Zone 6
Photolithography

Zone 5
Back-end

Zone 4
Thin films

Zone 3
Thin films

Zone 2
Etching

Zone 1
Photolithography

-1

Entrance

Changing room

Clean room

ISO 5 / Class 100

Clean room

ISO 6 / Class 1’000

Clean room

ISO 7 / Class 10’000

Technical area

ISO 7 / Class 10’000

370 m²

280 m²

150 m²

509 m²
CMI cleanroom concept

Philippe Flückiger
Director of operations

Secretariat Logistic

Marie-Noëlle Verhar

Céline Comaz Brébant

Administration

Philippe Langlet
Section head

Cyrille Hibert
Section head

Jean-Marie Voirol
Section head

Process

Facilities and Equipment
CMI cleanroom concept
1. **Safety and behaviour in the cleanroom (now)**
   - Formal presentation of CMi facilities and CMi rules
   - Cleanroom visit
   - Email from CMi secretary (process flow template)

2. **Project approval by CMi management (~1 week)**
   - You send a process flow or a draft to infocmi@epfl.ch
   - Process flow review by a technical committee
   - Email from CMi secretary (username, password)

3. **Start working in the cleanroom (few weeks)**
   - Trainings
   - Rights to book equipment
   - Work on your own according to process flow (reservation, login, processing, logout…)
# CMI user manual: process flow

## Process flow work
1. Process flow template
2. User’s modification
3. Process flow sent to CMI
4. Technical committee if necessary
5. Process flow correction
6. Process flow final review by CMI
7. Process flow accepted

<table>
<thead>
<tr>
<th>Step</th>
<th>Process Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>07</td>
<td>Photolith expo + develop &lt;br&gt; Machine: direct laser W + ACS200 &lt;br&gt; Mask: CD = 20 μm &lt;br&gt; Align tol: 1.5 μm</td>
</tr>
<tr>
<td>08/09</td>
<td>Metal Evaporation + lift-off &lt;br&gt; Machine: LAB600H &lt;br&gt; Metal: Ti / Au &lt;br&gt; Thickness: 10 / 60 (nm) + Solvent - sonication</td>
</tr>
<tr>
<td>10</td>
<td>Photolith PR coat &lt;br&gt; Machine: ACS200 &lt;br&gt; PR: AZ1352 – 2.0 μm</td>
</tr>
<tr>
<td>11</td>
<td>Photolith expo + develop &lt;br&gt; Machine: MA or Direct laser + ACS200 &lt;br&gt; Mask: CD = 20μm &lt;br&gt; Double side align</td>
</tr>
<tr>
<td>12</td>
<td>Dry Etch – Back Side &lt;br&gt; Material: SiO2 &lt;br&gt; Machine: SP35S &lt;br&gt; Depth: 0.5 μm</td>
</tr>
<tr>
<td>13</td>
<td>Resist Strip &lt;br&gt; Material: AZ1352 – 1.1μm &lt;br&gt; Machine: Tepla + Remover</td>
</tr>
<tr>
<td>14</td>
<td>KOH Etch – Back Side &lt;br&gt; Material: Si &lt;br&gt; Machine: KOH Wetbench &lt;br&gt; Depth: 323 μm</td>
</tr>
</tbody>
</table>
Training on equipment
- Usually one person at a time
- On your wafers in process (no dummies)
- On the agreed technology
- Limited to the necessary equipment agreed
- Justified only for long term projects
- Planned according to staff availability
- Use training request program

Users feedback to CMi staff
- Modify or adjust technology when problem occurs
- CMi memory
- Improve CMi offer
CMI user manual

CMi web site
https://cmi.epfl.ch/

+ fees
+ training request
+ mailing

Equipment user manual
Equipment reservation
Material ordering...
CMI user manual: working hours & staff support

- In CMI BM-1, Zone 9 (dicing) and zone 10 (parylene)
  - Open from Monday to Friday from 7am to 7pm
  - Staff support until 5pm
  - Work prohibited after 7pm

- In Zone 7 (ebeam lithography) and zone 8 (FIB)
  - Open 24h/7days
  - Staff support from Monday to Friday 7am to 5pm

- In CMI BM+1
  - Same rules as BM-1
  - 24/7 on request

CMI BM+1 device for night access (7pm to 7am) and WE
CMI user manual: fees

Academics
(Practical training, Semester & Master students, PhD students and Researchers)

- Tools are charged per usage time,
- Hourly rate depends on tools (see table),
- Materials and consumables are charged.
- Manual tools:
  resists, metals and PDMS charged separately.

Companies

- Basic fees (max 500.-/month),
- Hourly fees (see table).

> All rates (machines, reservation fees, consumables) are available on your CMI user account.

<table>
<thead>
<tr>
<th>Categories</th>
<th>EPFL</th>
<th>Ext. Academics</th>
<th>Companies</th>
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<td>Mask Aligner</td>
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<td>Hot Plate</td>
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<tr>
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<td>PDMS Line</td>
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<tr>
<td>Packaging</td>
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<td>25.00</td>
<td>31.00</td>
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<tr>
<td>Other tools</td>
<td>84.00</td>
<td>101.00</td>
<td>118.00</td>
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</table>
Problem on a processing equipment

General rules:

- **After each process step the user checks** that he got the desired result for their samples. Before starting a new process step, the user takes all possible safeguards (e.g. checking results of previous step, consulting SPC results if available, testing the equipment with a test sample, etc.).
- Despite the current precautions in place (preventive maintenance, SPC, calibrations and alignments, daily checks, trainings), the machine fabrication capability can be degraded by an inappropriate usage from previous users.
- **Any user who detects a problem must immediately report it to the staff** so that the equipment can rapidly be checked by the person in charge.
- **Any complaint** about an invoice, concerning or not defective process or equipment, **must be addressed to CMi within 24h** (one business day).
- **CMi** may refund the cost concerning a process step, but **will not refund the cost of all proceeding process steps**, nor the cost of lost samples.
- **Users are asked to regularly check their current month’s invoice**, and to address to CMi any request for corrections before the billing at the end of the month.
- Once the final invoice is issued, no request for refund can be treated and no modifications are possible.

What to do in case of problem on a processing equipment:

1. The user immediately **reports to CMi staff** so the concerned equipment can be checked and preventively put to maintenance state.
2. The user **sends an email** to the staff member in charge the same day with:
   a. User login
   b. Machine
   c. Date
   d. Time
   e. Related process flow document mentioning the concerned process step
   f. If possible, a picture of the sample
   g. The requested adjustment of the invoice
3. The user **transmits the sample** to the staff in charge for inspection.
4. If applicable, the user **checks the ongoing invoice** that agreed refund is effective, before the billing at the end of the month.
Cleanroom general rules

- Material should be stored in labelled basket
- All wafers should be in boxes with:
  - Labelled owner and date
  - Ideally with process flow in snap-on clear envelopes

- Lost and found shelf

- Wafers/samples must be handled with vacuum or mechanical tweezers
Entering CMI cleanroom
Cleanroom suits management: please enter and exit the cleanroom at the same dressing place!
Dressing in CMi BM -1 and CMi BM +1
Material introduction into cleanroom

- All the material introduced in CMi cleanroom:
  - Must be announced to infocmi@epfl.ch for the first time
  - Must be decontaminated:
    - in dedicated material room for BM -1
    - in dressing room for BM +1 and FIB room

- Outside the cleanroom: decontamination

1. Put on gloves.
2. Wipe with IPA.
3. Place inside the cabinet, on appropriate shelf.
4. Get dressed to access the cleanroom.
5. Collection from inside the cleanroom.

Operate the other way around to get the material out.
Material introduction into cleanroom
Delivery places and chemical storage
Mobile phone policy

No phones in processing area!
You may:
- Use an earpiece headset, (only 1 allowed, no listening to music in cleanroom!)
- Or go in the dressing room (best solution),
- Or go to grey area (acceptable solution).

Remark: staff may use mobile phones in the processing area for repairing/diagnosing tools.
Not a privilege but an exception!
Safety at CMi
Safety rules: general

- CAMIPRO required for each person entering or leaving the cleanroom
- Never work alone: a buddy is required in the cleanroom at all times
- Only one emergency phone number:

115

- Report any safety problems you encounter
- Wear protective glasses or medical glasses all the time
Safety rules: alarms & Evacuation in CMi BM -1

- Double tone horn
- Flashing red light
- Evacuate immediately with cleanroom clothing

Meeting point: BM 1.124 (CMi secretariat office)
wait there to be accounted for

Remark: red alarm can be activated by the push-buttons
Safety rules: chemicals and trash

NO CHEMICALS in personal lockers or in personal storing baskets!!!

Dedicated bins for Silicon wafers and other glass parts
NEVER trash sharp objects in regular bin with plastic bag
Safety rules: chemistry

- INFORM yourself (MSDS).
- Do NOT crowd fume hoods/wet benches!
- Only ONE user at a time for “strong” chemistry (concentrated acids/bases).
- Do NOT stress operator for quick finish.
- Finish clean and safe (workplace, bottles, wares…)

**Extra dressing**
- nitrile gloves
- safety apron
- face shield
- long gloves
SOP - Standard Operation Procedure

EPFL Center of MicroNanoTechnology

Product: Trimethylchlorosilane (TMCS)

User name: Jeffrey Pernollet
Creation Date: February 16, 2011
Review Date: Not yet done

IMPORTANT NOTE
This document is a standard operation procedure; it is not a substitute of the Material Safety Data Sheet (MSDS). Therefore, it is strongly advised to refer with great attention to the MSDS of the product before going further.

Filled by the user
Filled by the CMI staff

1. Standard Operation Procedure

1.1. Procedure name and description

SOP name: TMCS anti-sticking

This product is mainly used in PDMS casting processes as a surface conditioning treatment to prevent sticking between piece parts which come to contact for molding purposes but which need, in the end, to be easily separated from each other. Proceed on the dedicated wet bench as point out below.

- Put on single use additional gloves.
- Fetch the TMCS bottle in the "solvent" cabinet located on the right side of the wet bench.
- Place 2 or 3 drops of TMCS in the small glass receptacle located in the glass desiccator (single use pipettes are available for that purpose).
- Place the silicon/SUB mold in this very same desiccator.
- Close the desiccator and place it under vacuum (this causes the TMCS to evaporate and to form a passivation layer on the mold surface).
- Close the TMCS bottle and put it back in the "solvent" cabinet. Fill-In the "chemicals follow-up" document.
- When desired time is reached, vent the desiccator once. DO NOT open it yet. Put it back under vacuum for a while so all TMCS vapors are suck away.
- Vent it and open it. DO NOT breath directly above the open desiccator.
- Take your mold back and close the desiccator.

1.2. Working hours restrictions

Allowed under "strict buddy rule". A buddy may be any authorized user of the clean-room in visual contact with the authorized user. Strictly apply personal protective behavior of point 2.4.

EPFL Center of MicroNanoTechnology

1.3. Storage Location

TMCS bottle is located in Z12, in the "solvent" cabinet on the right side of the PDMS wet-bench.

Carefully close any open container and store it vertically to prevent any flow in case of leakage. DO NOT mix with water.

1.4. Recycling procedure

Dedicated recycling container is located in zone 12, by the TMCS desiccator on the wet bench.

2. Safety

2.1. Material Safety Data Sheet: see concerned document

2.2. Hazards associated to the chemical (choose according to MSDS)

2.3. Risk and Safety phrases

R11 Easily flammable
R14 Reacts violently to water contact
R35 Provokes serious burns

2.4. Protective behavior and equipment needed

Respiratory protection
Always wear the clean-room facial mask. Do not breathe vapors, gases. Ensure correct ventilation, manipulate under a venting hood.

Hands protection
In addition to the standard clean-room gloves, always manipulate using extra single-use gloves.

Eyes protection
Always wear the clean-room safety glasses.

CMI / Standard Operation Procedure (SOP)
Safety rules: chemistry

Specific CAMIPRO access for:

- **HF** Hydrofluoric Acid
- **HNO₃** Nitric Acid
- **TMAH** Tetramethylammonium Hydroxide
- Mixtures

Chemicals use authorization - CMi

This paper must be signed by all cleanroom users working in zone 14 (BM 1.116) with one or more chemicals (included mixtures) mentioned below:

*Please check the appropriate box.*

- **ACID** - Hydrofluoric acid (HF)
  CAS number: **7664-39-3**

- **ACID** - Nitric acid (HNO₃)
  CAS Number: **7697-37-2**

- **BASE** - Tetramethylammonium hydroxide (TMAH)
  CAS Number: **75-59-2**

The signing person hereby confirms to have read the MSDS of these chemicals (available here [https://cmiaccess.epfl.ch/restricted](https://cmiaccess.epfl.ch/restricted)) and understood risks. The user also commits to respect CMi Safety rules and never provide these chemicals to someone else.

When requested, CMi commits to give access to the above-mentioned chemicals stored under lock.

Date

Name user (in block letters please)

Lab / Company

Signature user

Signature CMi staff - Etching Dept
Thank you for your attention.

Now is the moment to ask questions, to share observations and to make comments.